PIRANHA

CT-P1, CL-P1

High-Speed Line Scan

Camera User's Manual

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DALSA

technology with vision

About DALSA

DALSA is an international high performance semiconductor and electronics company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing wafer foundry services. DALSA's core competencies are in specialized integrated circuit and electronics technology, and highly engineered semiconductor wafer processing. Products include image sensor components; electronic digital cameras; and semiconductor wafer foundry services for use in MEMS, power semiconductors, image sensors and mixed signal CMOS chips.

DALSA is a public company listed on the Toronto Stock Exchange under the symbol "DSA". Based in Waterloo, On. Canada, the company has operations in Bromont, PQ; Colorado Springs, CO; Eindhoven, NL; Munich, Germany and Tokyo, Japan.

All DALSA products are manufactured using the latest state-of-the-art equipment to ensure product reliability. All electronic modules and cameras are subjected to a 24 hour burn-in test.

For further information not included in this manual, or for information on DALSA's extensive line of image sensing products, please call:

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Introduction to Piranha

1.1 Camera Highlights

- 512, 1024, 2048, or 4096 element line scan; 10µm square pixels, 100% fill factor
- Low image lag and high blue response
- 25MHz typical data rate
- 8-bit data, EIA-644 (LVDS) format
- 2 or 4 outputs
- Exposure control and antiblooming
- C-mount optics for 512 & 1024 resolutions; F-mount for 2048 & 4096
- CE Compliant. Operation verified to limits set in EMC standards IEC 1000-4-2; 1995, 1000-4-3; 1995, 1000-4-4; 1995, and CISPR-22.

Design

The Piranha camera uses DALSA's patented modular architecture. This system of connecting circuit modules through standardized busses allows DALSA to build a high performance modular camera using the reliability, flexibility, and cost-effectiveness of high-volume interchangeable parts. Within the Piranha camera, a timing board (PB-P1-X206) generates all internal timing and a driver board (PB-P1-X138 for resolutions up to 2048; PB-P1-X139 for 4096) provides bias voltages and clocks to the CCD image sensor. For enhanced dynamic range, one or two A/D board (PB-xx-D344) process the video and digitize it to 10 bits before outputting the most significant 8 bits..

1.2 Image Sensor

The Piranha cameras use the IL-P1 and IT-P1 family of image sensors. They are available with 512 (IL-P1 only), 1024, 2048, or 4096 pixels with 10µm square pixels on a 10µm pitch with 100% fill factor.

Figure 1. IL-P1 Image Sensor

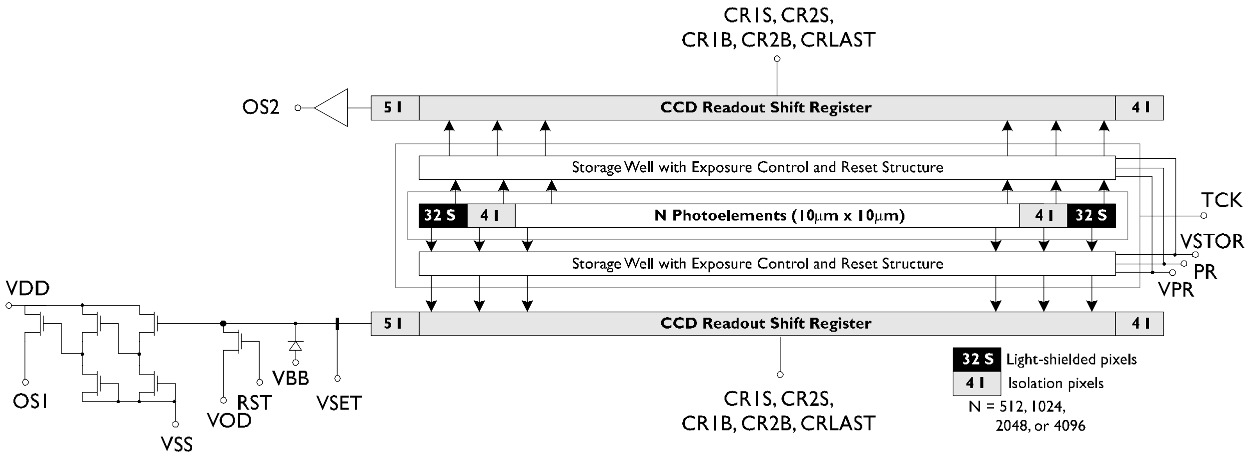
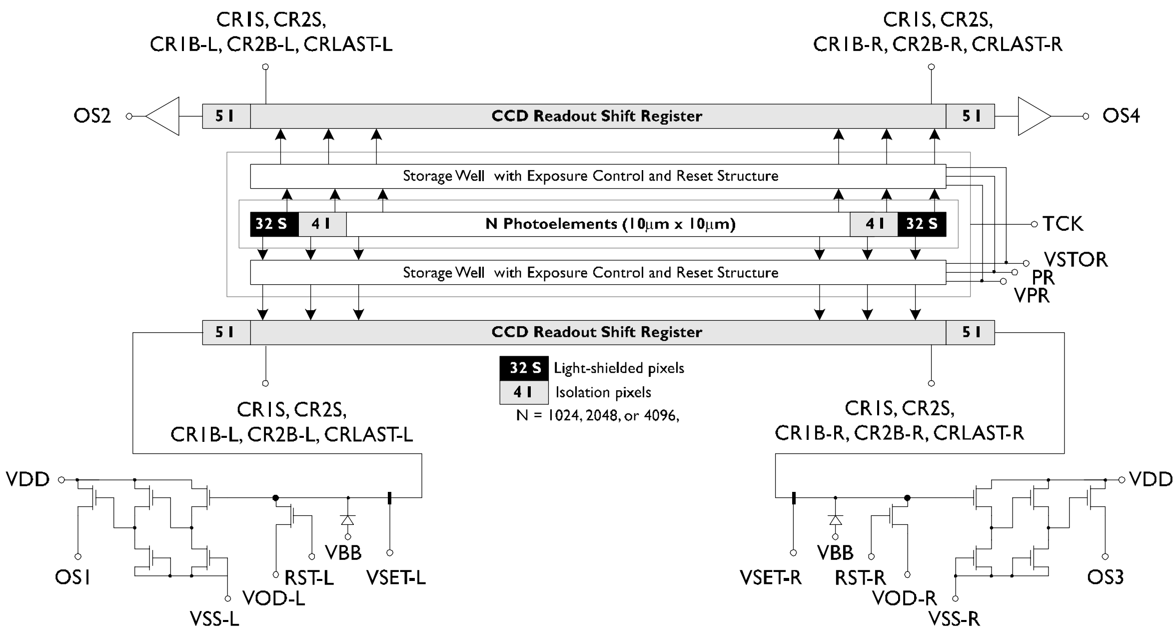


Figure 2. IT-P1 Image Sensor



1.3 Camera Performance Specification

Table 1. CT-P1 and CL-P1 Performance Specifications

Calibration Conditions	Units	Min.	Typ.	Max.	Notes
Data Rate (STROBE)	MHz	25	25		
Light Intensity	μW/cm^2		45		*1*
Line Rate (LVAL), max.	**Units**	**CT-P1**		**CL-P1**	
512	kHz	NA		79	
1024	kHz	79		43	
2048	kHz	43		23	
4096	kHz	23		11	
Specification	**Units**	**Min.**	**Typ.**	**Max.**	**Notes**
Saturation Output Amplitude	DN	243	250	254	
Output Gain Mismatch	DN			5	
Photoresponse Non-Uniformity (PRNU)					
Global, exposure control disabled	DN		8	15	
Pixel-pixel, exposure control disabled	DN		4	8	
Global, 50% exposure control	DN		8	15	
Pixel-pixel, 50% exposure control	DN		4	8	
Fixed Pattern Noise (FPN)					
Global, exposure control disabled	DN		2	3	*2,3*
Pixel-pixel, exposure control disabled	DN		2	3	*2,3*
Global, 50% exposure control	DN		2	3	*2,4*
Pixel-pixel, 50% exposure control	DN		2	3	*2,4*
DC Offset	DN	2	4	7	*3*
DC Offset Mismatch	DN			3	*1*
Exposure Control Offset	DN	2	4	7	*4*
Random Noise (pk-pk)	DN		2	4	*3*
(rms)	DN		0.5	0.8	*3*
Noise Equivalent Exposure	pJ/cm^2		121		
Saturation Equivalent Exposure	nJ/cm^2		60		
Responsivity	DN/(nJ/cm^2)		4.12		
Dynamic Range	ratio		496:1		
Supply Current +15.0 V	mA		200	400	
Supply Current +5.0 V (25MHz, terminated)	mA		1025	1300	
Supply Current +5.0 V(25MHz, unterminated)	mA		925	1200	
Supply Current -5.0 V	mA		175	200	

