

# Configuring the PXD1000 Digital Frame Grabber with a Digital Camera and Building a Compatible Cable

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The PXD1000 digital frame grabber is compatible with nearly all commercially available 40Mhz and below digital cameras. In order to use a digital camera with your PXD1000 digital frame grabber, a compatible cable and configuration file will be required. Imagenation provides direct support with compatible cables and configuration files for a number of the more popular digital cameras (see list below). Since support for new models of digital cameras are being added on a regular basis, please check the Imagenation Technical Support web page for an up-to-date list of all digital cameras with full support located on the Web at: [www.imagenation.com](http://www.imagenation.com) -> Technical Support -> PXD Series.

If your camera is not listed as one currently being supported, you will need to take a few more steps to configure the PXD1000 to work with your camera. *With the powerful PXD Configuration Utility, you can create a camera definition file for your particular camera and nearly any 40Mhz or lower digital camera can be configured and optimized to operate with the PXD1000.*

## Why Is It Necessary To Build a Unique Cable & Configuration File For Each Digital Camera?

Due to a lack of industry standards in the digital camera world, it is typically necessary to have a specially configured cable for the frame grabber and each digital camera make and model. This is because in general each digital camera can have unique connectors, signal pin-outs, data formats, and data widths (8, 10, 12 bits, etc...).

For example, suppose you plan to use a single channel 10-bit camera; the image data is transmitted on 10 twisted pairs (20 wires). If the camera is generating the timing for the frame grabber then at least Line-Data-Valid (LDV), Frame-data-valid (FDV), and the camera pixel clock (CAMERACLK) will be required. In addition, for example, if the camera uses a single exposure control implemented with EIA-644 and you want the frame grabber to control it, then another twisted pair is required. All in all, even this simple application requires at least 14 twisted pairs.

### Options for acquiring compatible digital cable: -

#### 1) Purchase from Imagenation

Imagenation provides full support for a number of different digital cameras. We provide camera guides, which include specific instructions for configuring the PXD1000 for the camera. Some camera guides and camera configuration files are located on the CD that comes with the

PXD1000. The Technical Support section of the Imagenaiton Web site will contain the latest and most up-to-date information on supported digital cameras.

The following is a partial list of supported cameras (see Web for updated list [www.imagenation.com](http://www.imagenation.com) as this list is constantly expanding).

<b>Camera Configuration Files &amp; Guides</b>	
<b>BASLER</b>	
BA101	Basler Area Scan A101 (Previously A113)
BL102	Basler Line Scan L102 (Previously L130)
BL203	Basler Line Scan L203 (Previously L240)
<b>DALSA</b>	
DALSA	Dalsa CA-D4/D7
<b>HITACHI</b>	
KPF100	Hitachi KPF 100
<b>KODAK</b>	
Kodak MASD has been acquired by Roper Scientific	
ES10	Kodak Megapplus ES 1.0
ES14	Kodak Megapplus ES 1.4i
<b>PULNIX</b>	
TM1001	Pulnix TM 1001-02
TM1010	Pulnix TM 1010
TM1040	Pulnix TM 1040
TM1300	Pulnix TM 1300
TM9701	Pulnix TM 9701
<b>RETICON</b>	
RLS	Reticon Line Scan
<b>UNIQ</b>	
UNIQ	UNIQ Cameras: UP-600, UP-1000, UP-1030, UP-900

## 2) Build your own cable:

If your camera is not listed you will need to create a camera definition file and build a compatible cable. We provide an easy-to-use camera configuration application and customizable cable assemblies that simplify camera and frame grabber setup. If you decide to build the entire cable you will need to consult your camera manual for the part number of the connector used on the camera. The mating cable plug for the PXD1000 is an AMP Amplimite .050 Series Cable Plug Connector, Series III (AMP PN: 749621-9) or equivalent. Imagenation also has two kit options for building your own cable from scratch:

- 1) Cable Kit CB-011 contains 50 twisted pairs and supports up to a full 32-bit camera.
- 2) Cable kit CB-012 contains 37 twisted pairs and is an option for one and two channel digital camera implementations of 10-bits or less.

There is no standard for wiring any particular camera. Imagenation provides information to help get you started on page 51 to page 53 in the users guide.

Start by making a map of the connections as shown on page 53. You will need to list all the required signals needed to drive your camera. In addition to the data lines, most digital cameras require at least a Line-Data-Valid (LDV), Frame-Data-Valid (FDV) and Pixel clock (CAMCLK). Addition signals may be needed depending on the camera used. These signals are most likely differential signals and require a twisted pair for each signal.

The connection of the Data signals is a little more involved. To start with Imagenation biases the Data connection to the upper bits of each channel. This means that that your data bits from the camera need to be shifted.

<b>Camera Data Channel 1</b>	<b>PXD DATA BITS</b>	<b>Camera Data Channel 2</b>	<b>PXD DATA BITS</b>
8 Bit (0-7)	-> Data Bits (8-15)	8 Bit (0-7)	-> Data Bits (24-31)
10 Bit (0-9)	-> Data Bits (6-15)	10 Bit (0-9)	-> Data Bits (22-31)
12 Bit (0-12)	-> Data Bits (4-15)	12 Bit (0-12)	-> Data Bits (20-31)
16 Bit (0-15)	-> Data Bits (0-15)	16 Bit (0-15)	-> Data Bits (16-31)
24 Bit (8-31)	-> Data Bits (8-31)		
32 Bit (0-31)	-> Data Bits (0-31)		

Also note that these signals always require two wires per signal. The J2 connector shown in Figure 1 of this guide (page 52 in the PXD1000 Users Manual) shows these signal labeled as Data(-) on the left and Data(+) on the right.

