



See the possibilities

User's Manual

TM-9730CL **TMC-9730CL**

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

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Warranty

Please contact your factory representative for details about the warranty.

Certifications

CE Compliance

The TM-9730CL series of cameras has been certified to conform to the requirements of Council Directive 89/336/EC for electromagnetic compatibility and to comply with the following European Standards:

EMCEN55022: 1998 + A1: 2000 CLASS A

EN55024: 1998 + A1: 2001

All JAI Inc. products bearing the CE mark have been declared to be in conformance with the applicable EEC Council Directives. However, certain factory-installed options or customer-requested modifications may compromise electromagnetic compatibility and affect CE compliance. Please note that the use of interconnect cables that are not properly grounded and shielded may affect CE compliance.

Contact the 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-9730 Series Operation Manual

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1. TM-9730CL Series Progressive Scan Shutter Cameras Hardware

1 Introduction

1.1 Product Description

The JAI Inc. TM-9730CL series consists of standard-resolution, standard-speed progressive scan CCD cameras.¹ The progressive interline-type CCD permits full vertical and horizontal resolution of very high speed shutter images and applications. The electronic shutter has speeds to 1/31,500 sec.

The TM-9730CL model has a Camera Link output and its key functions are externally controlled by means of the differential serial communication of Camera Link.

Applications for the TM-9730CL include machine vision, intelligent transportation systems, on-line inspection, gauging, character reading, and high-security surveillance.

1.2 Features

- Miniature size and light weight

The printed circuit boards in the TM-9730CL have been arranged based on a design philosophy that creates modular electronics for the camera, giving it flexibility. In addition, the use of miniature solid-state components results in a camera that is 44.5mm x 44.5mm x 77.0/88.7mm in dimension, (depending on configuration) and weighs from 171 to 198 grams. See “Specifications” on page 22

- Imager

The TM-9730CL uses a progressive scan interline transfer CCD that has the following features:

- Resolution of 768 x 484 active pixels for excellent image quality.
 - 11.6 x 13.6 μm pixels for high quality images.
 - High-speed electronic shutter capability for high dynamic resolution of moving objects and electronic iris control that eliminates the need for a mechanical shutter.
 - Progressive scan CCD eliminates interlace deterioration of image and increases ease of computer interface.
 - The camera is capable of data clock output of 14.318 MHz, and has an S/N ratio of 54dB.
 - The CCD for the TM-9730CL has built-in micro-lens.

¹ Unless specifically mentioned, all information in this manual is relevant to all cameras in the TM-9730CL series, including the TM-9730CL (monochrome) and the TMC-9730CL (color) and all RoHS versions, which are designated RM-9730CL and RMC-9730CL.

Note: The Kodak KAI -0373 imager used in the TM-9730CL 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-9730CL has a substrate drain-type shutter mechanism which provides superb pictures at various speeds without smearing. A built-in manual shutter speed control selects the electronic shutter rate of 1/30, 1/60, 1/125, 1/250, 1/1,000, 1/2,100, 1/4,500, 1/10,500, or 1/31,500 second.

- Output

The TM-9730CL has an 8-bit Camera Link digital output for interfacing with external image processing systems. The optional analog output is 1.0 Vp-p composite video (75 Ω).

- Warranty

The CCD solid-state image sensor allows the camera to maintain a superior performance level indefinitely while requiring virtually no maintenance. Please contact your factory representative for details about the warranty.

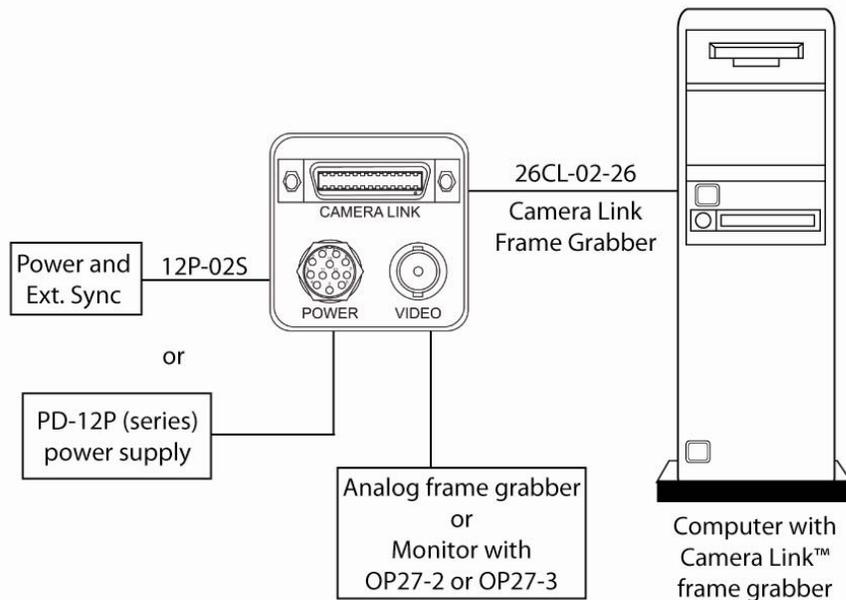
Warning:

Unscrewing the camera cover or opening the camera in any way will void the warranty unless prior written approval is obtained from the factory.

1.3 System Configuration

Figure 1 below presents a typical system configuration for the TM-9730CL camera.

Figure 1. TM-9730CL System Configuration.



2 Installation

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

2.1 Getting Started

2.1.1 Unpacking Instructions

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

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

2.1.2 Components List

Please begin by checking your order against the Components List shown below to assure that you have received everything as ordered, and that nothing has been overlooked in the packing materials. If any item is missing, please contact your JAI Inc. representative immediately.

- TM-9730CL camera
- Document download card (includes instructions on how to download the necessary documentation and software)

2.1.3 Accessories and Options

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

- Digital output cable
 - 26CL-02-26 (Camera Link cable)

Note: For CL models, the control software is downloadable. Serial communication is through the Camera Link cable. No additional accessories are required.

- PD-12UUP series power supply (see Section 2.2.4 on page 7)
- 12P-02S power cable
- Tripod Mounting Kit: TP-20
(for dimensions go to:
www.jai.com/EN/CameraSolutions/Products/Accessories/Pages/Home.aspx)

2.2 Camera Setup

2.2.1 Heat Dissipation

The TM-9730CL camera is a compact camera. Since all the electronics have been packed in a very small package, the outer case of the camera gets hot due to heat dissipation. The TM-9730CL will operate “stand alone”, but the following suggestions are recommended for optimum performance.

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

2.2.2 Connector Pin Configurations

2.2.2 (a) 12-Pin Connector

The TM-9730CL has a 12-pin Hirose connector for power input and signal integration. Pin #1 is Ground and pin #2 is +12V DC. The pinout table is shown below. For the TM-9730CL, serial communication camera control is done by means of the MDR26 Camera Link connector on the rear panel of the camera

Table 1 Hirose power and signal integration.

Pin	Description	Pin	Description
1	GND (power)	7	VD in
2	+12V DC	8	Reserved
3	GND (analog)	9	HD in
4	Video out	10	RXD (RS-232)*
5	GND (digital)	11	NC
6	Reserved	12	TXD (RS-232)*

OP25-3 - RS-232 on 12-pin

2.2.2 (b) Camera Link Connector

The TM-9730CL has a 26-pin connector on the rear panel to output Camera Link data. The connector pin-out is shown in Table 2 below.

Figure 2. The 26-pin connector.

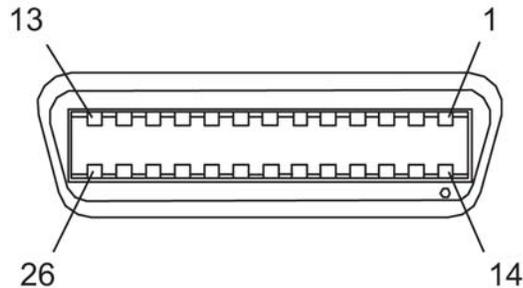


Table 2 26-pin Connector Pin Outs

Camera Link Connector MDR 26-pin Connector 10226-6212VC					
Pin #	Description	I/O	Pin #	Description	I/O
1	GND		14	GND	(Shield)
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	(CC1-)	NC	22	(CC1+)	NC
10	(CC2+)	NC	23	(CC2-)	NC
11	(CC3-)	Ext VD-	24	(CC3+)	Ext VD+
12	(CC4+)	Ext HD+	25	(CC4-)	Ext HD-
13	GND		26	GND	

*Note: SerTC: Differential Serial Communication to camera;
SerToFG: Differential Serial Communication to framegrabber.*

2.2.2 (c) Analog Output Connector

The TM-9730CL has a BNC connector on the rear panel to output non-standard progressive analog video or RS-170 analog video (optional OP27-1) or NTSC analog video (optional OP27-2).

Figure 3. TM-9730CL BNC connector

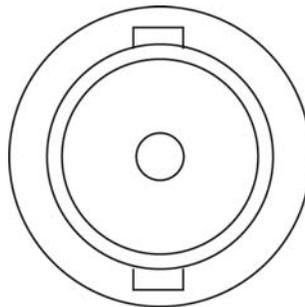


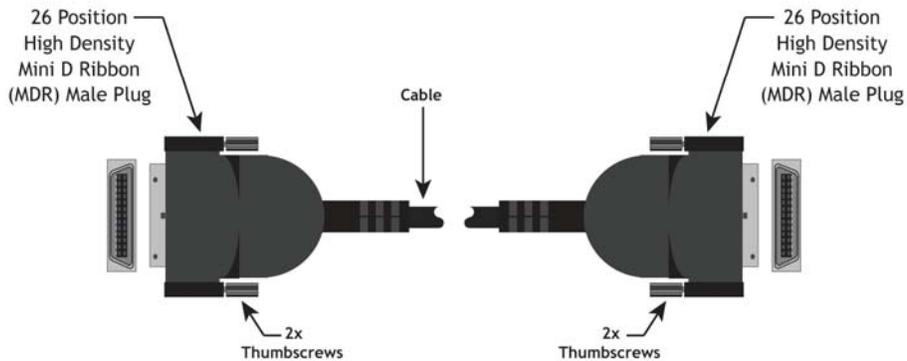
Table 3 Software Controllable Shutter Speed and Times Table

Shutter Number	Shutter Exposure Time
	Normal
0	no (1/30)
1	1/60
2	1/125
3	1/250
4	1/500
5	1/1,000
6	1/2,100
7	1/4,500
8	1/10,500
9	1/31,500

2.2.3 Camera Link Cable

The 26CL-02-26 cable assembly has been standardized as the Camera Link cable. This cable has the 26-pin connector on both ends. This is a straight-through cable. The pin-out configuration is shown in Table 2 on page 5.

Figure 4. Camera Link Cable



Note: For TM-9730CL, serial communication for camera control is done by means of the Camera Link connector on the rear panel of the camera.

Cable assemblies and board mount receptacles can be ordered from Intercon 1.

2.2.4 Power Supplies and Power Cable Setup

2.2.4 (a) Power Supplies

The TM-9730CL 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 with US plug (no 12-pin Hirose connector)
PD-12UUP	100-240V AC	1.2A universal voltage power supply with US plug and 12-pin Hirose connector
PD-12UE	100-240V AC/12V DC	1.2A universal power supply with European plug (no 12-pin Hirose connector)
PD-12UEP	100-240V AC/12V DC	1.2A universal power supply with European plug and 12-pin Hirose connector

If you are providing power through the 12-pin connector, the PD-12UUP and PD-12UEP power supplies are available with the 12-pin mating connector already attached to the leads from the power supply. The PD-12UU or PD-12UE power supply can be connected to the JAI Inc. power cable either directly or via a terminal strip.