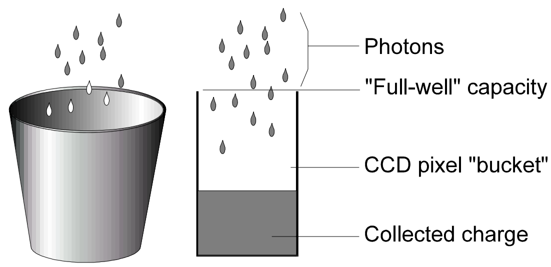
Notes

- DN = digital numbers, also known as "levels" (0-255 for 8-bit systems).

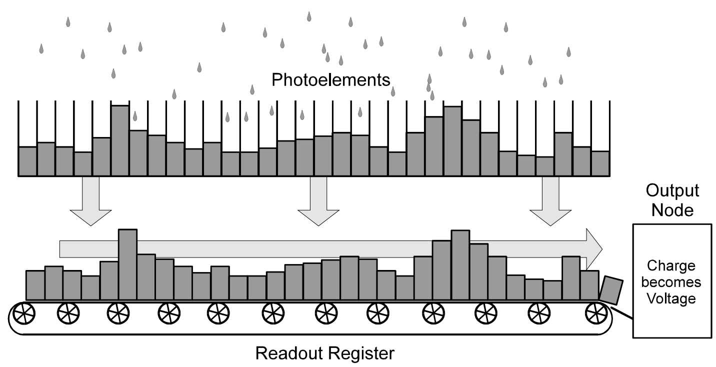
1. DC light source, bulb color temp. 3150°K, integrating sphere, HR750 hot mirror.
2. No pixel exclusions.
3. Exposure control disabled.
4. Exposure control enabled.

1.4 CCD Camera Primer

In a camera such as the Piranha, a CCD image sensor converts photons (light) into electrons (charge). When photons hit an image sensor, the sensor accumulates electrons. This is called charge integration. The brighter your light source, the more photons available for the sensor to integrate, and the smaller the amount of time required to collect a given amount of light energy.



The way photosensitive elements (pixels) on CCD image sensors collect charge has often been compared to wells or buckets filling with water. From this analogy comes the term "full-well capacity," meaning the maximum charge (number of electrons) a pixel well can hold without "spilling" charge onto adjacent pixels.



As an image sweeps over a line of pixels, the pixels collect charge. At certain intervals, the sensor transfers its collected charge to one or more readout registers, which feed each pixel's charge from the image sensor into an output node that converts the charges into voltages.

After this transfer and conversion, the voltages are amplified to become the camera's analog output. In digital output cameras, the camera's analog-to-digital (A/D) board converts voltages to digital numbers (0-255 for 8-bit cameras, 0-4095 for 12-bit cameras). These digital numbers are what the camera outputs as data to a framegrabber.

For more information on terms and concepts from the digital imaging industry, see DALSA's current Databook Glossary, CCD Technology Primer, and Application Notes.

2

Camera Hardware Interface

2.1 Installation Overview

Before setting up your camera or making cables for it, you should determine your application's requirements:

- Calculate the resolution, speed of object or web, and lighting required (see below for speed/resolution; see chapter 3 for optical guidelines).
- Identify the source of your EXSYNC control signal (framegrabber, custom controller, shaft/web encoder, etc.).

These choices affect the way you cable and configure your system. Note that most framegrabbers supply cables, but since you may have to build custom cables, interfaces, or controllers, planning ahead will save time and effort.

In order to set up your camera, you should take these steps:

1. Test and connect power supplies.
2. Test and connect User Bus control signals from framegrabber.
3. Test and connect data signals output from camera.

You must also set up the other components of your system, including light sources, framegrabbers, camera mounts, heat sinks, host computers, optics, and so on.

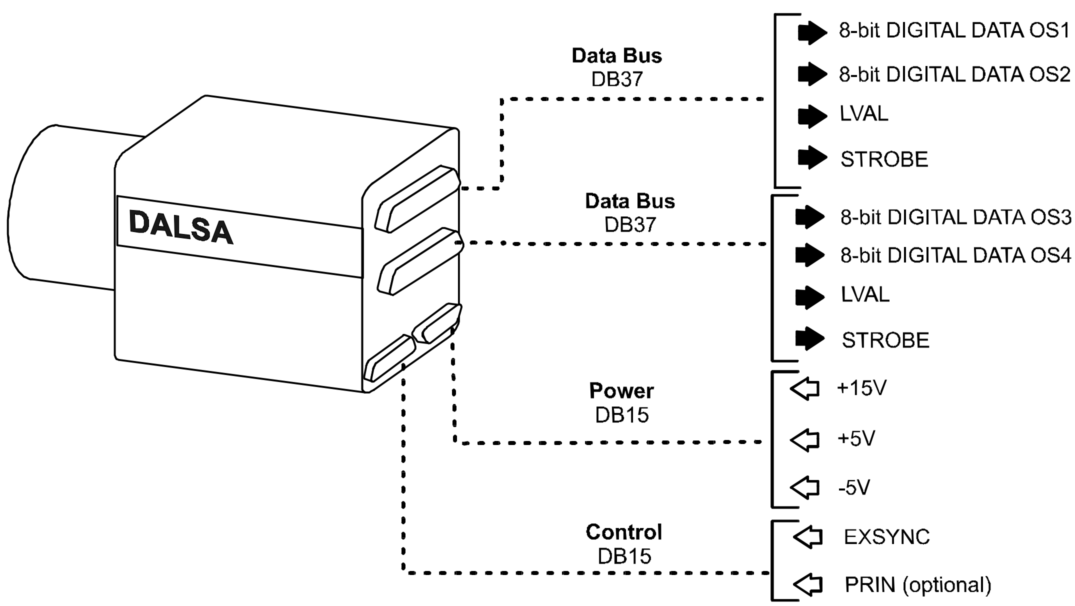
2.2 Calculating Speed and Resolution

When setting up your linescan application, you must know your application's requirements, including number of pixels, magnification, EXSYNC frequency, and shaft/web encoder details.

This example assumes that, for a particular application, you want to inspect a web 20cm wide moving 4m/s and you want 100µm on the web to be represented by one pixel (14µm).

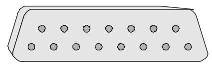
# Pixels necessary	= $\frac{\text{total width of image}}{\text{desired resolution}} = \frac{20\text{cm}}{100\mu\text{m per pixel}}$	**= 2000 pixels**
Magnification	= $\frac{\text{pixel size}}{\text{desired resolution}} = \frac{10\mu\text{m}}{100\mu\text{m}}$	**= 0.10**
EXSYNC Frequency	= $\frac{\text{web speed}}{\text{desired resolution}} = \frac{4\text{m/s}}{100\mu\text{m}}$	**= 40kHz**
Shaft Encoder Circumference	You require 1 pulse for every 100µm of object travel. Assuming a shaft/web encoder producing 1000 pulses/rev., shaft circumference must be 1000 x 100µm	**= 0.10m**

2.3 Input/Output



2.4 Connectors Pinouts, and Cables

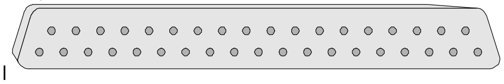
DB15F—Control (Inputs)



Mating Parts: Amphenol hood 17-1657-15
AMP plug 205206-3, AMP pin 745254-7,
Belden cable 9807 28AWG (or equivalents)