Data(-) - Data Bits 0-31 to pins 98-67

Data(+) - Data Bits 0-31 to pins 48-17

Here is some basic information on the J2 data connector for pins 1-15 and 65-51 on the PXD1000 Digital Frame grabber.

CAMCLK(-) - pin 65 & CAMCLK(+) - pin 15

Name: Camera Clock

Signal provided by: Camera

Purpose: indicates when Pixel is valid

Signal: Rising sensitive

LDV(-) - pin 64 & LDV(+) - pin 14

Name: Line Data Valid

Signal provided by: Camera

Purpose: tells which pixel is valid for a line

Signal: High or Low depending on camera

FDV(-) - pin 63 & FDV(+) - pin 13

Name: Frame Data Valid

Signal provided by: Camera

Purpose: Tells which lines are valid for frame

Signal: High or Low depending on camera

HD(-) - pin 61 & HD (+) - pin 11

Name: Horizontal Drive

Signal provided by: Frame Grabber

Purpose: Tells camera to provide a valid Pixel in line

Signal: High or low depending on camera

VD(-) - pin 60 & (+) - pin 10

Name: Vertical Drive

Signal provided by: Frame Grabber

Purpose: Tells camera to provide a valid line

Signal: High or low depending on camera

Ground/Strobe#0(-) - pin 59 & Strobe#0(+) - pin 59

Name: Strobe 0

Signal provided by: Frame Grabber

Purpose: Provides a series of timed pulses for use by application

Signal: Pulse train of gap, pulse, gap, pulse ...

Ground/Strobe#1(-) - pin 58 & Strobe#1(+) - pin 8

Name: Strobe 1

Signal provided by: Frame Grabber

Purpose: Provides a series of timed pulses for use by application

Signal: Pulse train of gap, pulse, gap, pulse ...

Synthclk(-) - pin 57 & Synthclk(+) - pin 7

Name: Synth Clock

Signal provided by: Frame Grabber

Purpose: Instructs camera to provide another pixel

Signal: Rising edge sensitive

WEN(-) - pin 56 & WEN(+) - pin 6

Name: Write Enable

Signal provided by: Camera

Purpose: Defined by camera

FIELD(-) - pin 55 & FIELD(+) - pin 5

Name: Field

Signal provided by: Camera

Purpose: signal for even or odd field for interlaced output

CTRL#0(-) - pin 54 & CTRL#0(+) - pin 4

Name: Control 0

Signal provided by: Frame Grabber

Purpose: Provides TTL output for use by application

CTRL#1(-) - pin 53 & CTRL#1(+) - pin 3

Name: Control 1

Signal provided by: Frame Grabber

Purpose: Provides TTL output for use by application

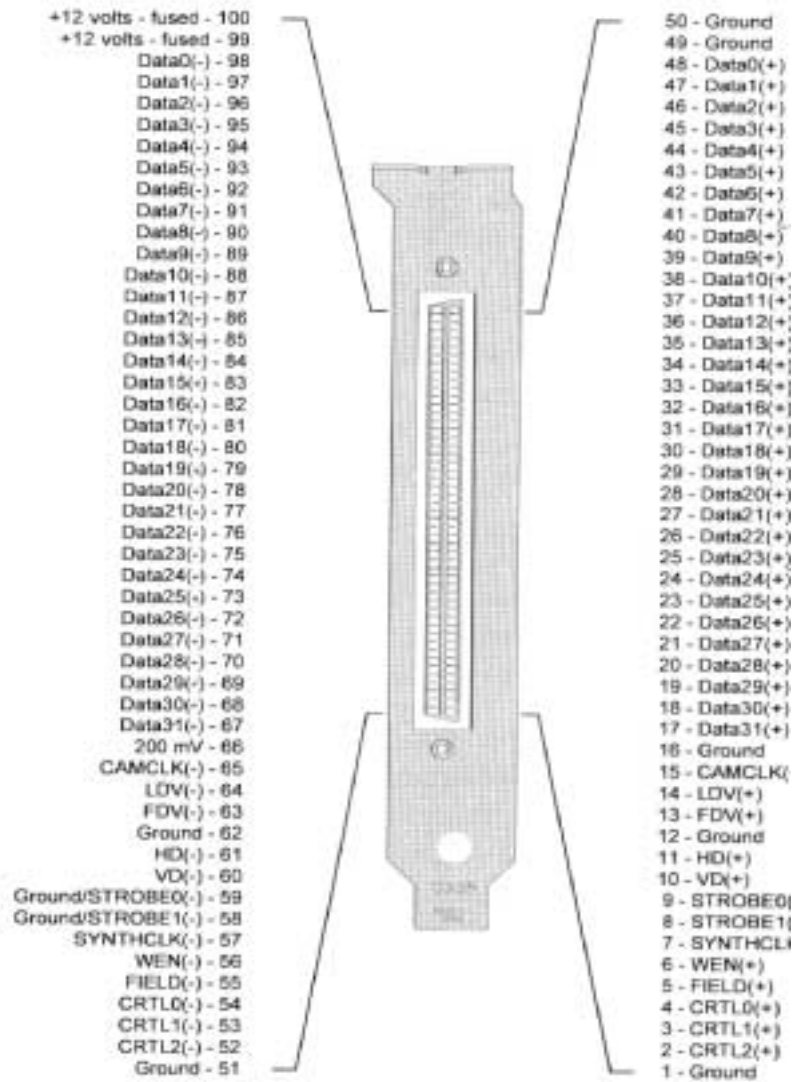
CTRL#2(-) - pin 52 & CTRL#2(+) - pin 2

Name: Control 2

Signal provided by: Frame Grabber

Purpose: Provides TTL output for use by application

Figure 1 Data connector (J2)