When wiring the PD-12UU power supply 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.

2.2.4 (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 pin-out diagram in “Hirose power and signal integration.” on page 4. The cable pin-out diagram is shown in Figure 5 below. The color-coded leads use Gray for Ground and Yellow for +12V.

Figure 5. 12P-02S Interface Cable (optional)

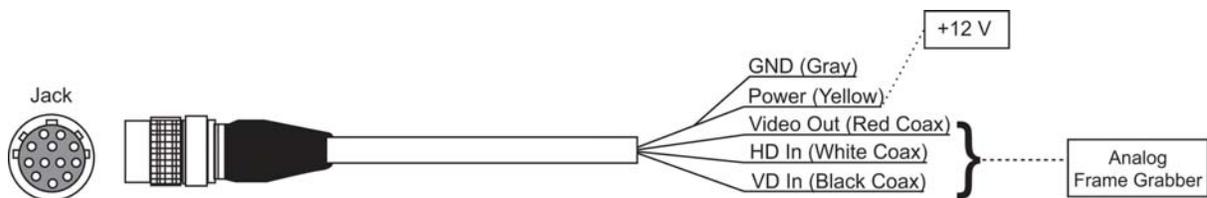


Table 4 12P-02S Interface Cable

12P-02S Interface Cable					
Pin#	Lead Color	Function	Pin#	Lead Color	Function
1	Gray	GND	7	Black coax	VD Input
2	Yellow	+12V DC	8	White coax shield	Reserved
3	Red coax shield	GND	9	White coax	HD Input
4	Red coax	Video	10	Brown	NC / Y Output*
5	Orange coax shield	GND	11	Blue	NC
6	Orange coax	NC	12	Black coax shield	NC / C Output*

*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.
* Option OP27-3, NTSC Y/C output.*

2.2.4 (c) Building Your Own Power Cable

Refer to the 12-pin connector pin-out in Section 2.2.2 (a on page 4. Connect the Ground lead to pin #1, and the +12V DC lead to pin #2 of the 12-pin connector. Power must be DC-regulated, and of sufficient current to properly power the camera.

2.2.4 (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 AC socket. This will power the camera up.

2.2.5 Attaching the Analog Video Output

When connecting the TM-9730CL to an analog frame grabber or a multisync monitor, use the BNC connector on the rear panel of the camera. The input of the monitor should be balanced for 75Ω termination. Standard RG-59 type coaxial cable should carry a full video signal for up to 100 feet.

The multi-conductor cable 12P-02S from JAI Inc. can be used to transmit analog video, power, sync. signals, and serial communication. The mini coaxial leads in JAI Inc. multi-conductor cables are designed for short runs of no longer than 100 feet.

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

2.2.6 Attaching the Camera Lens

The TM-9730CL camera accepts 2/3" or larger format size C-mount lenses. To attach the C-mount lens to the camera, carefully engage the threads and rotate the lens clockwise until it firmly seats on the mounting ring. Do not force the lens if it does not seat properly. Please note that some lenses with extremely long flangebacks may exceed the mounting depth of the camera.

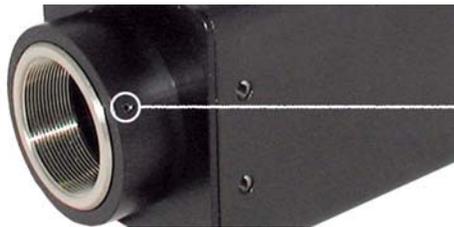
2.2.7 Adjustable Back-Focus

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

There should be an obvious need to refocus the lens before attempting to change the back focus. This is an 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 is wise to label cameras whose back focus was adjusted.

4. The camera must be connected to a monitor before attempting to adjust the back focus.
5. To back focus the camera, first attach a C-mount lens in the mount. Be certain that the lens is properly seated.
6. 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).
7. Loosen the three miniature hex set-screws (use a 0.9 mm hex wrench) that lock the focus ring in place. 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.

Figure 6. Back Focus Set-Screw Locations

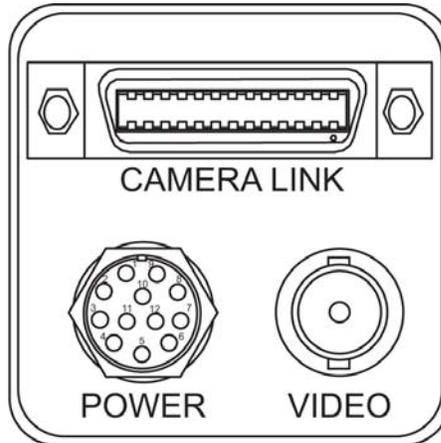


Loosen the three 2mm screws around the perimeter of the C-mount lens collar to adjust the back focus. Unless you absolutely must, do not attempt to adjust this focus.

3 Operation

3.1 Camera Back Panel

Figure 7. Camera Link back panel



3.1.1 Digital Output Connector

Refer to Section 2.2.2 on page 4 for Camera Link information.

3.1.2 Analog Output Connector

The TM-9730CL camera has a BNC connector on the rear panel to output analog video data.

3.1.3 Power and External Sync Connector

Refer to Table 2 on page 5 for information on the power and external sync. connectors.

3.2 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. Therefore, 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-9730CL uses a state-of-the-art progressive scanning interline transfer CCD which scans all lines sequentially from top to bottom at one frame rate (30Hz). Like a non-interlace computer screen, it generates a stable, crisp image without alternating lines and provides full vertical TV resolution of 525 lines (a normal TV monitor display may not be able to show images due to monitor 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.

The TM-9730CL outputs the progressive scan image with an electronic shutter in two different formats:

- Progressive scanning digital and analog output

The CCD signal goes through A/D and D/A converters and through 10-bit in, 8-bit out look-up table (LUT). The digital output is available from 26-pin Camera Link connector.

The analog output is the same as 75 Ω , 1Vp-p format at 30Hz rate available from BNC and 12-pin connector.

Note: Minimal blooming may occur due to the nature of the CCD.

3.3 Electronic Shutter

For more information about the electronic shutter, please see Section 1.2 on page 1.

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

The TM-9730CL 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 10-bit A/D input so that the full dynamic range of the CCD is utilized at 10-bit references as the input and the LUT output is converted into 8-bit to adjust the gamma correction.

Note: The knee LUT may not work with the Automatic Level Control since the results are unstable.

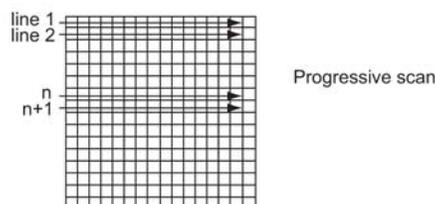
LUT selection:

- Linear / Gamma
- Knee LUT
 - Pre-defined Knee LUT
 - User defined Knee LUT
 (Caution: Knee LUT may cause ALC function to be unstable)

3.5 Scan Modes

The TM-9730CL supports the following scan modes:

Figure 8. Progressive scan



3.5.1 Full Progressive Scan

The normal scan mode progressively scans a full frame of 768 x 484 pixels at 30 frames per second using the standard 14.318MHz pixel clock and a single channel output. In contrast to interlace-scan cameras, all of the 484 lines in the frame are exposed simultaneously per image capture.

3.6 External Sync

The TM-9730CL accepts an external sync of standard HD and VD at TTL level for general locking to a system sync and clock. The external sync frequency requirement is as follows:

30 FPS
fHD = 15.73 KHz \pm 2%
fVD = 29.97 Hz \pm 2%
Pixel clock = 14.318 MHz

3.7 3G Stagger Color Filter (Color Versions)

3.7.1 Color Filter Array

The color filter array is the staggered “3G” color mosaic filter pattern. The CFA contains 75% green photosites and 25 red and blue photosites.

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.” Current high-speed computers allow such color interpolation to be done almost in real time. Because these cameras do not contain internal color-processing circuitry, 3G stagger cameras are smaller and less expensive than full-function color cameras.

3.7.2 3G Stagger Color Filter Array (CFA)

It is critical for the framegrabber 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.

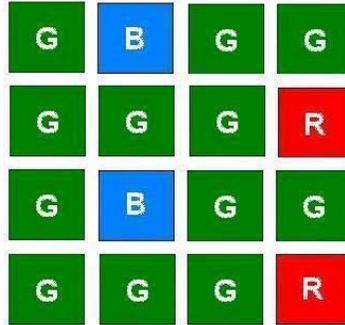
3.7.3 Interpolation Software

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.

3.7.4 Color Interpolation

The “3G stagger” 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.

Figure 9. The 3G Stagger Pattern



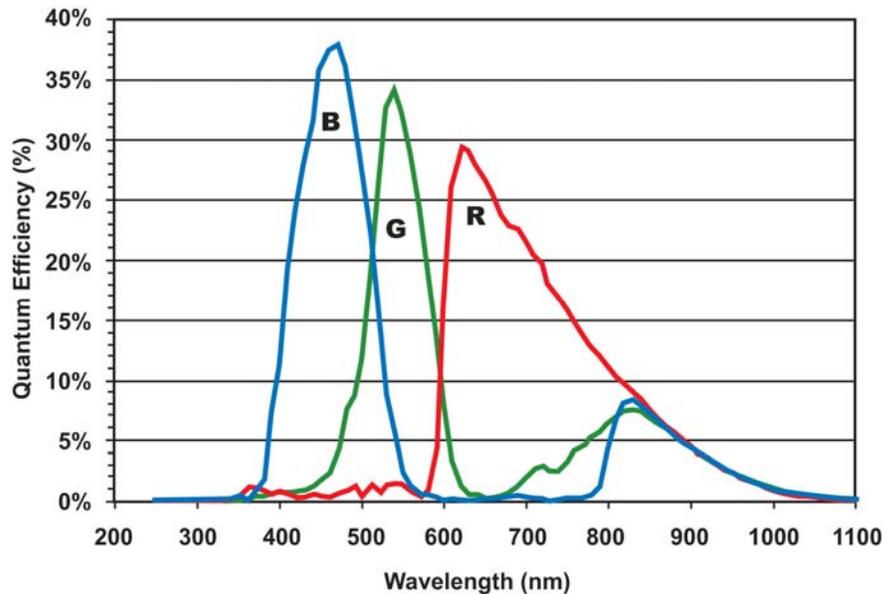
Color interpolation software or firmware performs the color preprocessing by filling the missing color pixels with neighboring pixels. It then separates the stream of data, (8-bit or 10-bit) into 3 (RGB) data (8-bit x 3) and adds the color matrix to adjust and balance each of the R,G, and B channels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

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 4 x 4 interpolation color matrix, white balance capability, etc.

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.

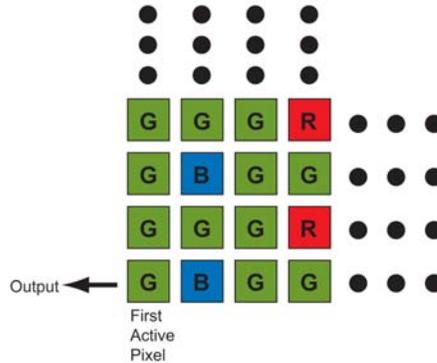
Figure 10. CFA spectrum graph.



3.7.5 Starting Pixel Configuration

All manufacturers produce similar CFAs, but there are slight differences between the CCDs produced by different manufacturers. The first line is generally R and G. The Sony CCD starts with R. The camera timing can be adjusted to start with either G or R by skipping the very first pixels at each lines. 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 will be exactly the same. Please contact JAI Inc. for further information regarding CCD manufacturers.