Pin	Signal	Pin	Signal
1	Future use	9	Future use
2	Future use	10	Future use
3	Future use	11	Future use
4	EXSYNCB	12	EXSYNC
5	PRIN	13	PRINB
6	Future use	14	Future use
7	No connect	15	No connect
8	No connect		

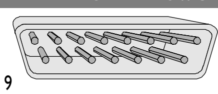
DB37F—Data Bus (Outputs)



Mating Parts: Amphenol hood 17-1657-37
AMP plug 205210-3, AMP pin 745254-7
Belden cable 9819 28AWG (or equivalents)

Pin	Signal	Pin	Signal B
1	BD7 (MSB)	20	BD7B
2	BD6	21	BD6B
3	BD5	22	BD5B
4	BD4	23	BD4B
5	BD3	24	BD3B
6	BD2	25	BD2B
7	BD1	26	BD1B
8	BD0 (LSB)	27	BD0B
9	AD7 (MSB)	28	AD7B
10	AD6	29	AD6B
11	AD5	30	AD5B
12	AD4	31	AD4B
13	AD3	32	AD3B
14	AD2	33	AD2B
15	AD1	34	AD1B
16	AD0 (LSB)	35	AD0B
17	STROBE	36	STROBEB
18	LVAL	37	LVALB
19	No connect		

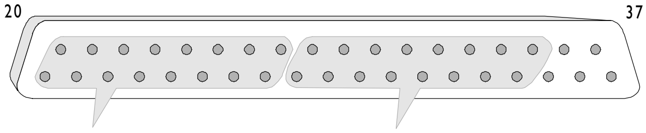
DB15M—Power



Mating Parts: Amphenol hood 17-1657-15
AMP receptacle 205205-2, AMP socket 745253-7,
Belden cable 9946 22AWG (or equivalents)

Pin	Signal	Pin	Signal
1	DGND	9	+5V Digital
2	+5V Digital	10	DGND
3	Future use	11	Future use
4	-5V Digital	12	Future use
5	Future use	13	-5V Analog
6	+15V Analog	14	AGND
7	+15V Analog	15	+5V Analog
8	AGND		

Note: Each DB37 connector supplies two channels of data (e.g. OS1+OS2, OS3+OS4)



Note: Do not connect to "Factory use," "Future use," or "No connect" pins.

2.5 Power Supplies

Follow these guidelines when setting up power supplies:

- Keep power cable connections as short as possible.
- Use an oscilloscope or multimeter to check the voltages present on your power/control cable **before** you connect it to the camera.
- **IMPORTANT**: If you use multiple power supplies, make sure all grounds are connected together both at the camera and at the supplies.
- Do not use the shield conductor on a multi-conductor cable for ground.

See section 1.3 for power supply requirements.

The companies listed below make power supplies that meet the camera's requirements, but they should not be considered the only choices. Many high quality supplies are available from other vendors. DALSA assumes no responsibility for the use of these supplies.

- Uniforce, 408-946-3864 (CA, USA)
- Vision 1, 406-585-7225 (MT, USA)
- Xantrex, 206-671-2966 (WA, USA)
- Power-One, 805-987-8741 (CA, USA)
- Tectrol Inc., 416-630-4026 (ON, CAN)

2.6 User Bus (Inputs)

The User Bus uses a DB15 connector and includes the mandatory control signal EXSYNC and optional signal PRIN. These signals must be supplied from your imaging system to the camera in EIA-644 (LVDS) format, which requires the use of twisted pair cable. DALSA recommends shielded cables. Maximum cable length depends on environmental factors and EIA-644 limitations. See Appendix A.

EXSYNC

EXSYNC is a mandatory control signal that initiates line readout. The rising edge of the EXSYNC control signal triggers line readout, so the frequency of EXSYNC equals line rate and also determines integration time. Note that EXSYNC is rising-edge sensitive and must toggle; restricting EXYNC to logic HIGH or logic LOW prevents line readout. Minimum high or low time is 100 ns. Minimum frequency is 300Hz.

Note: EXSYNC must not be clocked faster than the camera's specified line rate.

PRIN

PRIN performs asynchronous reset/electronic shuttering. It is an optional signal that can shorten the effective exposure time by resetting the pixels (clearing accumulated charge) on the image sensor between EXSYNC-triggered line readouts. PRIN is active during logic LOW; exposure effectively begins on the rising edge of PRIN.

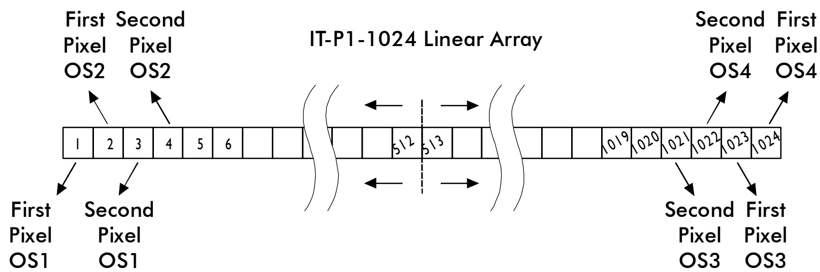
PRIN is an optional signal; if not using PRIN, connect PRIN to logic HIGH and PRINB to logic LOW..

2.7 Data Bus

The Piranha provides 8 bits of data in EIA-644 (LVDS) differential format at 25MHz. The data bus also includes synchronization signals STROBE and LVAL.

Pixel Order

The example below illustrates the order in which the CT-P1 outputs pixels. (For CL-P1, disregard OS3 and OS4) The example uses a 1024-pixel array, but the pattern is the same for 2048 and 4096-pixel arrays.



STROBE

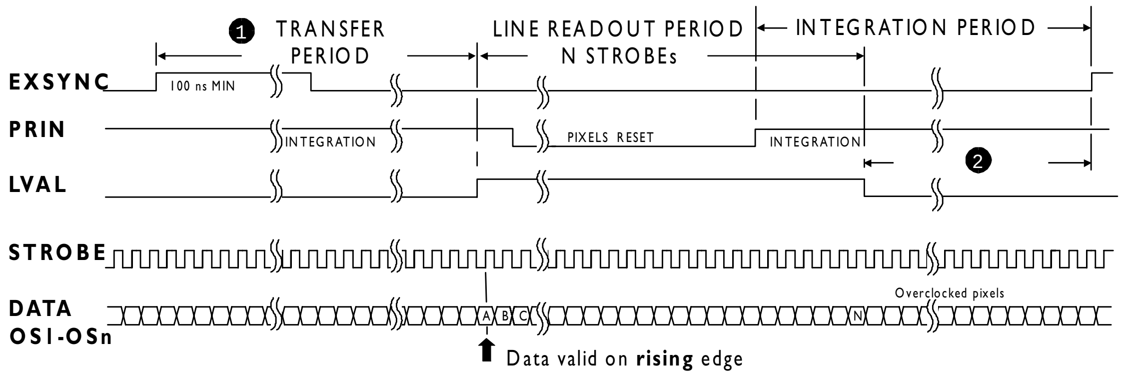
STROBE is a pixel clock signal for digital data. It is continuous, toggling even when data is not valid. Data is valid on its **rising edge** when LVAL is high.

IMPORTANT:
This camera's data is valid on the ***rising*** edge of STROBE, unlike previous DALSA cameras, which used the falling edge.

LVAL (Horizontal Synchronization)

LVAL high indicates the camera is outputting a valid line of pixels.

2.8 Timing

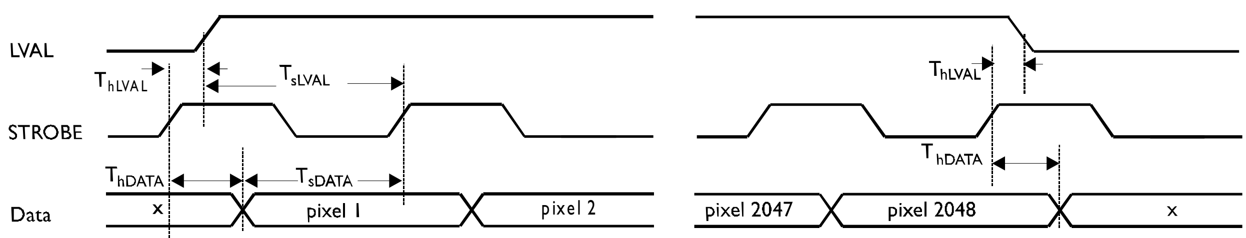


Notes

1 EXSYNC to LVAL in STROBEs : 60±1

2 LVAL to next EXSYNC in STROBEs, min.: 0

2.9 Detailed Timing



IMPORTANT:
This camera's data is valid on the *rising* edge of STROBE, unlike previous DALSA cameras, which used the falling edge.