### The I/O Connector (Optional)

All other signals (except for camera data and timing) are available at the I/O connector. This includes the trigger, strobes and two general-purpose inputs and two outputs. Figure 4.2 shows the signals on the I/O connector

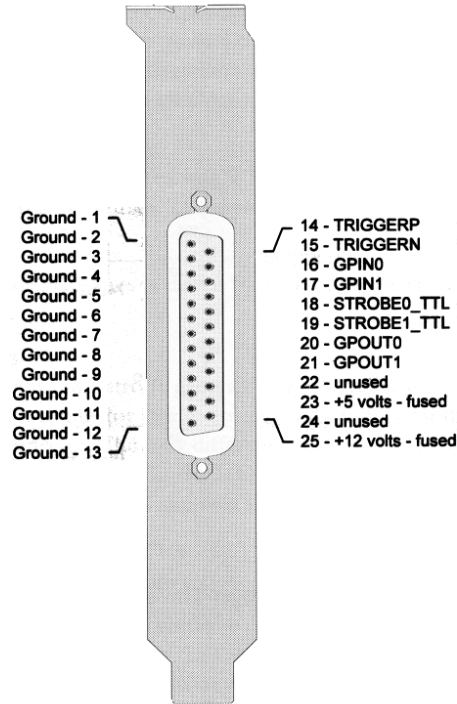


Figure 4.2 The I/O connector

### 3) Build from cable with compatible FG connector

For cameras where standard cables are not available, you can purchase an Imagination cable-kit and build one or make your own from scratch. In addition you will need to consult your camera manual for the part number of the connector used on the camera and get the pin out of the camera connector from the camera manufacturer.

If you use a camera that has 10 or fewer data bits, we recommend that you use Cable Kit CB-012-00. With some cameras every data line may need to be terminated to 200mv (provided at pin 66 of J2), In this case the smaller cable will have fewer wires that need to be terminated.

### Making a data cable for 10-bit and Smaller Cameras

**Cable kit CB-012-00 is appropriate for cameras with up to 10 data bits.** This includes all single channel cameras and two channel cameras with up to 10 bits per channel. *(Note: the PXD1000 manual incorrectly*

states that the CB-012-00 kit was appropriate for single channel digital cameras of up to 20-bits)

The kit contains a cable with 37 twisted pairs of wires terminated on one end by a 100-pin connector, which mates to the PXD1000. On the other end the wires have been prepared for attaching to a connector (which you must supply) that mates to your camera.

### Cable kit CB-012-00

Signal	Pin	Wire Color (Wire/Stripe)	Pin	Signal
GROUND	1	Purple/Orange	51	GROUND
	2	NC	52	
CRTL1(+)	3	Blue/Orange	53	CRTL1(-)
CRTL0(+)	4	Gray/Orange	54	CRTL0(-)
FIELD(+)	5	Brown/Pink	55	FIELD(-)
WEN(+)	6	Green/Yellow	56	WEN(-)
SYNTHCLK(+)	7	Green/Orange	57	SYNTHCLK(-)
STROBE1(+)	8	Brown/Orange	58	GND/STROBE1(-)
STROBE0(+)	9	Pink/White	59	GND/STROBE0(-)
VD(+)	10	Blue/Yellow	60	GND/VD(-)
HD(+)	11	Brown/Yellow	61	GND/HD(-)
GROUND	12	Brown/White	62	GROUND
FDV(+)	13	Orange/Yellow	63	FDV(-)
LDV(+)	14	Gray/Tan	64	LDV(-)
CAMCLK(+)	15	Purple/Tan	65	CAMCLK(-)
GROUND	16	Gray/Pink	66	200MV
Data31(+)	17	White/Orange	67	Data31(-)
Data30(+)	18	Brown/Green	68	Data30(-)
Data29(+)	19	Purple/Yellow	69	Data29(-)
Data28(+)	20	White/Yellow	70	Data28(-)
Data27(+)	21	Brown/Blue	71	Data27(-)
Data26(+)	22	Tan/White	72	Data26(-)
Data25(+)	23	Purple/Pink	73	Data25(-)
Data24(+)	24	Blue/Tan	74	Data24(-)
Data23(+)	25	Blue/Pink	75	Data23(-)
Data22(+)	26	Purple/White	76	Data22(-)
	27	NC	77	
	28	NC	78	
	29	NC	79	
	30	NC	80	
	31	NC	81	
	32	NC	82	
Data15(+)	33	Blue/White	83	Data15(-)
Data14(+)	34	Brown/Tan	84	Data14(-)
Data12(+)	35	Tan/Pink	85	Data13(-)
Data13(+)	36	Gray/Yellow	86	Data12(-)
Data11(+)	37	Brown/Purple	87	Data11(-)
Data10(+)	38	Brown/Gray	88	Data10(-)
Data9(+)	39	Tan/Green	89	Data9(-)
Data8(+)	40	Green/Pink	90	Data8(-)
Data7(+)	41	Pink/Yellow	91	Data7(-)



Data6(+)	42	Tan/Yellow	92	Yellow/Tan	Data6(-)
	43	NC	93	NC	
	44	NC	94	NC	
	45	NC	95	NC	
	46	NC	96	NC	
	47	NC	97	NC	
	48	NC	98	NC	
GROUND	49	Tan/Orange	99	Orange/Tan	+12V_FUSED
GROUND	50	Orange/Pink	100	Pink/Orange	+12V_FUSED

### Making a data cable for 11-bit to 32-bit Cameras

Cable kit CB-011-00 is appropriate for cameras from 11 data bits to 32 data bits.