Figure 11. CFA configuration options



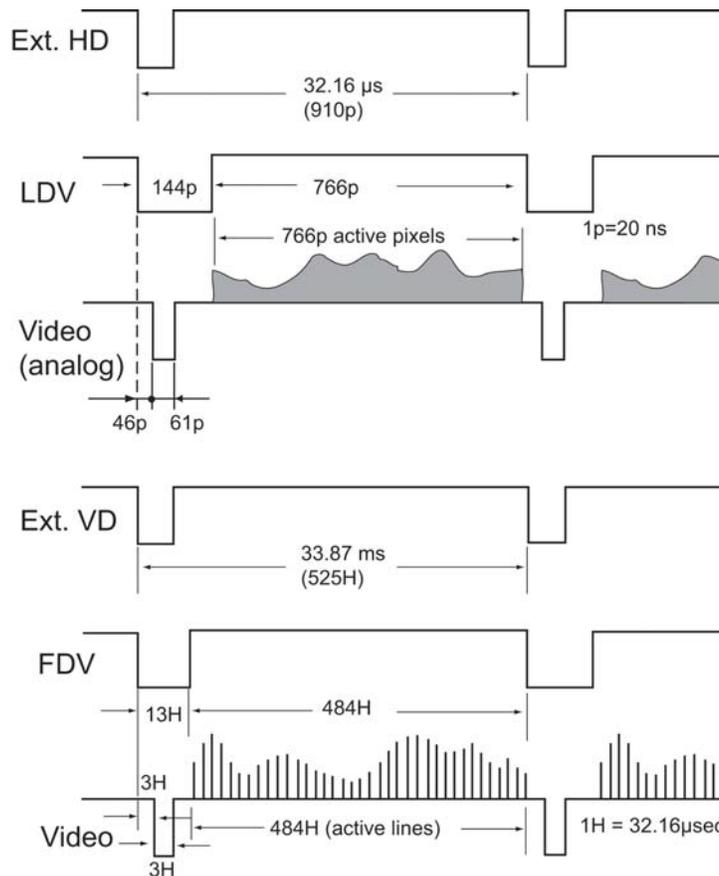
3.7.6 Sync and Data

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 B/W cameras.

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

If the frame grabber has a standard B/W configuration file, then AccuPiXEL color cameras can use that configuration file to operate. Please consult JAI Inc., or your framegrabber supplier for compatibility information.

Figure 12. Example of the TMC-9730CL (progressive scan output).



It is important to meet the exact starting pixel at LDV and the starting line of FDV. If the starting pixel or line is shifted due to the image capture configuration, then the interpolation software can be adjusted for the correct starting point. In figure A, if the first pixel is shifted (missed), the color interpolation should start with G-R. If the first line is missed in A, the interpolation order will be B-G.

3.7.7 Camera Functions

AccuPiXEL color cameras perform all functions the same way as B/W cameras. However, because of color characteristics, the following issues are different:

- LUT (Look-up Table)

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 may vary slightly, adjusting V (bottom) may be necessary.

3.8 Camera Timing Charts

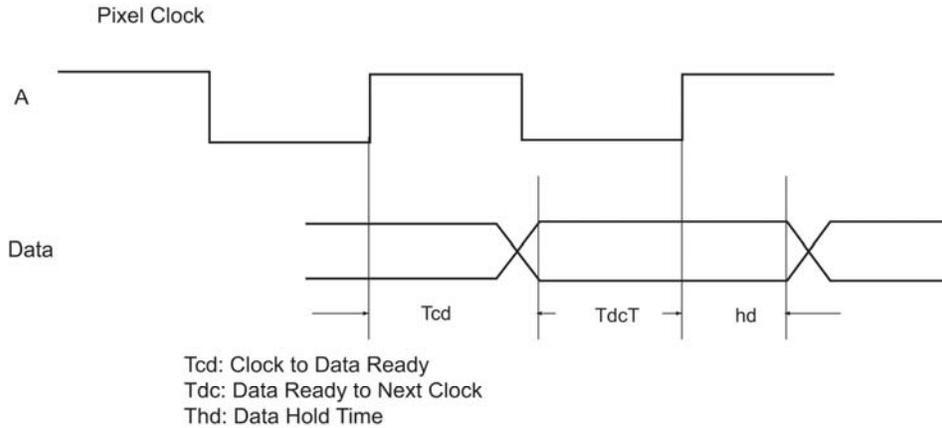
Model: TM-9730CL

Operation Mode: 30 Frame /sec

Master Clock: 28.636 MHz, M=34.92 nsec

Pixel Clock: 14.318 MHz, P= 69.84 nsec

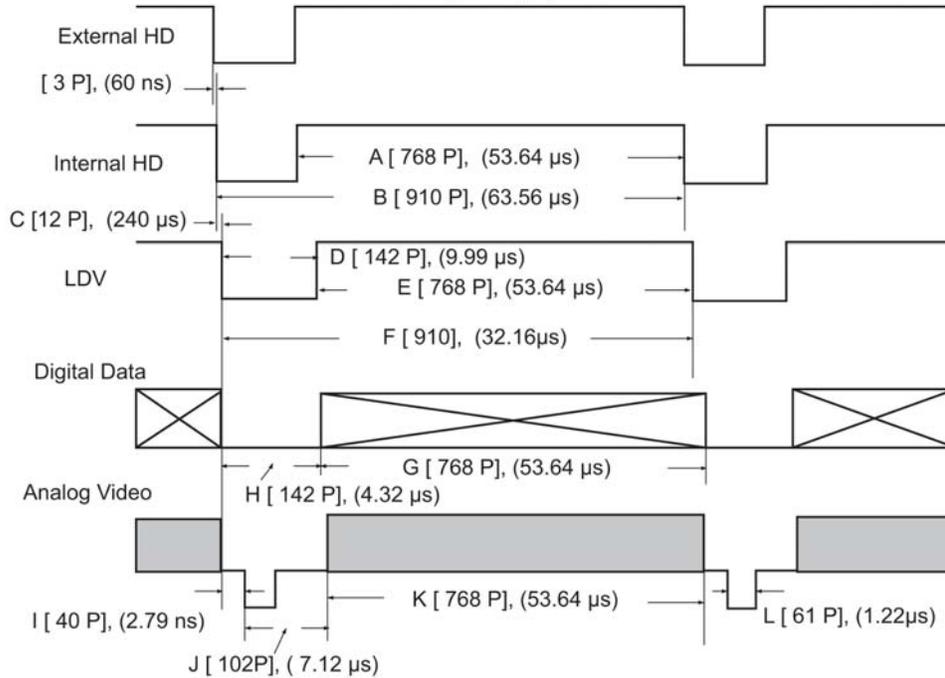
1. Pixel Clock and Digital Data



Tcc = 35 nsec, Tdc = 30 nsec, Thd = 5 nsec.

2. Horizontal Signals

fHD = [15.73KHz]
tHD = [63.56 μs]



CAMERA TIMING CHARTS

Model: TM-9730CL

Operation Mode: 30 Frames/Second

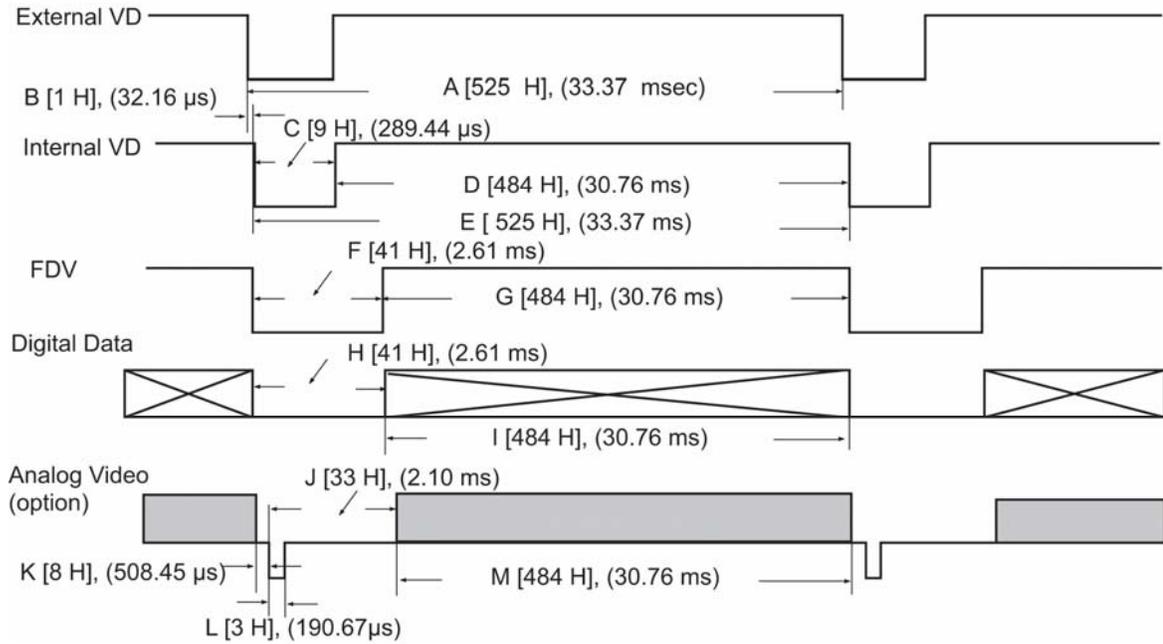
Master Clock: 28.636MHz, M = 34.92 nsec

Horizontal Frequency: 15.74KHz

Pixel Clock: 14.318 MHz, P = 69.84 nsec

1H = 63.56 usec

3. External Reset Timing



4 Troubleshooting

4.1 Problems and Solutions

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

4.1.1 Symptom: No Video

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

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

4.1.2 Symptom: Dark Video

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

- Shutter selection
- Iris opening on the lens

4.1.3 Symptom: Non-Synchronized Video

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

- Proper mode output
- Frame grabber software camera selection

Note: Breaking the factory seal without prior approval from the factory will void the product warranty.