Param.	Description	Units	Min.	Typ.	Max.
T_{hLVAL}	LVAL hold	ns		7	
T_{sLVAL}	LVAL setup	ns		33	
T_{hDATA}	Data hold	ns		15	
T_{sDATA}	Data setup	ns		25	

3

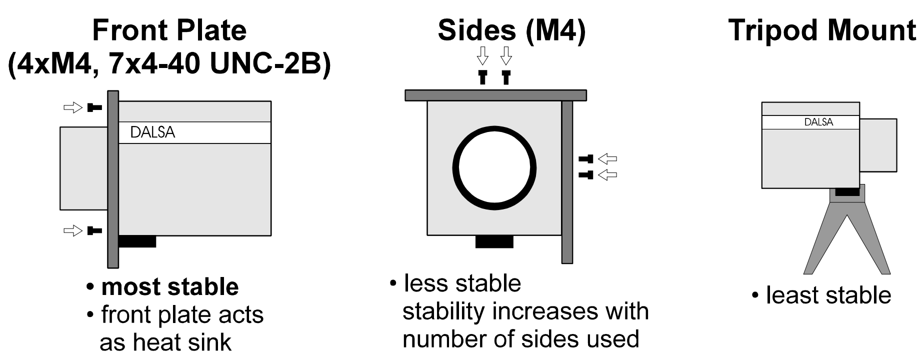
Optical and Mechanical Considerations

3.1 Mechanical Interface

The camera's electronics are housed in an anodized aluminum case. See Figure 3 and Figure 4.

3.2 Mounting

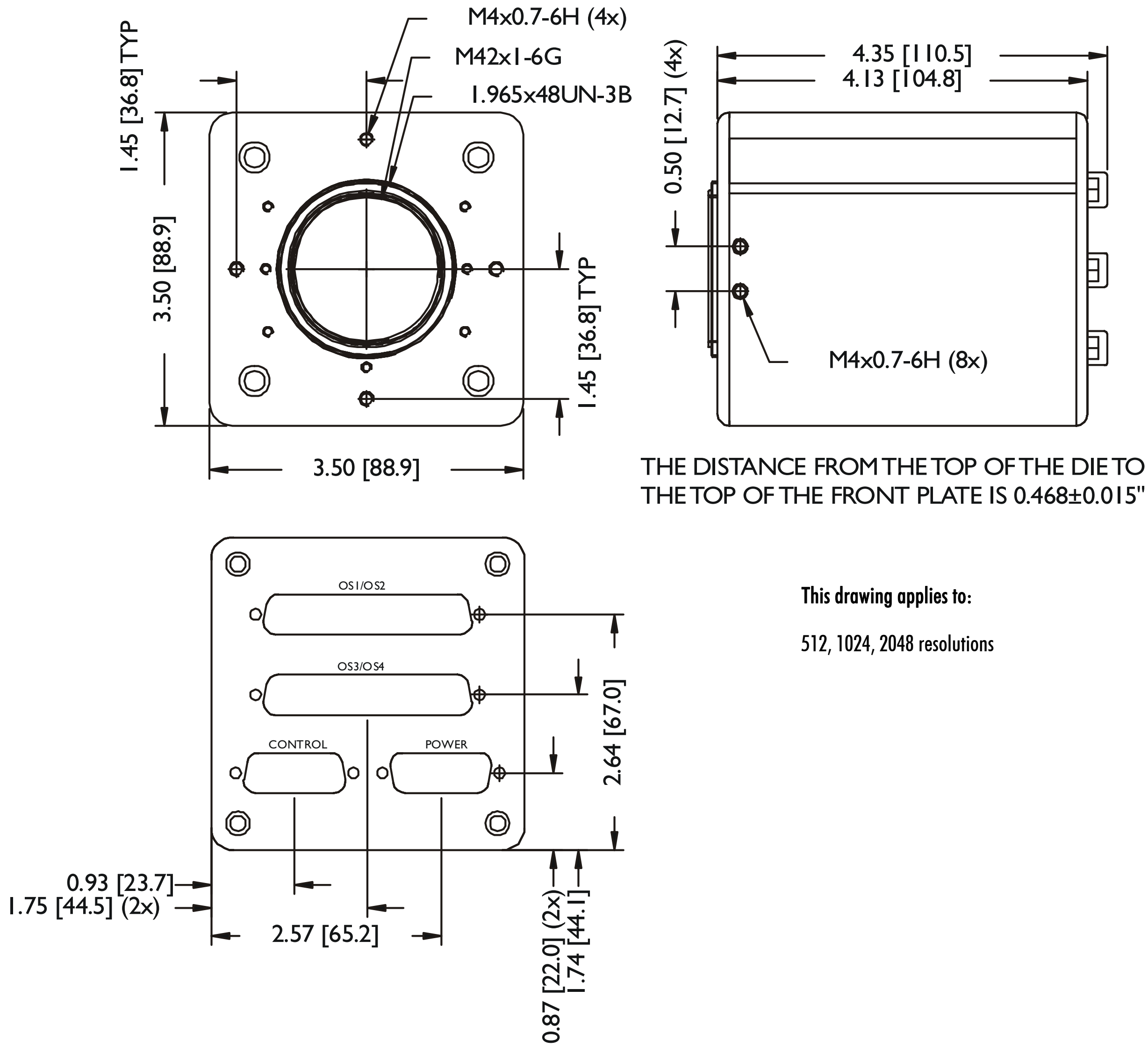
For maximum stability and best heat sinking, DALSA recommends mounting the camera by its front plate. There are four M4 threaded holes and seven 4-40 UNC holes tapped into the front plate for mounting or attaching heat sinking. Other mounting options include M4 holes on the sides of the camera (stability increases with number of sides used) and the tripod mount (least stable).



3.3 Environment

For best operation, the camera and cables should be shielded from environmental noise sources. The camera should also be kept as cool as possible. Specified operating temperature is 0-40° C. Mounting holes (see above) allow you to attach heat sinking.