The kit contains a cable with 50 twisted pairs of wires terminated on one end by a 100-pin connector, which mates to the PXD1000. On the other end the wires have been prepared for attaching to a connector (which you must supply) that mates to your camera.

### Cable kit CB-011-00

Signal	Pin	Wire Color (Wire/Stripe)	Pin	Wire Color (Wire/Stripe)	Signal
GROUND	1	Purple/Orange	51	Orange/Purple	GROUND
CRTL2(+)	2	Green/White	52	White/Green	CRTL2(-)
CRTL1(+)	3	Blue/Orange	53	Orange/Blue	CRTL1(-)
CRTL0(+)	4	Gray/Orange	54	Orange/Gray	CRTL0(-)
FIELD(+)	5	Brown/Pink	55	Pink/Brown	FIELD(-)
WEN(+)	6	Green/Yellow	56	Yellow/Green	WEN(-)
SYNTHCLK(+)	7	Green/Orange	57	Orange/Green	SYNTHCLK(-)
STROBE1(+)	8	Brown/Orange	58	Orange/Brown	GND/STROBE1(-)
STROBE0(+)	9	Pink/White	59	White/Pink	GND/STROBE0(-)
VD(+)	10	Blue/Yellow	60	Yellow/Blue	GND/VD(-)
HD(+)	11	Brown/Yellow	61	Yellow/Brown	GND/HD(-)
GROUND	12	Brown/White	62	White/Brown	GROUND
FDV(+)	13	Orange/Yellow	63	Yellow/Orange	FDV(-)
LDV(+)	14	Gray/Tan	64	Tan/Gray	LDV(-)
CAMCLK(+)	15	Purple/Tan	65	Tan/Purple	CAMCLK(-)
GROUND	16	Gray/Pink	66	Pink/Gray	200MV
Data31(+)	17	White/Orange	67	Orange/White	Data31(-)
Data30(+)	18	Brown/Green	68	Green/Brown	Data30(-)
Data29(+)	19	Purple/Yellow	69	Yellow/Purple	Data29(-)
Data28(+)	20	White/Yellow	70	Yellow/White	Data28(-)
Data27(+)	21	Brown/Blue	71	Blue/Brown	Data27(-)
Data26(+)	22	Tan/White	72	White/Tan	Data26(-)
Data25(+)	23	Purple/Pink	73	Pink/Purple	Data25(-)
Data24(+)	24	Blue/Tan	74	Tan/Blue	Data24(-)
Data23(+)	25	Blue/Pink	75	Pink/Blue	Data23(-)
Data22(+)	26	Purple/White	76	White/Purple	Data22(-)
Data21(+)	27	Blue/Gray	77	Gray/Blue	Data21(-)
Data20(+)	28	Blue/Purple	78	Purple/Blue	Data20(-)

Data19(+)	29	Blue/Green		79	Green/Blue	Data19(-)
Data18(+)	30	Green/Purple		80	Purple/Green	Data18(-)
Data17(+)	31	Gray/Purple		81	Purple/Gray	Data17(-)
Data16(+)	32	Gray/Green		82	Green/Gray	Data16(-)
Data15(+)	33	Blue/White		83	White/Blue	Data15(-)
Data14(+)	34	Brown/Tan		84	Tan/Brown	Data14(-)
Data12(+)	35	Tan/Pink		85	Pink/Tan	Data13(-)
Data13(+)	36	Gray/Yellow		86	Yellow/Gray	Data12(-)
Data11(+)	37	Brown/Purple		87	Purple/Brown	Data11(-)
Data10(+)	38	Brown/Gray		88	Gray/Brown	Data10(-)
Data9(+)	39	Tan/Green		89	Green/Tan	Data9(-)
Data8(+)	40	Green/Pink		90	Pink/Green	Data8(-)
Data7(+)	41	Pink/Yellow		91	Yellow/Pink	Data7(-)
Data6(+)	42	Tan/Yellow		92	Yellow/Tan	Data6(-)
Data5(+)	43	Gray/White		93	White/Gray	Data5(-)
Data4(+)	44	Green		94	Yellow	Data4(-)
Data3(+)	45	Tan		95	White	Data3(-)
Data2(+)	46	Purple		96	Orange	Data2(-)
Data1(+)	47	Brown		97	Gray	Data1(-)
Data0(+)	48	Blue		98	Pink	Data0(-)
GROUND	49	Tan/Orange		99	Orange/Tan	+12V_FUSED
GROUND	50	Orange/Pink		100	Pink/Orange	+12V_FUSED

**a. Build from cable with compatible Camera connector**

If you plan to build a cable using a compatible Camera connector then you will need a compatible mating cable plug for the PXD1000. The mating cable plug for the PXD100 is an AMP Amplimite .050 Series Cable Plug Connector, Series III (AMP PN: 749621-9) or equivalent

**b. How long can the Digital Cable be?** Imagination recommends that the cables for the digital camera to PXD1000 be 10 meters in length or less. If cables are any longer than 10 meters, unpredictable results may occur. There is not an easy answer to this question for cables longer than 10 meters. Cables up to 10 meters should work for all cameras. Beyond 10 meters, the answer begins to depend more on the camera and the speed of the data than on the frame grabber. In general, the higher the speed, the shorter the cable. A 40MHz camera, for example, would need a shorter cable than a 20 MHz camera.

The problem with a long cable is that the wire sets up a distributed capacitance. It can change the timing of the bits. If the timing of the bits changes then the frame grabber will miss data. A high quality camera will have a guard band on the bits to compensate for some small timing changes.