4.2 Information and Support Resources

For further information and support:

Phone: (408) 383-0300
(800) 445-5444

Fax: (408) 383-0301

Mail: JAI, Inc.
Sales Department
625 River Oaks Parkway
San Jose, CA 95134
ATTN: Video Applications

Web Site: www.jai.com

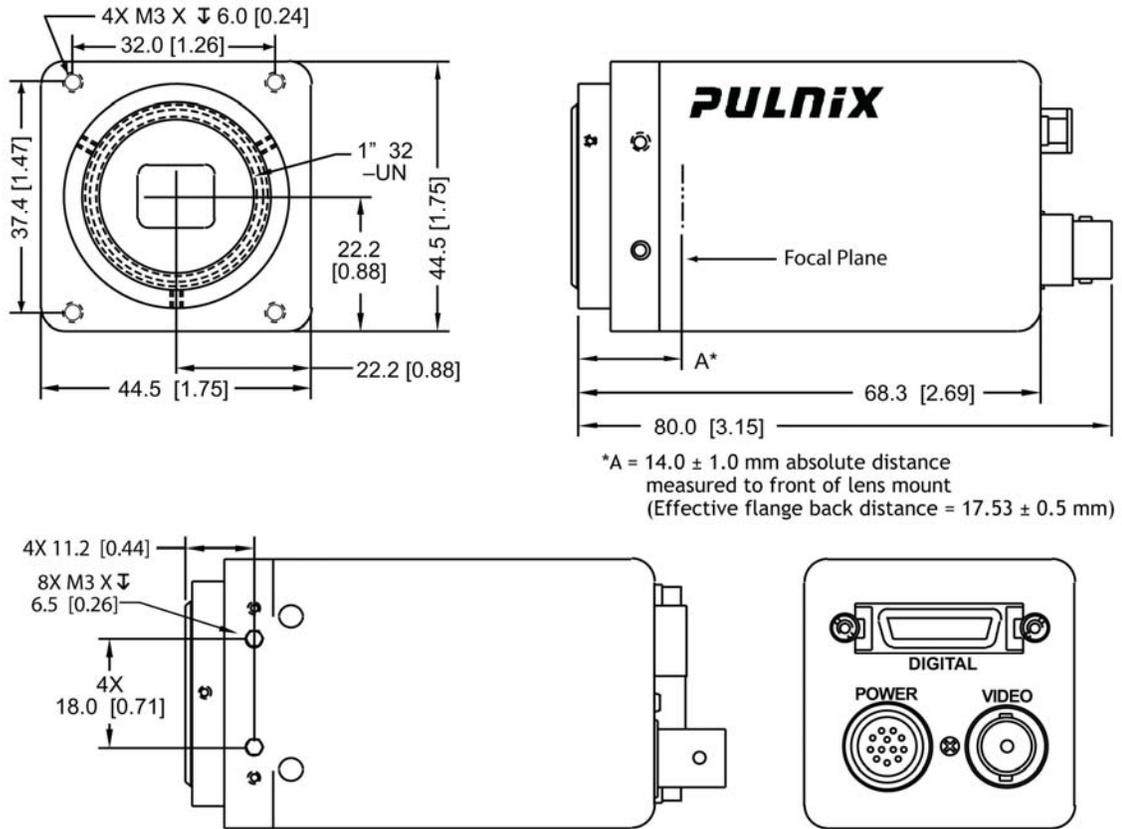
5 Camera Specifications

Table 5 Specifications

Model	TM-9730CL Series
Imager	TM-9730CL Monochrome - 2/3" progressive scan interline transfer CCD TMC-9730CL Color - 2/3" progressive scan interline transfer Bayer CCD
Active Area	8.9mm (H) x 6.6mm (V)
Active Pixels	768 (H) x 484 (V)
Cell size	11.6µm x 13.6µm
Scanning (Active Pixels)	768 (H) x 484 (V) @ 30 Hz
Sync	Internal/external auto switch HD/VD, 4.0 V impedance 4.7K Ω 30Hz±5% non-interlace HD= 15.734 kHz±5%
Data Clock Output	14.318 MHz
Resolution	Digital: 768 (H) x 484 (V) Analog; over 570 TV lines (H) x 484 TV lines (V)
S/N Ratio	≥ 54dB
Min Illumination	1.0 lux, f=1.4 (no shutter) @ 30fps
Video Output	Analog: 714mV, 75 Ω Progressive Scan (Non-interlace) Camera Link: (8 bit)
Gamma	Programmable LUT (1.0 std.)
Lens Mount	C-mount (adjustable)
Power Req	12V DC±10%, 330 mA (typical at 25° C)
Operating temperature	Full performance: -10° C to 50° C
Extended temperature	-40° C to +65° C (reduced performance may occur)(OP22-5-1)
Random vibration	7Grms (10Hz to 2000Hz)
Shock	70G, 10-11 msec
Size (W x H x L)	44.5mm x 44.5mm x 68.3mm without connectors
Weight	Standard camera without tripod mount: 171 g, 6.0 oz. (TM-9730CL), Standard camera with tripod mount: 183.2 g, 6.5 oz. (TM-9730CL) Digital Zoom camera without tripod mount: 184.4 g, 6.5 oz. (TM-9730CL), Digital Zoom camera with tripod mount: 197.2 g, 7.0 oz. (TM-9730CL)
Optional Functions	Auto Level Control (ALC[EE & AGC])(OP1-5); Imager Blemish Map (OP2-1); Blemish Compensation (monochrome)(OP2-5); UV Imager (monochrome) (OP21-UV); Conformal Coat (OP22-5-5); RS-232 on 12P (OP25-3); Analog frame buffer & RS-170 video conversion (OP27-1); NTSC Y/C output (color only)(OP27-2); Y/C output (color only) (OP27-3); Digital Zoom 2:1 (monochrome only)(TBD) (OP60-2)
Optional Accessories I/O	CL 26CL-02-26 Camera Link cable (2m) Power cable 12P-02S power cable with open leads (2m) Power supply PD-12UUP series (includes power connector) Tripod Mounting Kit TP-20

5.1 Physical Dimensions

Figure 13. 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.

5.2 Spectral Response

Figure 14. Monochrome Spectral Response

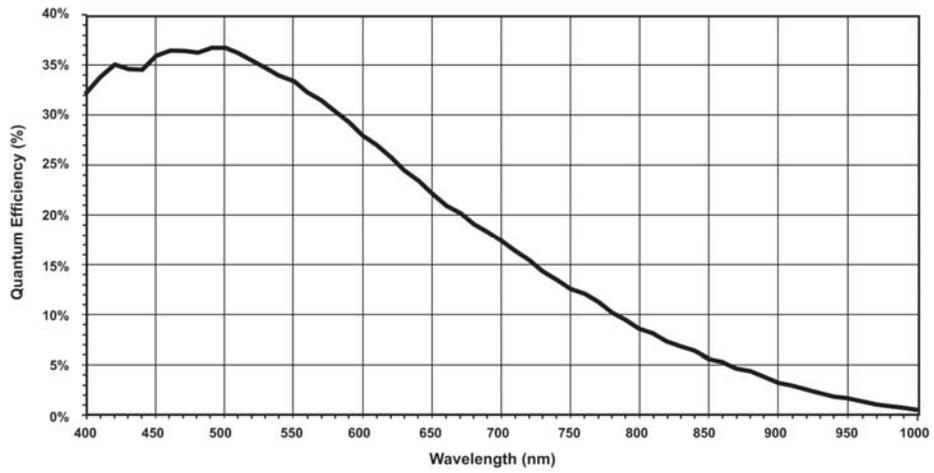
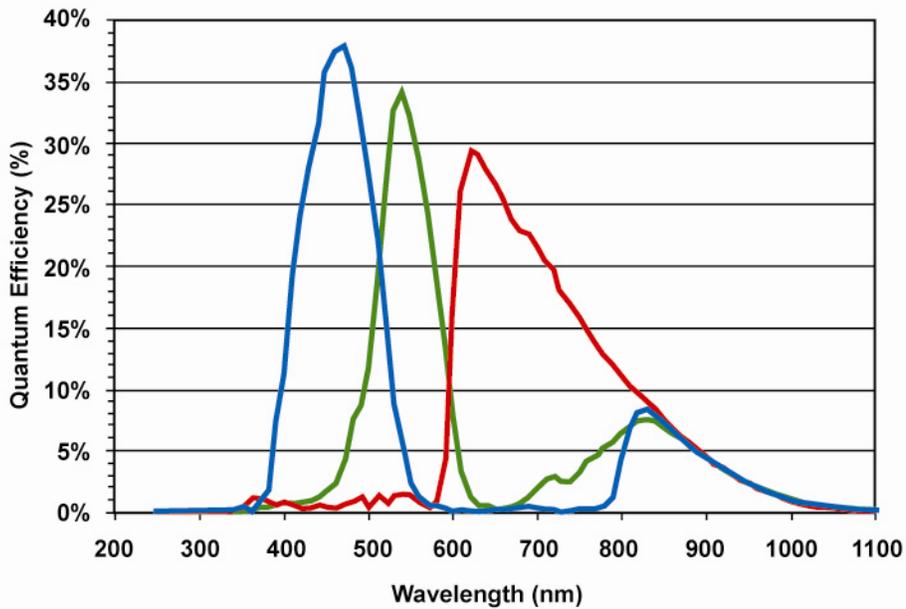


Figure 15. Color Spectral Response



2. Camera-Control Software

6 Introduction

The AccuPiXEL series cameras are high resolution, progressive scan cameras with JAI-proprietary LUT control and other excellent features. The camera control software was developed to function as standard software for the entire AccuPiXEL series. This software 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. 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. This document addresses the AccuPiXEL version 5.0.0 software, last modified in 2007 and available for download at www.jai.com.

6.1 Software Installation

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

6.1.1 Before Installing the AccuPiXEL Series Camera-Control Software

Before installing the AccuPiXEL series Camera-Control Software, please note the following.

- The AccuPiXEL camera-control software is tested for Microsoft Windows 2000 and XP operating systems.
- We recommend that you use small fonts for the Display Properties dialog box in the control panel.
- The AccuPiXEL series camera-control software requires one free communication port that is not in conflict with other peripherals such as the mouse or modem.
- Installation of the AccuPiXEL series camera-control software requires 2.0 MB of free space on your PC hard disk.
- Uninstall any previous versions of AccuPiXEL on the hard drive. See Section 6.1.4 on page 27.

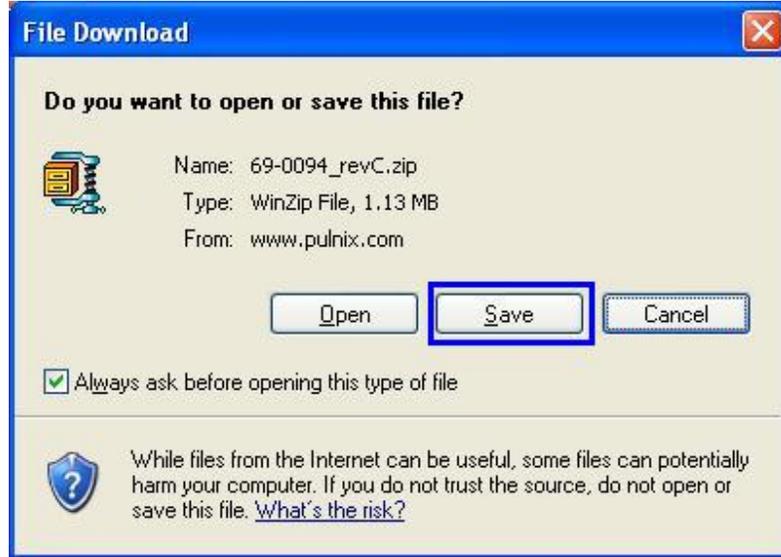
6.1.2 Installing the Software

To install the AccuPiXEL series camera-control software, follow the steps below.

1. Download the AccuPiXEL software from the JAI web site at www.jai.com. Locate the software by going to the camera description, clicking on the Software link, or searching AccuPiXEL using the site search feature.
2. Click on the “Save” button to save a compressed copy of the software to the hard drive of your system. Do not confuse AccuPiXEL with dual-tap AccuPiXEL software.

Note: If you go to software and download based on the camera description, for example, TM-9730CL, the software download is the correct, and latest released version.

Figure 16. Use Save to download a copy of the software.



The software is compressed, and it may be necessary to install decompression software if you are using an older operating system.

Use decompression software to create the installation software directory.

Figure 17. Select and Extract the compressed files.