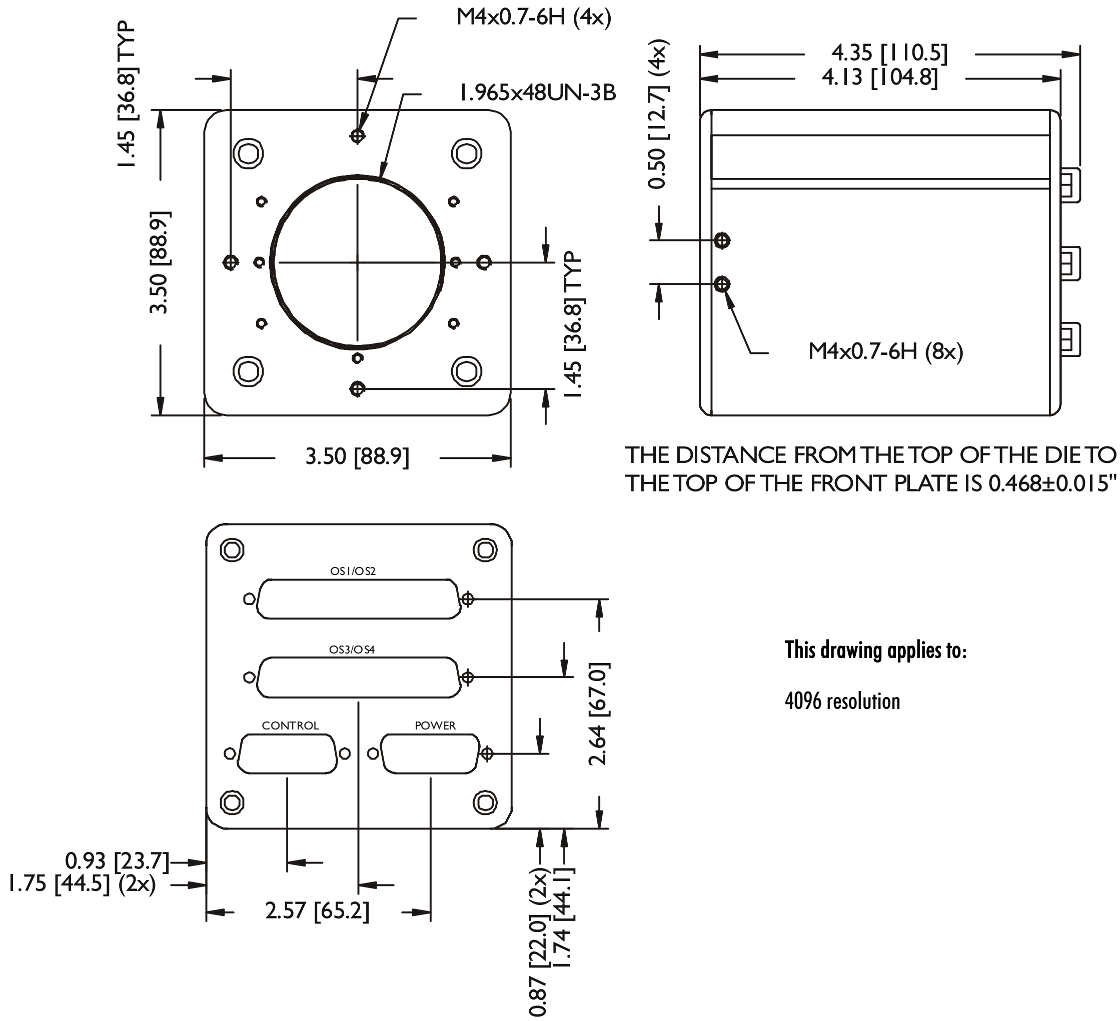
Figure 3. Mechanical Interface—512, 1024, and 2048 Resolutions



This drawing applies to:

512, 1024, 2048 resolutions

Figure 4. Mechanical Interface—4096 Resolution



This drawing applies to:

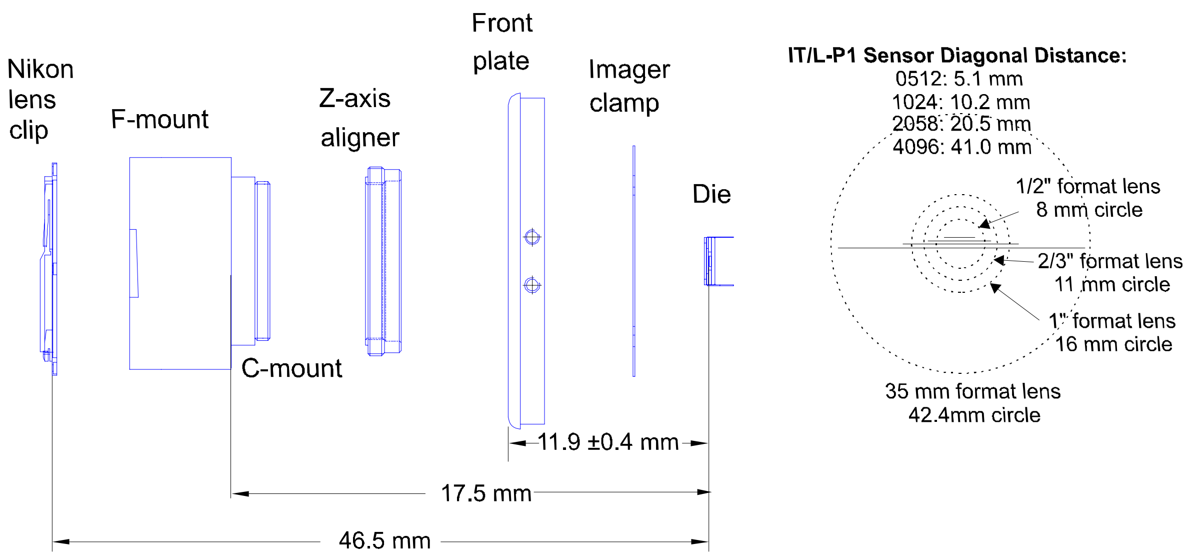
4096 resolution

3.4 Optical Interface

Lens Mounts

The 512 and 1024-pixel Piranhas come with a mount adapter for C-mount lenses, which have a back focal distance of 17.5 mm. The 2048 and 4096 models come with mount adapters for F-mount (35mm Nikon-compatible) lenses, which have a back focal distance of 46.5 mm. Ensure that the image circle diameter of the lens to be used is as great as the diagonal of the imaging region of the image sensor.

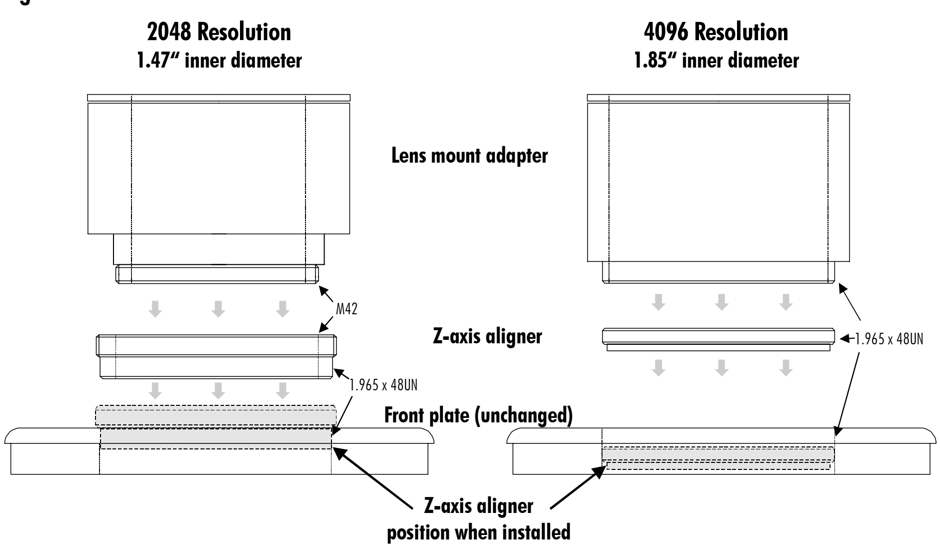
Figure 5. Optical distances and image circles



Note: Exploded view

Note that the 4096-pixel cameras use different lens mounts than the 2048-pixel cameras. The two are not interchangeable. See Figure 6.

Figure 6. Lens Mounts: 2048 vs. 4096



IMPORTANT: The camera's Z-axis alignment is optimized for the adapter provided. Do not interchange lens adapters between cameras.

Illumination

The amount and wavelengths of light required to capture useful images depend on the particular application. Factors include the speed, and spectral characteristics of objects being imaged, exposure times, light source characteristics, optics, environmental and acquisition system specifics, and more. Experimentation is often the best way to achieve desired results.

It is often more important to consider exposure than illumination. The total amount of energy (which is related to the total number of photons reaching the sensor) is more important than the rate at which it arrives. For example, $5\mu J/cm^2$ can be achieved by exposing $5mW/cm^2$ for 1ms just the same as exposing an intensity of $5W/cm^2$ for 1µs.

Light Sources

Keep these guidelines in mind when setting up your light source.

- Halogen light sources generally provide very little blue relative to IR.
- Fiber-optic light distribution systems generally transmit very little blue relative to IR.
- Some light sources age; over their lifespan they produce different spectra. This aging may not be uniform—a light source may produce progressively less light in some areas of the spectrum but not others.