LVDS is designed to allow cables up to several hundred feet, however, much of that depends on the camera and the frequency.

Regardless of if your cable ends up being longer or shorter than 3 meters, all cable wires must be of equal length due to the extremely sensitive timing characters of the Frame Grabber and Digital Camera interface.

## The PXD Configuration Application

Imagenation provides a program called PXD Configuration Application which is used to create a configuration file for your digital camera. The following described each box in configuration application

### Setting the camera Information (Select Camera Information Tab)

- a) Pixel Type (also known as bit depth)
  - i. Y8, Y10, Y12, RGB32
- b) Camera Type
  - i. Area Scan
  - ii. Line Scan or TDI

### Image Geometry (Select Image Geometry Tab)

- a) Image Size (Set resolution for camera used)
  - i. Width (in pixels)
  - ii. Height (in pixels)
- b) Image format (set appropriately for camera used)
  - i. First button is for single channel, non-interlaced camera
  - ii. Second button for single channel, interlaced camera
  - iii. Next Three buttons are for 2-Channel cameras.
  - iv. Next Three buttons are for 4-Channel cameras.
  - v. The Custom button allows you to define a new format.

### Exposure Timing (Select Exposure Timing Tab)

- a) Exposure control Type
  - i. Async for cameras that generate frames that are occasionally controlled by something other than the frame grabber. For example this setting can be used to generate a frame only when it is triggered by some external mechanism (snap-shot mode).
  - ii. Free run for cameras that output continuous frames of video based on internal timing or synched to the drive signals from the grabber. (Live video mode)
  - iii. Strobes to set the frame grabber to generate strobe signals at the strobe0 and strobe1 pins. This can be used to program the exposure or integration time or used as a general-purpose output signal or strobe light.
- b) Strobe 0 and Strobe 1.
  - i. This sets the polarity of the output to high true or low true.
- c) Camera Control 0,1,2
  - i. This sets the polarity of the general-purpose control pins High true or Low true.

- d) Exposure and Strobe Timing Settings (Exposure control Type set to strobe)
  - i. Exposure type
    - a. Strobes set the frame grabber to generate signals at the strobe0 and strobe1 pins. These signals can be used to program the exposure or integration time of the camera.
    - b. Fixed Exposure means that the camera's exposure is not adjustable. You can still program the strobes, but the exposure time features are not available.
    - c. Unknown Exposure is used if the exposure is unknown or not programmable. In this case, the strobes do not control the exposure and are used for other output.
    - d. Variable Exposure allows you to set exposure timing within a software application. The exposure time is added to the strobe duration if only 1 strobe is enabled or to the time between strobes if 2 strobes are enabled
  - e) Delay and Period
    - i. Delay and Period are part of the strobe timing. They set the delay between strobes and the period of each strobe pulse. Strobes set the frame grabber to generate signals at the Strobe#0 and Strobe#1 pins.

#### Setting the Video Timing (Select the Video Timing tab)

- a) Enter Pixel clock speed (from the camera specification)
  - i. The pixel clock speed is used to set the clock generator of the frame grabber. This setting must be correct in order for the camera to work properly.
- b) Set the Frame Speed.
  - i. If the exposure time on your camera (which should be listed in your camera manual) is longer than the minimum frame period, use Variable
- c) Set the Horizontal and Vertical Sync.
  - i. Number clocks before valid pixels from the horizontal sync
  - ii. Number of lines before valid image lines from the vertical sync
  - iii. You most likely will find the horizontal and vertical sync information in your camera's manual or you can derive it from the timing diagram in the camera manual. You can also experiment with the numbers and see what works best.

#### Advanced Video Timing (Select the tab and enter the appropriate information)

- a) For cameras that use Horizontal Drive, the frame grabber generates an Hdrive pulse and the camera synchronizes to it. The camera then generates an LDV (Line Data Valid) signal and sends it back to the frame grabber. The frame grabber uses the LDV to detect the starting pixel of each line from the camera.

- i. Pulse Width: in number of clocks
  - ii. Output polarity: Low or High true
  - iii. Strobe#l wire: Output the HDrive signal to strobe1 and strobe1 ++1 wires in addition to the HDrive wire
  - iv. Clocks from Data to Hsync: number of clocks from last pixel on the line to following horizontal sync.
  - v. For cameras that use Vertical Drive, the frame grabber generates a V drive pulse and the camera synchronizes to it. The camera then generates an FDV (Frame Data Valid) signal and sends it back to the frame grabber. The frame grabber uses the FDV to detect the starting line of each frame from the camera.
    - Pulse Width: in number of clocks
    - Output polarity: Low or High true
    - Strobe#O wire: Output the VDrive signal to strobe#O and strobe#O++1 wires in addition to the VDrive wire
    - Clocks from Data to V sync: number of lines from last line to following vertical sync.
- b) If your camera is an interlaced camera, enter the appropriate information under Interlace Control.
- Starting Field: either 0 or 1
  - First Line Length: Length of the first line on field 0 and field 1. Both fields are usually set to the width of the image size.
  - Vdrive offset: Number of pixel clocks after the edge of the Hdrive that Vdrive goes active.
- c) If your camera requires a clock from the PXDI000 set the Clocks per Pixel. Most cameras require one clock per pixel, but some require two. Refer to your camera manual for the correct setting.
- d) Set the Strobe/Drive Signal. This is the type of output signals generated by the frame grabber (either RS422 or TTL), for HDrive, VDrive, strobeO, and strobel.