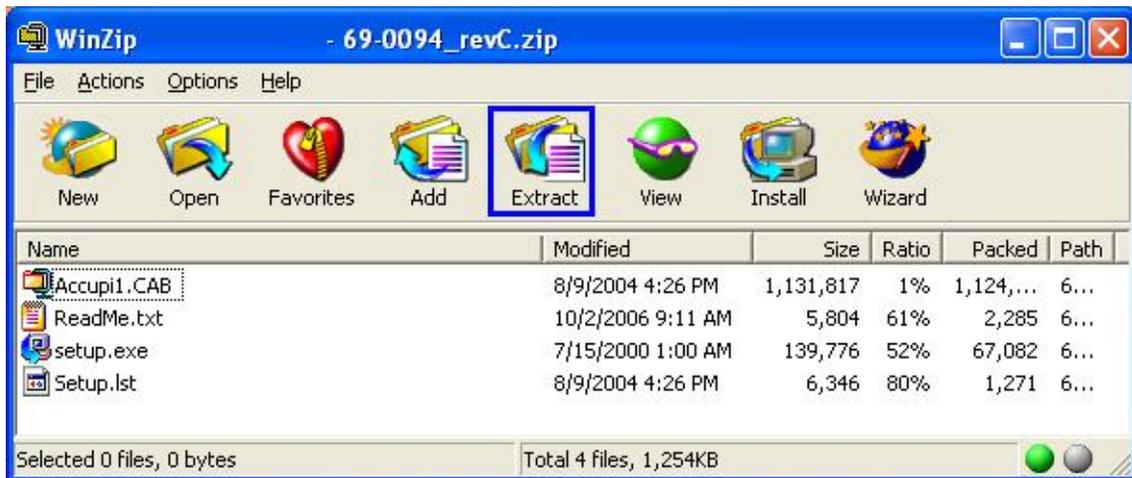
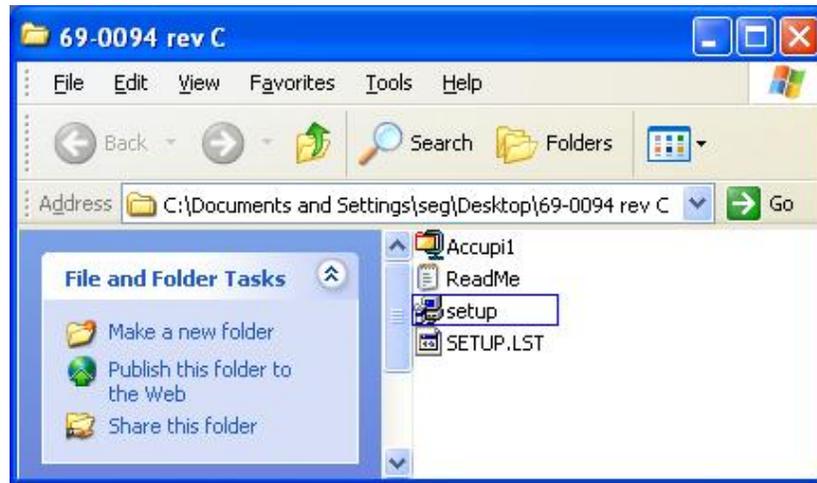


Figure 18. The extraction creates a directory named “69-0094 rev C”



3. Open the directory and double-click on setup to begin the install.
4. Follow the installation instructions.

Note: You can change the installation directory if you want.

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

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

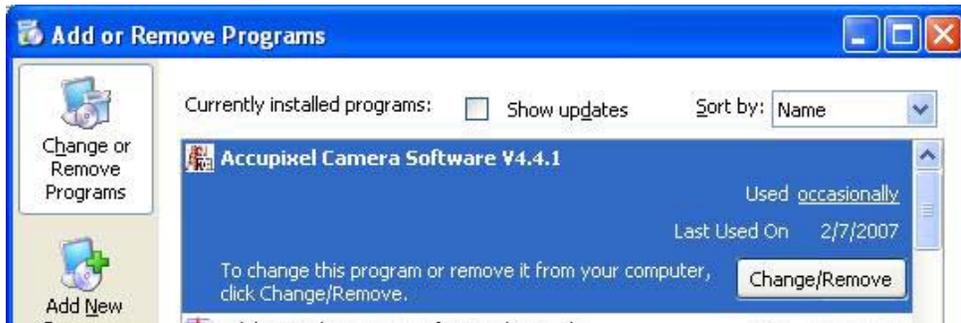
The AccuPiXEL software does not function if a frame grabber can not be located. The current JAI Cam2Net software installs the frame grabber dll “clsrc2n.dll”. For more details on compatible frame grabbers see the “ReadMe” file in the “69-0094 rev C” directory created from the AccuPiXEL download.

6.1.4 Uninstalling the Software

You might want to uninstall the previous version of AccuPiXEL before installing version 4.4.1 You can uninstall the AccuPiXEL series camera-control software from the control panel. To uninstall, follow the steps below.

1. Open “Add or Remove Programs” in the control panel.
2. Select the old version of AccuPiXEL camera software from the list of installed software.
3. Click the “Change/Remove” button, then click “Yes” to confirm.

Figure 19. Use Add/Remove to uninstall AccuPiXEL software.



6.1.5 Accessing the AccuPiXEL software

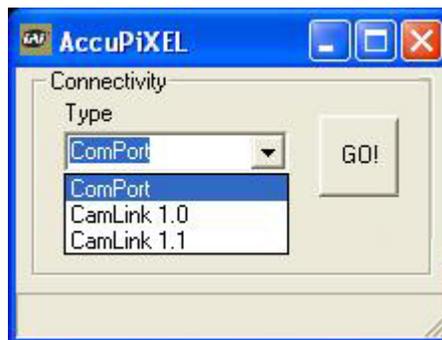
Once the software has installed go to the “Start” menu on the main screen to run AccuPiXEL. Click on All Programs>AccuPiXEL Camera V5.0.0>AccuPiXEL Camera. This opens the small selection dialog box used to configure the camera to run AccuPiXEL.

Figure 20. The Start Menu gives easy access to the AccuPiXEL software.



6.1.6 Connection

A dialog box opens to allow interface selection. Select ComPort and enter port number that the camera is connected to. (User should be familiar with their PC ComPorts settings.)



6.1.7 Framegrabber Choices

The function choices are ComPort, CamLink 1.0 and CamLink 1.1. Choose either CamLink 1.0 or CamLink 1.1.

Select Frame Grabber board index. This index is for users who install multiple Camera Link framegrabbers. For a single board user, the index is selected as zero for default.

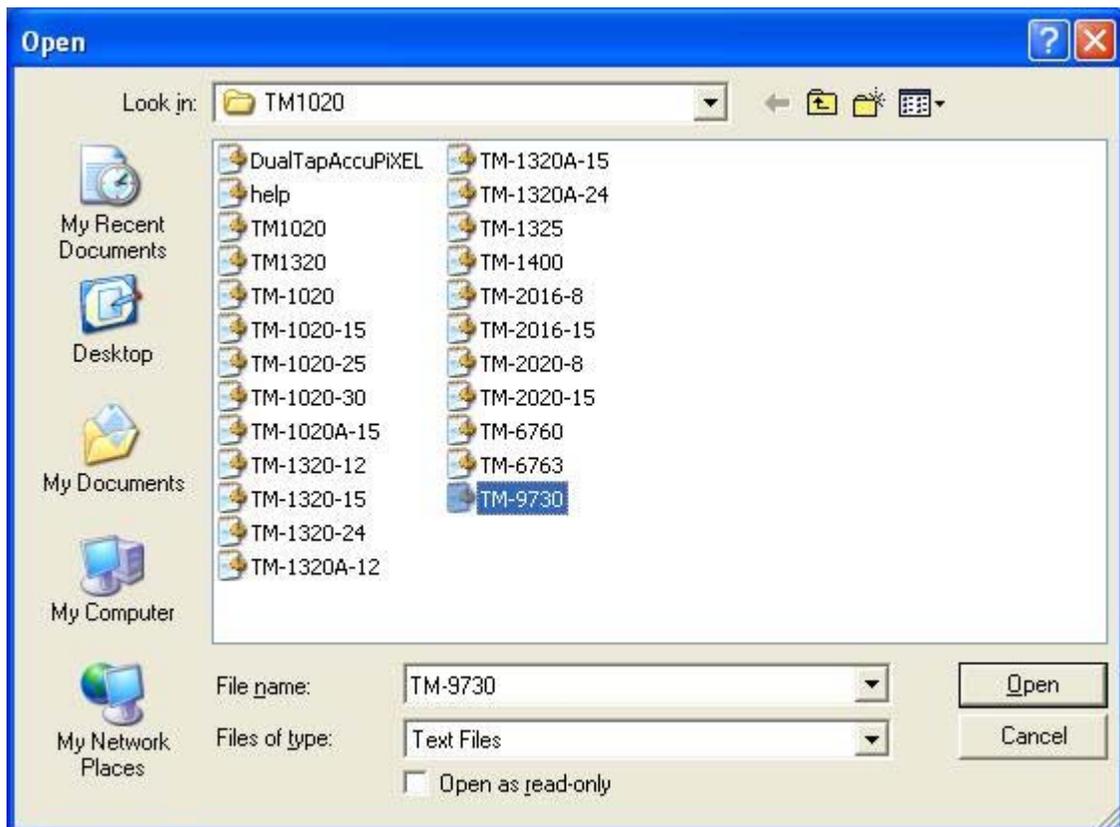
Figure 21. Choose a framegrabber version, verify Board Index; click GO!



6.1.8 CamLink 1.0

When you choose the CamLink 1.0 version it is necessary for you to locate and double-click to link the framegrabber DLL. Once the DLL is linked choose the matching camera series. In this case the TM-9730CL.

Figure 22. Choose the matching configuration file for the software.



6.1.9 CamLink 1.1

If you select CamLink 1.1 the software searches for all CamLink 1.1 compliant frame grabbers. The AccuPIXEL software displays available frame grabber DLL's. Choose the framegrabber the camera is connected to and click on the GO! button.

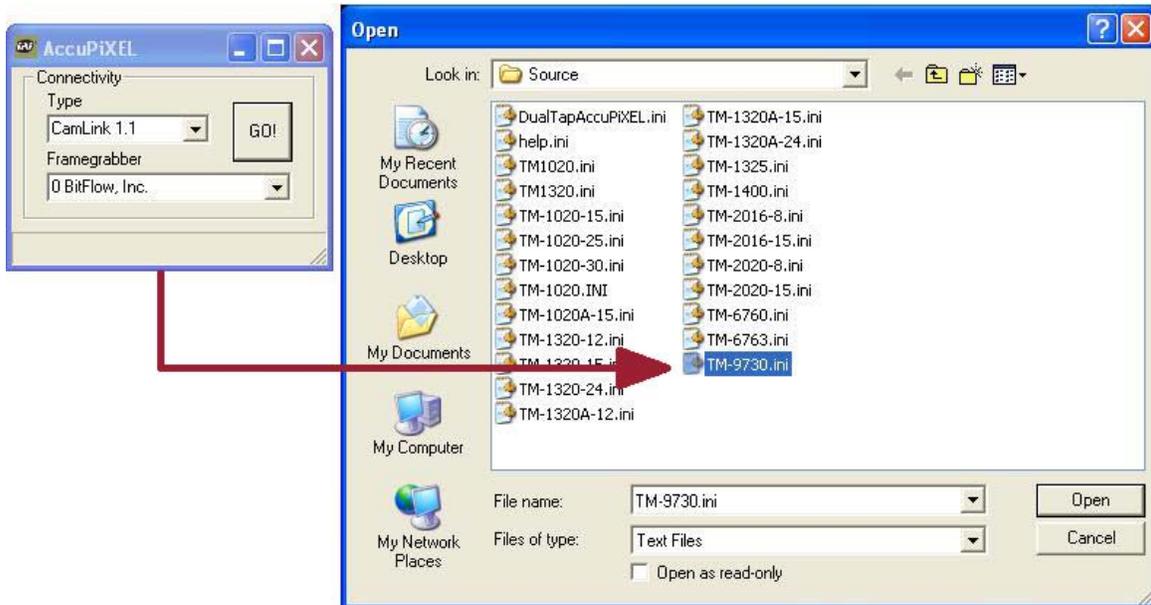
Figure 23. AccuPIXEL displays framegrabber DLLs.