Filters

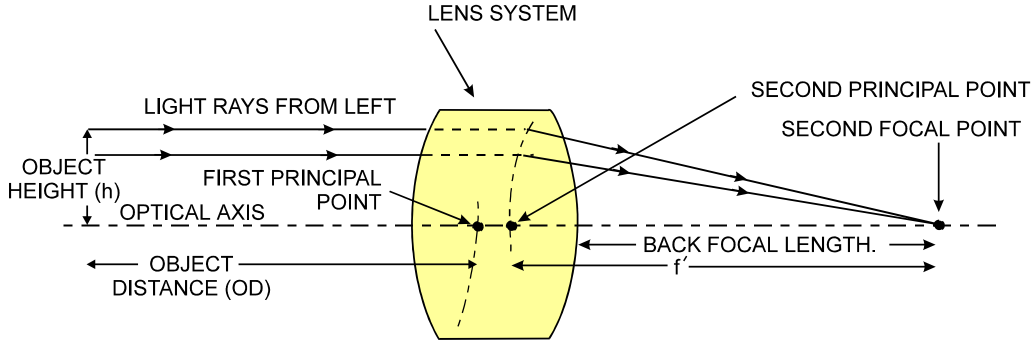
CCD cameras are extremely responsive to infrared (IR) wavelengths of light. To prevent infrared from distorting the images you scan, use a "hot mirror" or IR cutoff filter that transmits visible wavelengths but does not transmit wavelengths over 700 µm. For example, the Schneider Optics™ B+W 489, which includes a mounting ring, the CORION™ LS-750, which does not include a mounting ring, or the CORION™ HR-750 series hot mirror.

3.5 Lens Modeling

Any lens surrounded by air can be modeled for camera purposes using three primary points: the first and second principal points and the second focal point. The primary points for a lens should be available from the lens data sheet or from the lens manufacturer. Primed quantities denote characteristics of the image side of the lens. That is, h is the object height and h' is the image height.

The *focal point* is the point at which the image of an infinitely distant object is brought to focus. The *effective focal length (f')* is the distance from the second principal point to the second focal point. The *back focal length (BFL)* is the distance from the image side of the lens surface to the second focal point. The *object distance (OD)* is the distance from the first principal point to the object.

Figure 7. Primary Points in a Lens System



Magnification and Resolution

The magnification of a lens is the ratio of the image size to the object size:

$$m = \frac{h'}{h}$$

where m is the magnification, h′ is the image height (pixel size) and h is the object height (desired object resolution size).

By similar triangles, the magnification is alternatively given by:

$$m = \frac{f'}{OD}$$

These equations can be combined to give their most useful form:

$$\frac{h'}{h} = \frac{f'}{OD}$$

This is the governing equation for many object and image plane parameters.

Example: An acquisition system has a 512 element, 10µm pixel pitch line scan camera, a lens with an effective focal length of 45mm, and requires that 100µm in the object space correspond to each pixel in the image sensor. Using the preceding equation, the object distance must be 450mm (0.450 m).

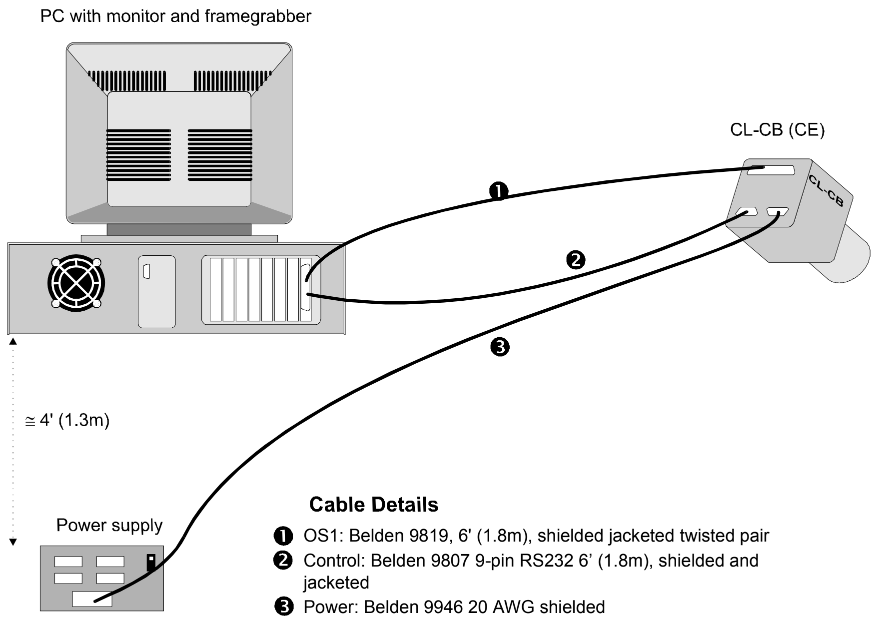
$$\frac{10\mu m}{100\mu m} = \frac{45mm}{OD} \qquad OD = 450mm\,(0.450m)$$

3.6 EMC Operation

The Piranha has been designed for EMC compliance (see Appendix B for standards). With the typical system as base, follow these specific guidelines to ensure best performance:

- Keep control and data cables as short as possible.
- Ensure that all cable shields have 360° electrical connection to the connector.
- Fasten and secure all DB25 connectors with screws.

Figure 8. EMC Test Setup



4

Troubleshooting

The information in this chapter can help you solve problems that may occur during the setup of your camera. Remember that the camera is part of the entire acquisition system. You may have to troubleshoot any or all of the following:

- power supplies
- framegrabber hardware & software
- light sources
- operating environment
- cabling
- host computer
- optics
- encoder

Your steps in dealing with a technical problem should be:

1. Follow the troubleshooting flowchart (Figure 9 in this chapter).
2. Try the general and specific solutions listed in sections 4.1 and 4.2.
3. If these solutions do not resolve your problem, see section 4.3 on getting technical support.

4.1 General Solutions

Connections

The first step in troubleshooting is to verify that your camera has all the correct connections. Follow the troubleshooting flowchart shown in Figure 9.