#### Relationship to various pins

Camera Control 0,1,2 general purpose control pins can be used to control camera modes. For example the Dalsa CA-D7 camera has features, which cause the camera to output only half the resolution but at faster frame rate. The control pin can be used to control this feature on this camera. (Refer to page 43 of the user guide).

#### Troubleshooting tips and hints when using the PXD Configuration Application.

##### Shape edges or ring around the images:

Shape edges or rings around the image on the screen may indicate that the pixel clock lines need to be swapped. Swap the lines in the cable to the pixel clock CAMCLK(-) - pin 65 & CAMCLK(+) - pin 15 and see if the problem goes away.

Dim image:

- With smooth gradations -Try Increase lighting, check cameras F-Stop, Exposure control settings.
- With banding-Check cable wiring of the data bits. Remember that Imagenation biases the Data connection to the upper bits of each channel. If this is wrong you may not be seeing all the bits.

All Black image:

- Check cable wiring.  
FDV, LDV, Pixel Clock hook up.
- Check Power connector to camera. (if power from FG check to see if power connector is hooked up to PXD1000.
- Is the camera shutter open.
- Try setting Configuration Application to free running mode.
- Some cameras have enable line that needed to be connected to Control0, which will need to be set High in the Configuration Application.
- Check Exposure setting.
- Is the image depth set correct in the Configuration Application Y8, Y10, Y12 or RGB32.

Output formats/standards – i.e. RS422, TTL, LDVS(?)

RS644/RS422 are the type of input/output signal generated by the camera. They are parallel differential signal (The state of the signal at the receiver is determine by the potential difference between two wires)

The Interface data receivers are LVDS on the data connector and the signals on the I/O connector are single ended TTL only (Reference pages 51-58 and 336 of our manual). The LDVS lines will work with standard TTL levels but require a change to the cable wiring to the connector. The type of output signal generated by the frame grabber (single ended TTL or differential RS422) can be set for Hdrive, Vdrive, strobe0 and strobe1. Note that the strobe outputs on the I/O connector are TTL level signals only.

TTL : Transistor Transistor Logic (5v Level true)

LVTTTL: Low Voltage Transistor Transistor Logic ( 3.3 Volt Level True )

LVDS: Low Voltage Differential Signals (The state of the signal at the receiver is determined by the potential difference between two wires.)

## Digital Frame Grabber Information

### **The WEN Signal**

This signal is an input to the frame grabber from the camera and is typically treated as a FTV (Field Data Valid). This signal is available on I/O line 1. The signal can be set to trigger a grab using the SetTriggerSource function.

### **Data line Options**

8 bit, 10 bit, 12 bit, 14 bit, 16 bit, 32 bit – Bits/Pixel

For a monochrome camera this describes the maximum number of resolvable gray levels that the camera can provide. Eight bits per pixel (256 gray levels) is quite common with 10, 12 and 14 bits/pixel available in some models. A distinct advantage of digital camera results from having the digital-to-analog converter moved from the frame grabber card into the camera. This reduces the effects of transmission line noise on the quality of the image, making the least significant bits in each pixel more meaningful.

### **Modes – 8x1, 8x2 – Channel**

As the resolution of the image sensor and the bits/pixel and the frame rate increase, larger and larger amounts of image data must be transferred to the frame grabber. To keep frame rates high many digital cameras deliver image data via multiple (synchronized) digital outputs called channels. Each channel is used to transfer only a portion of the image information. For example the Dalsa CA-D4 is 1024 x 1024, 8-bit/pixel camera can operate as either a one or two channel camera.

In order for a digital frame grabber to be able to receive more than one pixel at a time it must first have a digital input port that is wide enough to handle the number of simultaneous data bits the camera is transmitting. In two-channel mode, the Dalsa CA-D4 transmits two 8-bit pixels on each clock. A digital grabber with at least a 16-bit input port would be required.

### **Triggers – methods and options**

A trigger signal can be set to trigger a grab using the SetTriggerSource function. The function can also define the type of trigger event that will cause the trigger LATCH\_RISING, LATCH\_FALLING, IO\_INPUT\_HIGH, IO\_INPUT\_LOW and DEBOUNCE. The input lines that can serve to trigger a grab are the Trigger line I/O line 0, WEN I/O line 1, and GPINO input 0 line I/O line number 7. (Refer to page 241 of the PXD Users Guide).

### **Debounce**

Mechanical switches used as trigger inputs typically bounce, creating spurious edges, when the contacts open or close. You will probably need

to debounce this signal. The debounce flag can be set using the SetTriggerSource function. If the debounce flag is set then two trigger signals are required. One signal is set to TRIGGERP line 14 of the I/O connector. The other is sent to TRIGGERN line 15 of the I/O connector. By sending the signal to TRIGGERP the internal state will be set to one state. By sending the signal to TRIGGERN the internal state will be set to the reversed state. This can be accomplished using a SPDT type switch.

### **Burst PCI Rate versus Sustained PCI Rate**

A bus master can burst data across a well-designed PCI bus at 132MB/second. Other devices on the bus can request and gain access to the bus, lowering the sustained performance. The ability of a frame grabber to sustain data transfers without losing data is related to the ability of the grabber to buffer data while another user has control of the bus. The higher the input data rate from the camera, the more the grabber needs to buffer. The maximum transfer rate that a grabber can sustain is related to how efficient the buffering scheme on the board is and how efficient the PCI interface is.