6.1.10 Choose the appropriate camera.

The AccuPIXEL software opens a default folder to allow you to select the camera using the software. Be sure to select the correct camera description.

Figure 24. Select the camera connected to the system.



The main menu opens once the camera and DLL configurations are correct. See “GUI Features” on page 31 for details on using the interface to configure the camera.

7 GUI Features

The AccuPiXEL series Camera Link software communicates through the Camera Link connector on the back panel of the camera.

7.1 Menu Bar

Camera Output Protocol

About

Most of these menu bar options are set up in the process of opening the main screen. They are detailed later on in this document.

7.2 Main Screen

Exposure Control

- Shutter Mode
- Shutter Switch

Gain Control

- Gain

Blemish Correction (OP2-5)

Auto Level Control

Table Selection

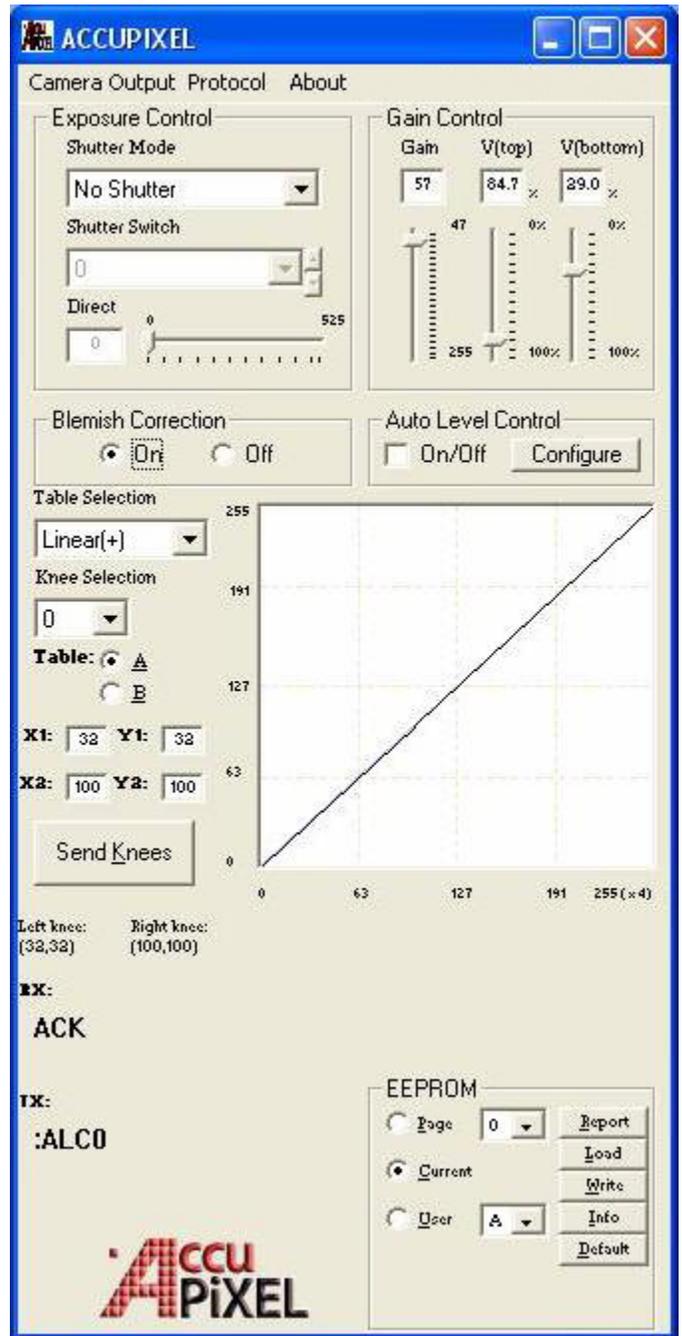
- Linear Selection
- Knee Selection
- Gamma Selection

RX

TX

EEPROM

- Page
- Current
- User



7.3 Operating The Control Software

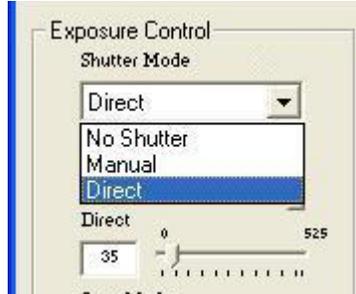
7.3.1 Exposure Control

In Exposure Control, you can specify the shutter mode. Scan mode is deactivated for the TM-9730CL.

7.3.1 (a) Shutter Mode

In the Shutter Mode drop-down list box you can select No Shutter mode, Manual, or Direct shutter.

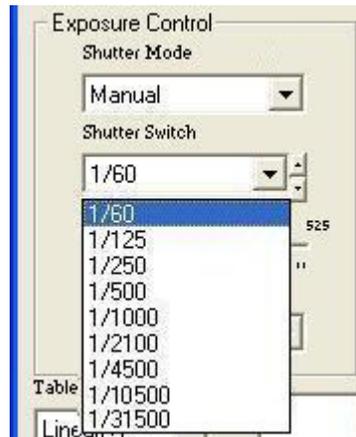
Figure 25. Shutter Mode drop-down list box.



7.3.1 (b) Shutter Time

Use the Shutter Switch drop-down list box to select a pre-configured shutter speed.

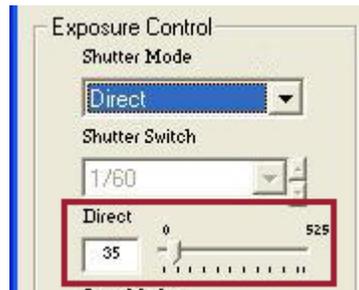
Figure 26. The Shutter Switch drop-down list box.



7.3.1 (c) Direct

The Direct drop-down list box allows you to select camera speed using a slider. The camera must be in Direct Shutter Mode. The Shutter Switch is disabled when Direct is active.

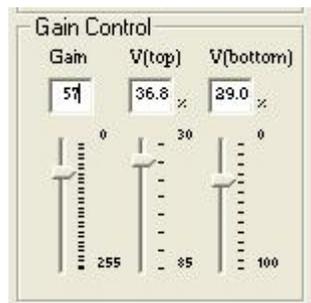
Figure 27. Setting Direct Exposure Control



7.3.2 Gain Control

This control is available when the on/off checkbox in the Auto Level Control is not checked. Auto Level Control; Gain Control. The Gain Control box allows you to change the Gain value from 0 to 255 (integer). To change the value, move the slider, or enter the value directly into the text box.

Figure 28. Gain Controls



7.3.2 (a) V-Top

The V(top) box allows you to change the V(top) value of the A/D converter from 30% to 85% (integer). To change the value, move the slider or enter the value directly into the text box. The scale goes from zero to 255.

7.3.2 (b) V-Bottom

The V(bottom) box allows you to change the V(bottom) value of the A/D converter from 0 to 100% (integer). To change the value, move the slider or enter the value directly into the text box.

Note: Gain Control is enabled or disabled based on several conditions. If a camera is purchased without Auto Level Control (ALC) the gain control is always available. If the camera has the ALC option, Gain Control is turned off by the software because the ALC automatically overrides any manual settings. If ALC is present the user can turn off the Auto Level Control which then activates the Gain Control.

7.3.3 Blemish Correction (Optional-OP2-5)

The Blemish Correction control helps compensate for any irregularities in the CCD which might adversely affect the image quality. If desired the control can be turned off using the radio buttons.

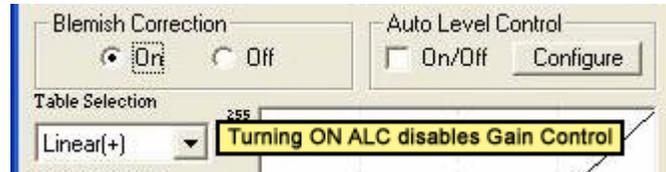
Figure 29. Blemish Correction Radio Buttons



7.3.4 Auto Level Settings

Verify the on/off checkbox is checked to activate the Auto Level Control if the camera has the ALC option.

Figure 30. Auto Level Control

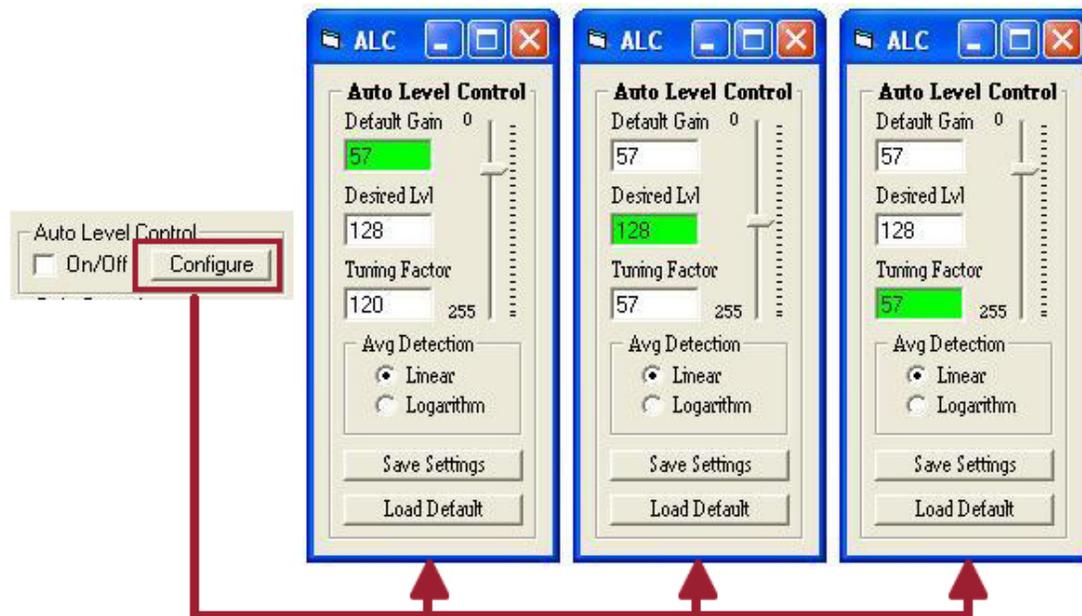


7.3.4 (a) Setting the ALC

Click the Configure button.

Set the Gain, Desired Lvl, and Tuning Factor and click Save Settings. The Load Default button allows access to stored settings.

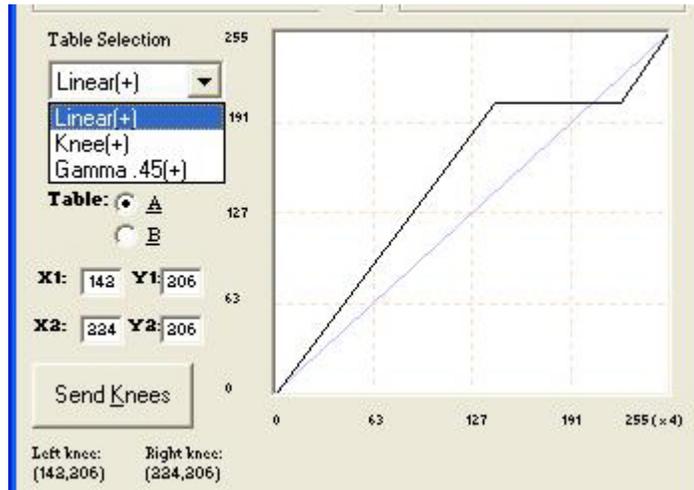
Figure 31. Active Auto Level Control



7.3.5 Table Selection

The Table Selection box allows you to select linear, knee, or gamma 0.45 camera output.