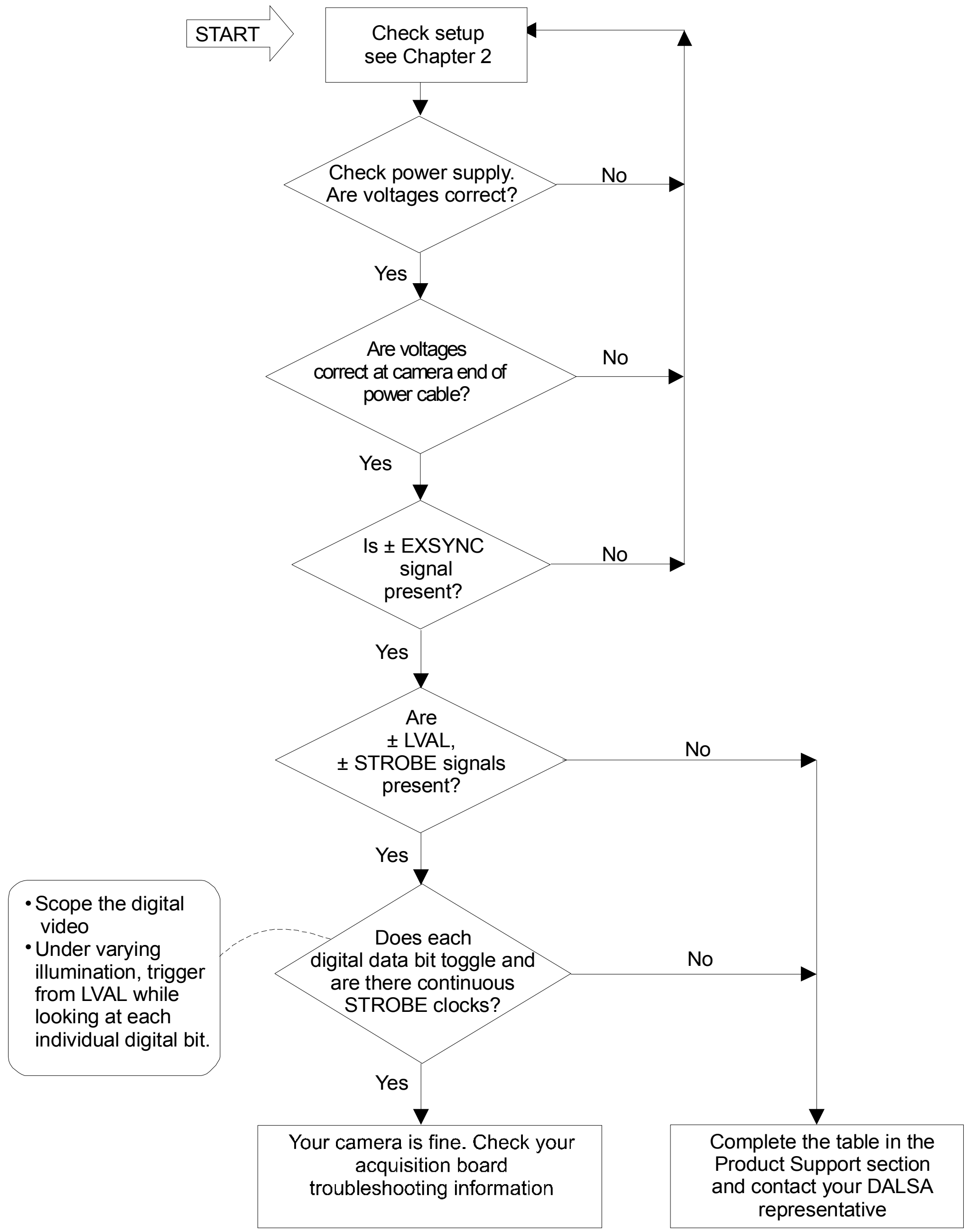
Power Supply Voltages

Check for the presence of all analog and digital voltages at the camera DB25 connector. Verify that all grounds are connected together at both camera and power supply.

EXSYNC

EXSYNC must toggle (300 Hz min.). The camera will not output lines if EXSYNC is restricted to logic HIGH or logic LOW. Using an oscilloscope, check the camera end of the control signal cable to verify that EXSYNC and EXSYNCB toggles.

Figure 9. Troubleshooting Flowchart



Data Clocking/Output Signals

Verify the presence of the data clocking and output signals below. Trigger the oscilloscope from the rising edge of LVAL (ch1; DC coupled). Adjust the oscilloscope time base to allow for a complete cycle of each signal:

- **STROBE**—Verify the presence of the STROBE and STROBEB signals. There should be a continuous clock signal present at the same frequency as your data rate.
- **LVAL**—Verify the presence of the LVAL and LVALB signals.

- **Digital Output—**Do not probe LVDS data signals with a scope probe unless it has less than 0.5pf of capacitance. If you can probe safely, use LVAL to trigger the scope sweep. Illuminate the camera target and check each individual data bit on ch2 of the oscilloscope (±D0 - D7 on the digital output connector). The digital output data signal should change value when light is blocked from the camera lens.

If any of the above signals are missing, contact DALSA product support.

4.2 Specific Solutions

No Output or Erratic Behavior

If your camera provides no output or behaves erratically, it may be picking up random noise from long cables acting as antennae. Where possible, connect unused pins to known logic levels. Do not attach wires to unused pins. Verify that the camera is not receiving spurious PRIN, MCLK, or USR_EN inputs.

Line Dropout, Bright Lines, or Incorrect Line Rate

Verify that the frequency of EXSYNC supplied to the camera does not exceed the camera's maximum specified line rate.

Noisy Output

Check your power supply voltage outputs for noise. Noise present on these lines can result in poor video quality. Low quality or non-twisted pair cable can also add noise to the video output.

Verify that your acquisition system samples data on the **rising edge** of STROBE.

Offset Varies or Drifts

The camera will experience offset drift and the dark level will increase if the camera's EXSYNC signal stops or is below 300 Hz. The camera is meant to be run with a continuous EXSYNC frequency. EXSYNC should pulse to logic HIGH to start the readout of each line, return to logic LOW, and stay LOW until after line readout and clamping.

Vertical Patterns in Output

If dark columns or vertical patterns appear in your output, the optical path may be contaminated. Clean your lenses and sensor windows with extreme care.

1. Take standard ESD precautions.
2. Wear latex gloves or finger cots.
3. Blow off dust using a filtered blow bottle or dry, filtered compressed air.
4. Fold a piece of optical lens cleaning tissue (approx. 3" x 5") to make a square pad that is approximately one finger-width.
5. Moisten the pad on one edge with 2-3 drops of clean solvent—either alcohol or acetone. Do not saturate the entire pad with solvent.

6. Wipe across the length of the window in one direction with the moistened end first, followed by the rest of the pad. The dry part of the pad should follow the moistened end. The goal is to prevent solvent from evaporating from the window surface, as this will end up leaving residue and streaking behind.

7. Repeat steps 2-4 using a clean tissue until the entire window has been cleaned.

8. Blow off any adhering fibers or particles using dry, filtered compressed air.

Horizontal Lines or Patterns in Output

Patterns can be caused by low-frequency illumination variations. Use a DC or high-frequency light source.

Stuck Bits

If data bits seem to be stuck or do not change, check that the camera is not saturated by preventing light from entering. Next, disconnect the digital cable from the camera. Check the digital signals at the output of the camera, ensuring that the correct values are present. Check all cable connections, especially right at the connector; poor connections or broken wires will cause randomly changing bits or stuck bits.

4.3 Product Support

If the troubleshooting flowchart (Figure 9) indicates a problem with your camera, collect the following data about your application and situation and call DALSA Product Support.

Note: You may also want to photocopy this page to fax to DALSA.

Customer name	
Organization name	
Customer phone number **fax number**	
Complete Product Model Number (e.g. CL-P1-1024W-ECE1)	
Complete Serial Number	
Your DALSA Agent or Dealer	
Acquisition System hardware (framegrabber, host computer, light sources, etc.)	
Acquisition System software (version, OS, etc.)	
Power supplies and current draw	
Data rate used	
Control signals used in your application, and their frequency or state (if applicable)	☐ EXSYNC ☐ BIN ☐ MCLK Other _______ ☐ PRIN
Detailed description of problem encountered.	*please attach description with as much detail as appropriate*

With this information ready, call your local DALSA representative. They may direct you to DALSA Technical Sales Support:

	North America	Europe	Asia
Voice:	519-886-6000	+49-8142-46770	519-886-6000
Fax:	519-886-8023	+49-8142-467746	519-886-8023

Appendix A

EIA-644 Reference

EIA-644 is an electrical specification for the transmission of digital data. The standard is available from the EIA (Electronic Industries Association). It defines voltage levels, expected transmission speeds over various cable lengths, common mode voltage operating requirements for transmitters and receivers, and input impedances and sensitivities for receivers. The table below gives a quick comparison between EIA-644 and RS422 (another differential standard).

Table 2. RS422 vs. EIA-644

Parameter	RS422	EIA-644
Differential Driver Output Voltage	±2-5V	±250-450mV
Receiver Input Threshold	±200mV	±100mV
Data Rate	<30Mbps	>400Mbps
Supply Current, Quad Driver (no load, static)*	60mA	3.0mA
Prop. Delay of Driver, max.*	11ns	3ns
Prop. Delay of Receiver, max.*	30ns	5ns
Supply Current, Quad Receiver (no load, static)*	23mA	10mA