### **EIA422-B vs. EIA-644**

These are "balanced" data transmission standards that require two wires per signal. The state of the signal at the receiver is determined by the potential difference between the two wires and not by the difference between the signal on a single wire and ground. Since each wire in the pair is subjected to roughly the same transmission environment, electrical noise adds equally to both wires. This "common mode" noise is subtracted at the receiver. This makes both of these standards particularly useful in noisy environments. EIA-644 operates at lower voltage differences than EIA-422 providing higher transmission bandwidths. EIA-644 transmitters and receivers also introduce less line-to-line skew meaning that signal integrity is better preserved even when the transmitter is EIA-422 and the receiver is EIA-644.

### **Frame Rate**

Refers to the sustained rate at which a camera can generate images. It is usually the longer of the exposure time or the image transfer time.

### **Input Look-up Tables (LUTs)**

LUTs are useful for several pixel operations that free the processor from mundane pixel mapping. Typical uses include

- applying a gamma correction
- mapping the input pixel values to another set of values
- performing a threshold operation to produce a binary image

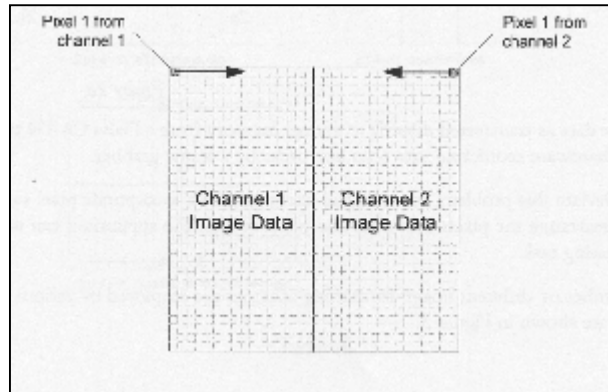


**Pixel Clock Source**

Most digital cameras provide their own pixel clock to the frame grabber but in situations where a custom frame and pixel rate are required, the frame grabber must create the pixel clock for the camera. A pixel clock source provides more flexibility for the system integrator.

## Pixel Swizzling

The second aspect of multi-channel cameras that can cause problems for digital frame grabbers is the ordering of the received pixels. Figure 1 illustrates how the Dalsa CA-D4 two-channel camera transmits pixels to the frame grabber. Two pixels are received on the first pixel clock; pixel 0 from the top left edge of the image and pixel 1023 (remember there are 1024 pixels/line in the) from the top right. On each successive clock the next pixel received from each channel is from



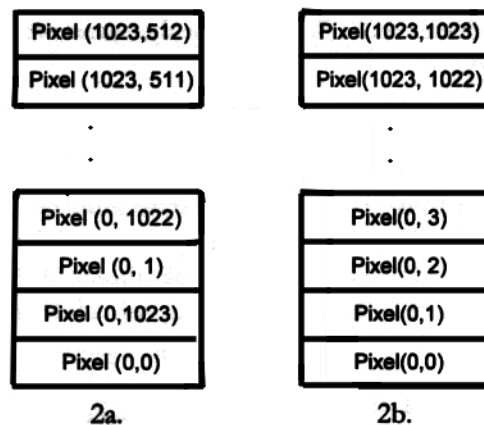
one step in toward the centerline.

Figure 2.

Channel 1 in the Dalsa CA-D4 (in 2 channel mode) transmits image data beginning at the left edge of the top row continuing to the midpoint at which time it returns to the left edge to begin line two. It continues sending the data line by line until it reaches the bottom of the image. Channel 2 transmits right to left, stopping at the midpoint and in a similar fashion transmitting each half line from top to bottom.

If this information were simply transferred to system memory (Figure3), the end-user application would not have a coherent image but instead would need to de-scramble the image software, a time consuming task.

Figure 3.



2a.

2b.

Image data as transferred directly to system memory from a Dalsa CA-D4 two-channel camera and 2b after hardware reordering into scan line order by a frame grabber.

To alleviate this problem, many digital frame grabbers incorporate pixel swizzling circuitry to dynamically rearrange the pixels into scan line order so that the application can immediately begin the image-processing task.

Different cameras employ a number of different image-formatting schemes. The most common are shown in Figure 4.