Figure 32. Look Up Table options.

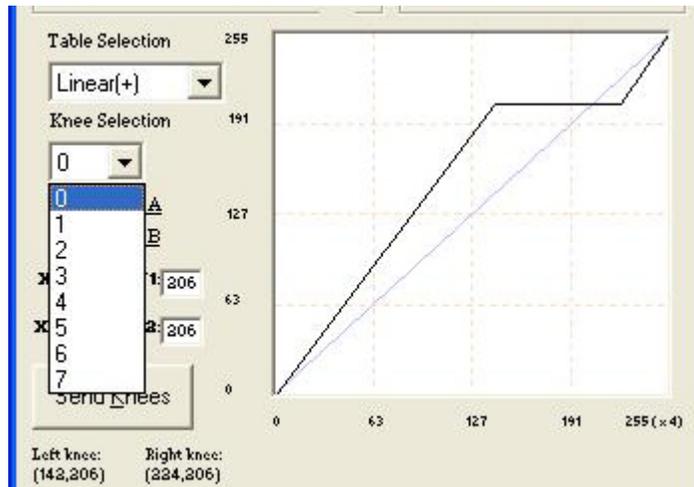


7.3.5 (a) Knee Selection

The Knee Selection box allows you to select the pre-set knee control Look Up Table (LUT). The AccuPiXEL series cameras have eight preset knee control LUTs.

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

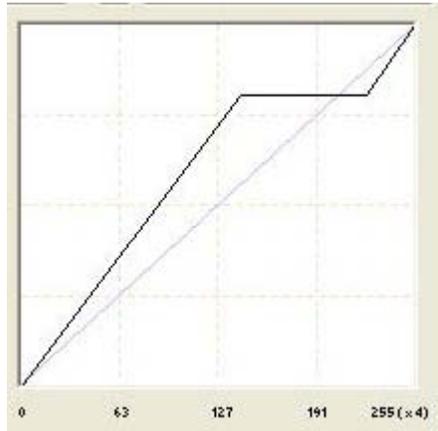
Figure 33. Knee Selections



7.3.5 (b) 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 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.

Figure 34. Graphical Knee Selections



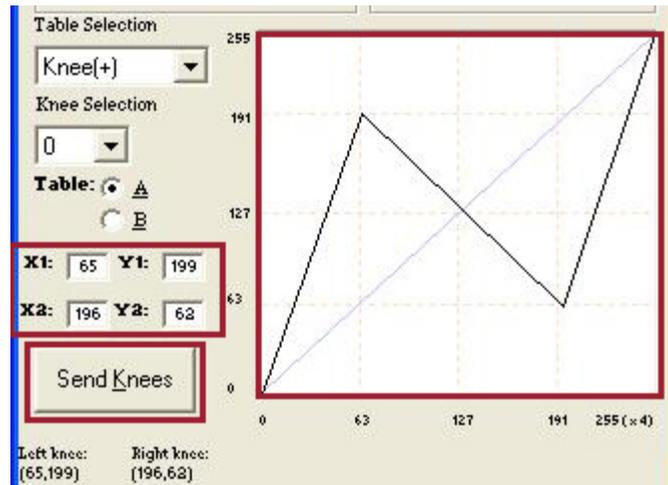
7.3.5 (c) Table

The A and B designations access two different memory locations for loading knees from a table.

7.3.5 (d) X1, X2, Y1, Y2

The X and Y controls left of the graphical knee control allow LUT configuration by entering numbers instead of dragging on the graphical control. This is useful when the desired LUT settings are known. Use the Send Knees button to implement settings.

Figure 35. Sending Knee Settings



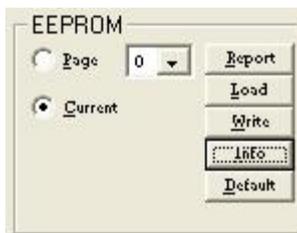
7.3.6 EEPROM Settings

The EEPROM settings can be accessed, restored, and saved using the main menu. The current page (Current) or a setting stored in memory (Page) can be accessed by clicking the appropriate radio button, selecting the page number, and then choosing the button for the desired functionality.

The Report button provides all of the saved or current information, depending on the setting. Load makes a stored configuration the active configuration. Write creates a new setting; if a setting

already exists it is overwritten, with certain exceptions. Info provides the details about a configuration, but does not load the configuration. Default opens the settings used for camera startup from a new boot.

Figure 36. EEPROM access from the main menu



8 GUI Menu Bar

The “Load” option in the menu bar allows you to restore the Gain Table setting from EEPROM. Click on “Load” and select “From Gain Table” in the menu to restore the setting from four user memory pages and four preset setting memory pages. See “EEPROM Settings” on page 37.

8.1 Camera Output Protocol

Figure 37. Buffer Size



8.2 “About” Menu

Click on the About menu to view current software version details.

Figure 38. Software version details



9 AccuPiXEL Series Camera Customer and Serial Commands

The AccuPiXEL series cameras can be controlled by serial command either by means of 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 :SA9<CR> to the camera. The following table contains serial commands that can be used to control the camera.

Table 6 Auto Level Control Commands (Optional-OP1-5)

Command	Description	Response	Comments
:ALC0<cr>	Disable Auto Level Control	:<ack><cr>	
:ALC1<cr>	Enable Auto Level Control	:<ack><cr>	
:ALC?<cr>	Enquire Status of Auto Level Control	:<ack>ALC[x]<cr>	x=0 (disabled) 1 (enabled)
:G0=[xx]<cr>	Set Default Gain for ALC:xx=H100H1FF	:<ack><cr>	If xx is too high or too low ALC may be unstable.
:G0?<cr>	Enquire Default Gain for ALC	:<ack>G0=[xx]<cr>	xx=H100-H1FF
K1=[xx]<cr>	Set Tuning Factor K1:H100-H1FF	:<ack><cr>	Value must compromise both response time and stability of ALC performance
:K1?<cr>	Enquire Tuning Factor	:<ack>K1=[xx]<cr>	xx= H100-H1FF
:X0=[xx]<cr>	Set Desired Level of ALC:xx=H100-H1FF	:<ack><cr>	If xx is too high or too low ALC may be unstable
:X0?<cr>	Enquire Desired Level of ALC	:<ack>X0=[xx]<cr>	xx=H100-H1FF
:STF<cr>	Save user tuning factors	:<ack><cr>	
:LTF<cr>	Load user tuning factors	:<ack><cr>	
:LTF0<cr>	Load factory default tuning factors	:<ack><cr>	
:LOG0<cr>	Set to linear average detection for ALC	:<ack><cr>	
:LOG1<cr>	Set to Log average detection for ALC	:<ack><cr>	
:LOG?<cr>	Enquire if current user is linear or log	:<ack>LOG[x]<cr>	X=0 (linear) 1 (log)

Table 7 Serial Commands Table

	First Character	Second Character	Third Character	Response	Functions
1	“S” (Shutter)	“M” (Manual)	“0” - “9” Mode	ACK	Manual Shutter Mode
		“X”	“000” - “419”	ACK	Direct Shutter Mode
2	“G” (Gain)	“M”	“00” - “FF”	ACK	Gain Control
3	“V” (A/D Vref)	“T” (Top)	“00” - “FF”	ACK	Vtop reference setting
		“B” (Bottom)	“00” - “FF”	ACK	Vbtm reference setting
4	“W” (Write)	“P” (Page)	“0” - “6”	ACK	Write current setting to Page EEPROM
		“U” (User)	“A” - “D”	ACK	Write current setting to User EEPROM
		“S” (System)	“A” - “D”	ACK	Write current setting to System EEPROM
5	“L”	“P” (Page)	“0” - “6”	ACK	Restore setting from Page EEPROM
		“U” (User)	“A” - “D”	ACK	Restore setting from User EEPROM
		“S” (System)	“A” - “D”	ACK	Restore setting from System EEPROM
		“N” (kNee)	“0” - “9”	ACK	Load Preset Knee Table
6	“R” (Report)	“P” (Page)	“0” - “6”	ACK	ACK + “P” + (“9” - “F”) + 16 bytes
		“U” (User)	“A” - “D”	ACK	ACK + “U” + (“A” - “D”) + 6 bytes
		“S” (System)	“A” - “D”	ACK	ACK + “S” + (“A” - “D”) + (6 bytes)
		“R” (Current)		ACK	ACK + “RR” + 16 bytes
		“X” (Execute)		ACK	Set Camera with loaded data
		“D” (Date)		Info	Report CPU program version
7	“T” (Table)	“N” (kNee)	X1 + Y1 + X2 + Y2	ACK	(X1, Y1) coordinate for knee 1 X1, Y1, X2, Y2: “00 - FF” (X2, Y2) coordinate for knee 2
		“M” (Gamma)		ACK	
		“L” (Linear)		ACK	
		“C” (Switch A, B Table)	“0” or “1”	ACK	

Note: One byte of data consists of two ASCII codes. For example, 0x3A is “3” (0 x 33) and “A” (0 x 41). <ACK> is 0 x 06. <NAK> is 0 x 15. <CR> is 0 x 0D.

Note: 1-byte data is represented in 2 ASCII characters, e.g. 0x3A is “3A” or 0x3341.

<CR> = 0x0D Command or response terminator

<ACK> = 0x06 Command accepted

<NAK> = 0x15 Command not accepted

RS Command: RR<CR>

RS Return: RR + “16 bytes” + <CR>



Table 8 16 Bytes Status Report

Byte 1	MGCL (1 byte)	--	CDS Gain
Byte 2	Vtop(1 byte)	--	A/D reference voltage Top
Byte 3	Vbtm(1 byte)	--	A/D reference voltage Bottom
Byte 4	XA1 (1 byte)	--	X-Coordinate of right knee for table A
Byte 5	YA1 (1 byte)	--	Y-Coordinate of right knee for table A
Byte 6	XA2 (1 byte)	--	X-Coordinate of right knee for table A
Byte 7	YA2 (1 byte)	--	Y-Coordinate of right knee for table A
Byte 8	XB1	--	X-Coordinate of left knee for table B
Byte 9	YB1	--	Y-Coordinate of left knee for table B
Byte 10	XB2	--	X-Coordinate of left knee for table B
Byte 11	YB2	--	Y-Coordinate of left knee for table B
Byte 12	FUNCFLAG1 (1 byte)	--	function flag #1
Byte 13	FUNCFLAG2 (1 byte)	--	function flag #2
Byte 14	SHTRNUM (1 byte)	--	current shutter number
Byte 15, 16	SHTRVAL (2 byte)	--	manual/direct shutter value

Table 9 Function Flag Description 1

BIT	7	6	5	4	3	2	1	0
FUNC-FLAG #1	LOGAVG= 0-Linear Avg 1-Log Avg	ALCFLG= 0=Off, 1-On	BLMFLG Blemish Compensation= 0-Off, 1-On	Resv	SHTR2 FLG	SHTR1 FLG	MSEL2 FLG	MSEL1 FLG

SHTR2FLG (Bit3) -- 00 - (0) no shutter, 01 - (1) normal shutter

SHTR1FLG (Bit2) -- 10 - (2) direct shutter, 11- (3) async shutter

MSEL2FLG (Bit1) -- 00 - (0) normal scan, 01 - (1) partial scan #1 (optional)

MSEL1FLG (Bit0) -- 10 - (0) normal scan, #2 (optional), 11-(3) two-row scan

Table 10 Function Flag Description 2

BIT	7	6	5	4	3	2	1	0
FUNC-FLAG #2	RS-170	TSELFLG	Resv	LUTB2FLG	LUTB1FLG	Resv	LUTA2FLG	LUTA1FLG

TSELFLG (Bit4) -- 0 - Select table A, 1 - Select table B

LUTB2FLG (Bit3) -- 00 - Linear mode; 01 - Knee mode (for table B)

LUTB1FLG (Bit2) -- 10 - Gamma mode; 11 - Direct input mode (reserved)

LUTA2FLG (Bit1) -- 00 - Linear mode; 01 - Knee mode (for table A)

LUTA1FLG (Bit0) -- 10 - Gamma mode; 11 - Direct input mode (reserved)

RS-170=0-Progressive, 1-Interlace

10 Configurable Order Options

10.1 OP1-5 ALC (Automatic Level Control)

ALC keeps the average of output level to a specific value (available for users to specify). ALC is achieved by implementing both AGC (automatic gain control) and AEC (automatic exposure control). AGC controls gain from 8dB to 28dB. AEC controls exposure time from 31.8uS to 33.3mS. Therefore, the camera is possible to work at a very wide dynamic range (10000:1).