* based on National Semiconductor DS90C031/2

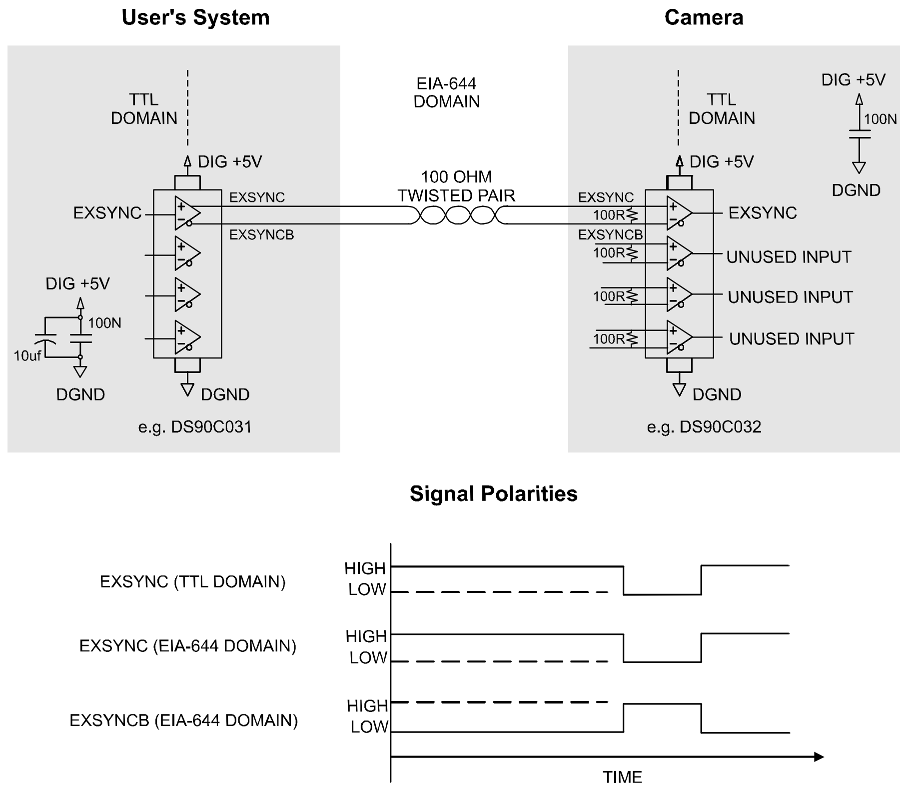
The standard requires that two wires (e.g. twisted pair) be used to transmit one signal in a differential mode. This means that one wire will be logic HIGH while the other wire is logic LOW. Voltage swing between HIGH and LOW is approximately 350mV, with a typical offset of approximately 1.25V. The use of differential signal transmission allows the receiver to reject common mode voltages. This noise rejection improves data integrity and allows cameras to be installed in an industrial environment.

EIA-644-compatible line receivers and drivers are available from many different IC manufacturers in a variety of fabrication technologies such as CMOS and GaAs. The EIA-644 standard does not define specific voltages, so it can migrate from 5V power supplies to 3.3V and sub-3V. DALSA recommends the use of 5V CMOS line drivers and receivers such as National Semiconductor parts DS90C031 quad line driver and DS90C032 quad line receiver.

To achieve full benefit of the common mode rejection, twisted pair cable should be used for all EIA-644 signals. The cable impedance should be 100 Ohms and the cable terminated at the receiving end with a 100 Ohm resistor. All EIA-644 inputs in a DALSA camera are terminated with 100 Ohms between the (+) and (-) of a signal. Figure A-1 (a) shows an example of an EIA-644 transmission.

DALSA indicates the (+) signal by the name of the signal; i.e. EXSYNC, while the (-) signal is indicated by either an overscore over the name or appending the letter B to the end of the name; i.e. $\overline{\text{EXSYNC}}$ or EXSYNCB. The (+) signal has the same sense as the TTL signal which is sent or received; i.e. when EXSYNC in the TTL domain is HIGH then EXSYNC in the EIA-644 domain is HIGH. The (-) signal has the opposite sense of the TTL domain signal and so if EXSYNC TTL is HIGH then EXSYNCB EIA-644 is LOW. Figure 6 shows the relationship.

Figure 7. EIA-644 Example



Unused EIA-644 Inputs and Outputs

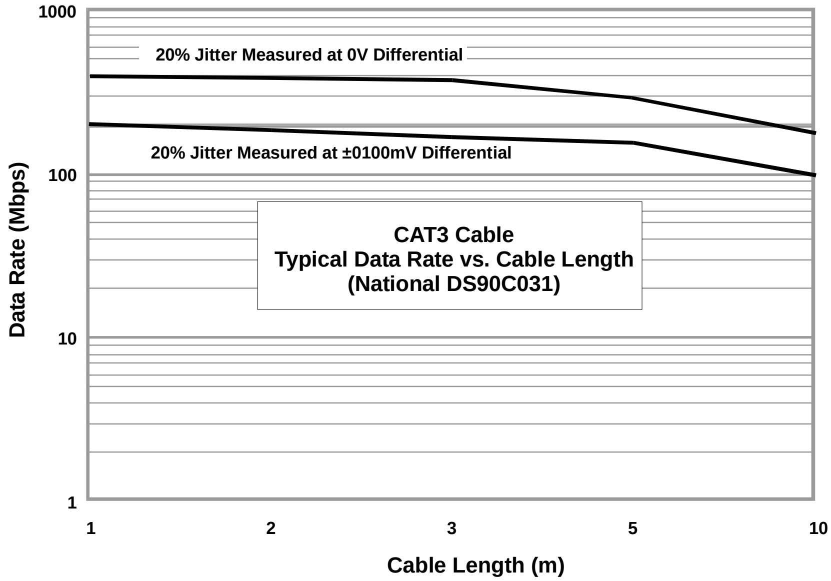
Unused **outputs** should be left unconnected. This will reduce power dissipation within the camera and reduce radiated emissions.

Unused **inputs** should also be left unconnected; EIA-644 chips have fail-safe features that guarantee a known logic state (HIGH) in fault conditions (unconnected, shorted, or unterminated). **Do not connect cables to unused inputs.** Cables can act as antennae and cause erratic camera behavior.

Cable Lengths

Figure 8 shows a graph of ideal communication data rate vs. cable length for the EIA-644 standard.

Figure 8. EIA-644 Data Rate vs. Cable Length



Appendix B

EMC Declaration of Conformity

We, **DALSA**
605 McMurray Rd.,
Waterloo, ON
CANADA N2V 2E9

declare under sole responsibility, that the product(s):
Piranha CT-P1, CL-P1

fulfill(s) the requirements of the standard(s)
EMC: **FCC Part 15**
ICES-003
EN 55022: 1998
EN 55024: 1998
EN 61000-6-1: 2001

This product complies with the requirements of the Low Voltage Directive This product complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE mark accordingly.

Place of Issue	Waterloo, ON, CANADA
Date of Issue	25 May 2005
Name and Signature of authorized person	**Hank Helmond** **Quality Manager, DALSA Corp.**

This Declaration corresponds to EN 45 014.

Appendix C

Revision History

Revision Number	Change Description
00	Manual release.
01	Specification changes to CT-P1 and CL-P1 Piranha after Test Results Review.
02	Updated camera performance specifications from 03-16-00345,6-00 to 03-16-00360,1-00. Updated recommended mating connectors for CE application.
03	Changed sensor diagram. Added information on output format (order of taps.) Changed maximum camera currents. Removed pretrigger information from timing diagram. Added +/-1 strobe tolerance to EXSYNC to LVAL timing spec.
04	Changed maximum line rates specs to truncate to 1 significant digit instead of rounding up. (p.6) Corrected electrical interface diagram - wrong part numbers for differential driver, receivers. Wrong pinout for OS1/OS3 on DB37 connector. (p. 12)
05	Removed inappropriate reference to area architecture, changed EMC description, updated troubleshooting section for linescan camera.
06	Corrected EMC Declaration.
07	Removed 40%/50% PR spec from performance specs. ECE specifications changed to a 50% PR. ECE PRNU was changed to a max of 15 DN and typ of 8 DN, Pixel to pixel ECE PRNU was changed to max 8 DN, typ 4 DN. references to 2 models of P1 cameras with and without exposure control (EC1W and ECEW) was removed.
08	Correction to page 8: changed note 2 to specify zero exclusions.
09	Updated manual with revised 4k lens mount
10	Performance spec table, page 7, updated.
11	Page 13, Section 2.6 Data Bus incorrectly identified the data format as RS422. Corrected to read EIA-644 (LVDS).
12	Updated the date (from November 2000 to November 2002) and signature (From Doody to Helmond) in the EMC Compliance in Appendix B, page 30. Helmond is now responsible for EMC signatures.
13	Updated Appendix B: EMC Declaration of Conformity with updated EMC codes. Former ones were from 1995-1997 and were outdated.

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