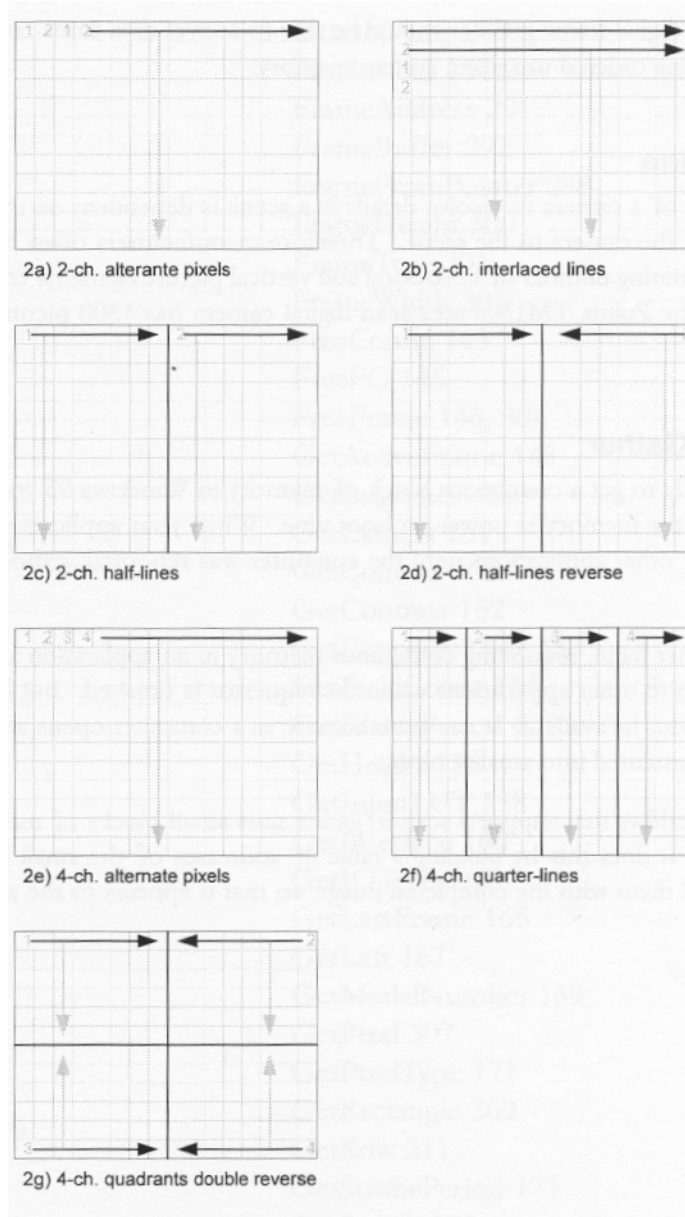


Figure 4.

A modern digital frame grabber should be able to convert data from cameras with each of these formats into scan line ordered images in system memory.

### **Resolution**

The ability of a camera to resolve details in a scene is dependent on the type of lens employed and the relation of the camera to the scene. Therefore manufacturers often describe the resolution of a camera by the stating number of horizontal and vertical picture elements contained in the image sensor. For example, the Pulnix TM1300 area-scan digital camera has 1300 picture elements in each row by 1030 rows.

### **Scatter/Gather**

Traditionally to get a contiguous block of memory in Windows 95 you had to use a kernel level driver to capture the memory at power-on boot time. When your application was done the memory couldn't be used by other applications until the computer was rebooted without the contiguous block memory request.

On the other hand, requesting contiguous memory in an application at run-time allows the memory to be freed up to other applications when the requestor is finished. But large contiguous blocks of memory might not be available at run-time because as a computer opens and closes applications the memory gets fragmented into smaller blocks.

A frame grabber that supports scatter/ gather uses small blocks of memory as if it has a large contiguous block. It does this by building a table of addresses of the small blocks and stepping through the table to fill them with the completed image, so that it appears to the application as one large block.

## **Troubleshooting**

### **Symptom:**

Black Screen Where Image Should Be

### **Possible Cause/Solution:**

- Verify that the data lines and at a minimum the HDV, LDV, and CAMCLK (Pixel Clock) are connected correctly on the cable. If the Camera is providing the Pixel Clock (most common) then the CAMCLK (pins 65 & 15) will be used. If the Frame grabber is providing the Pixel Clock, then the Synthclk (pins 57 & 7) will be used.
- Verify that the power is properly connected to the camera. If the camera is being powered off the board, then make sure the power pins are connected in the cable and that the 12 volt floppy power connector is connected to the J1 connector on the PCD1000.

- Verify that proper lighting exists and that the camera shutter is open and allowing sufficient light into lens.
- Verify that exposure time is not too short.
- Verify camera is in free-running default mode option mode.
- Verify that all “enable” lines are connected for the camera. For example, some cameras have a line called “Control line” which needs to be set to the CTRL0 in order for the camera to function. The Control Lines can be set either “HIGH” or “LOW” in the PXD configuration application under “Exposure Timing”.
- Image depth or image dimensions may be incorrect. Verify that camera is configured properly for pixel type, (i.e. 8, 10 12 bit, 32bit RGB etc..), and verify that image dimensions are set correctly, (i.e. 1000x1000 2000x2000, etc..)

**Symptom:**

- Receiving ERR\_CORRUPT message in the PXD Configuration Application.

**Possible Cause/Solution:**

- This error message is a very non-specific message that indicates the application is unable to interpret or understand the image. A likely cause is that some setting in the configuration is incorrect. Correct configuration problem.

**Symptom:**

- Changing gray image or changing image present but indistinguishable or jumbled.

**Possible Cause/Solution:**

- Data lines wired incorrectly. Verify that on the PXD1000, the data lines coming from the camera are biased to the higher order bits (see example in this manual). For example, if a one-channel 10 bit camera was wired to pins 0 – 10 rather than 6-15 (like it is suppose to be), then only data-lines 9 and 10 would actually be receiving data input from the camera, and thus changing the display while data-lines 11-15 would remain constant. In other words, the 10 bit image would only have 2 bits of that image changing and thus cause an unrecognizable, but change image on the display.
- Camera channel selection.. For example, if a two-channel camera is sending 8 bit images to the FG, but the cable is wired for pins 0-15 rather than pins 8-15 and 24-31, then the resulting display may be unpredictable.
- Verify that pixels per-line are set incorrectly.
- Incorrect Pixel ordering scheme. If the pixel order sent out from the camera is 2-ch, half-lines reversed, and something other than this is selected in the PXD Configuration, then unpredictable results will occur.
- Any combination of the above. It is possible that the any of the above configuration issue may be present. Verify all configurations with the PXD Configuration Application and the Camera’s User Guide.

**Symptoms:**

- Image has speckling or small spots
- Sharp edges in the image have rings

- Graduations have stripes

**Possible Cause/Solution:**

- If any of the symptoms described above exist, try reversing the Pixel Clock pins. The pins which should be swapped will depend on whether the pixel clock is being driven by the camera (most common) or is driven by the Frame Grabber. For example, if the camera is driving the pixel clock, try reversing the CAMCLK pins (pin 65 and pin 15), or if the Frame Grabber is driving the pixel clock, try reversing the Synthclk pins (pin 57 and pin).

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