Note: When ALC is active, LUT must be either Linear or Gamma .45. Selecting any other knee control LUT may cause an unstable result.

10.2 OP2-1 Imager Blemish Map

10.3 OP2-5 Blemish Correction (monochrome only)

In an attempt to provide blemish free images the TM-9730CL has a built-in blemish correction feature. Through a calibration process, all blemished pixels are detected and their positions are stored in an EEPROM in the camera. The known blemished pixels are corrected by replacing the value of the nearest neighbor pixels. This feature is only available in monochrome cameras.

10.4 OP21-UV UV Imager(monochrome only)

Microless and glassless imager. No imager warranty with this option.

10.5 OP22-5-1 Extended Temperature

-40°C – +65°C (reduced performance may occur).

10.6 OP22-5-5 Conformal Coat

10.7 OP25-3 RS-232 on 12P

Not available with Y/C (OP27-3)

10.8 OP27-1 RS-170 Video Timing

Analog frame buffer for RS-170 video conversion for local monitors, recorders, or other video standard equipment.

Figure 39. Frame Timing Chart

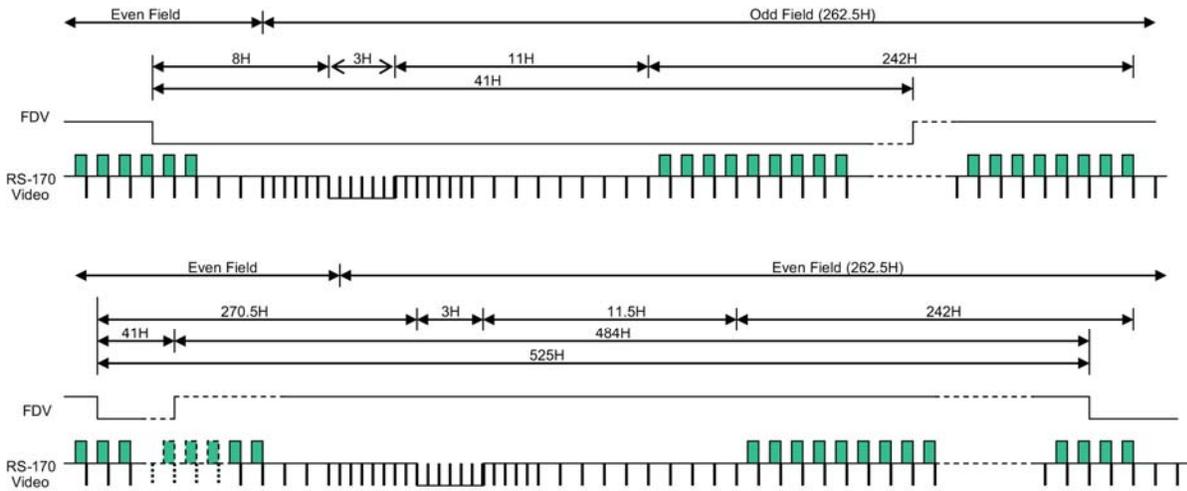
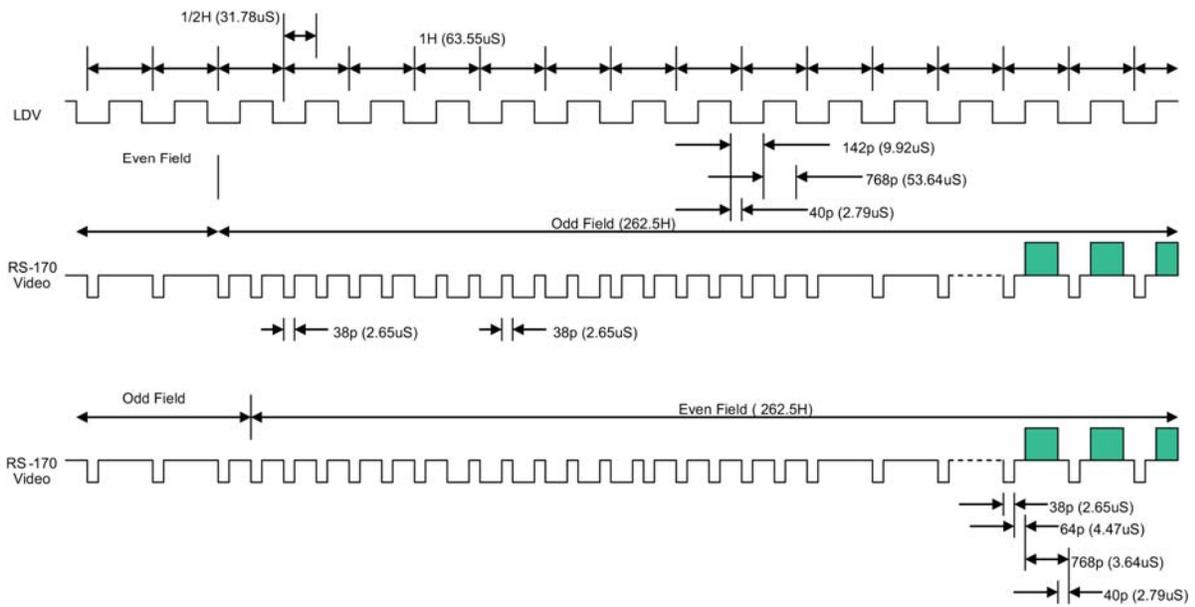


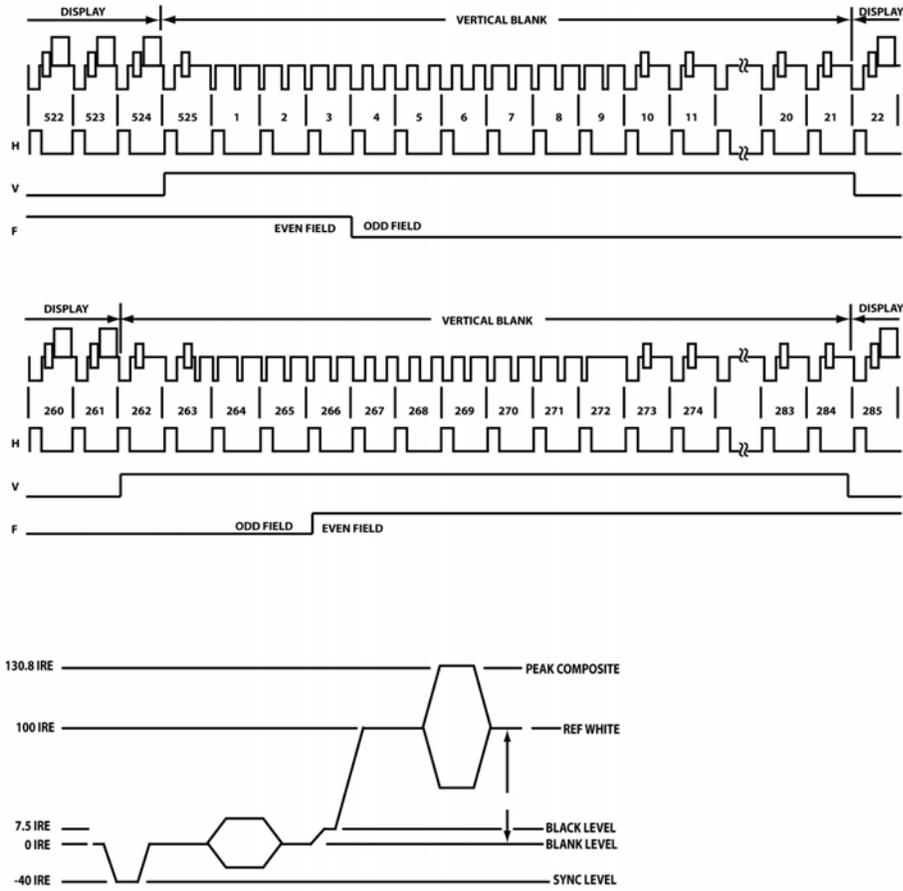
Figure 40. Line Timing Chart



10.9 OP27-2 NTSC (color only)

NTSC composite video. Active video is 708 (H) x 480 (V).

Figure 41. NTSC Composite Video Levels

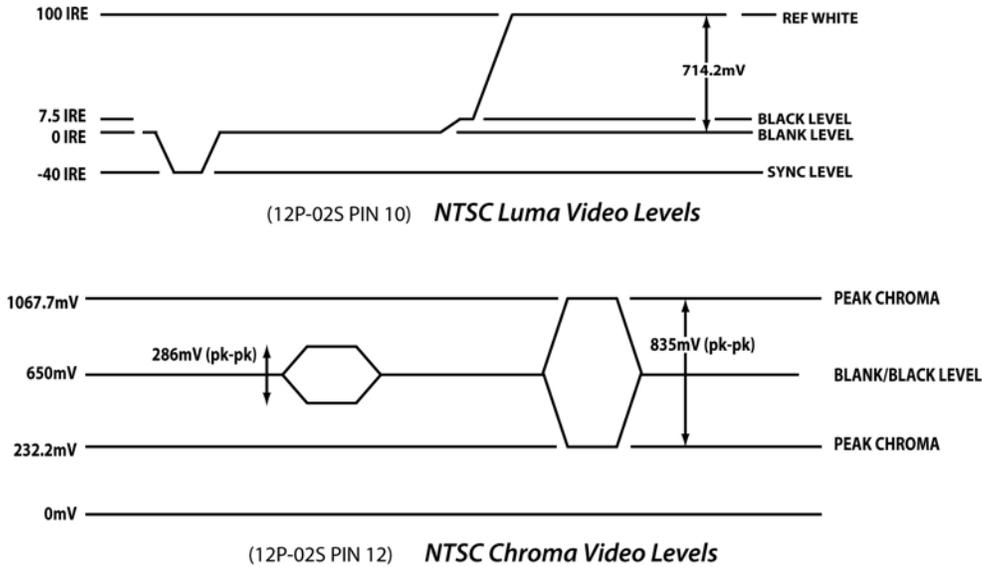


10.10 OP27-3 NTSC Y/C output (color only)

NTSC Y/C has better performance since it separates luma and chroma signals. Y/C output is from the 12-pin Hirose connector.

Pin 10 is Y (luma) Pin 12 is C (chroma)

Figure 42. NTSC Video Levels



10.11 OP60-2 Digital Zoom 2:1 (monochrome only)

Digital zoom takes image information from a portion (or subset) of the pixels in the CCD and enlarges the pixels to fill the entire display. Information from the CCD pixels not used for the digital zoom is discarded.

The TM-9730CL is capable of a maximum of 3x zoom, which uses one third (256 x 162 pixel area) of the CCD. This option is offered for monochrome cameras only.

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