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CAPET

CONCOURS EXTERNE

Section : Génie électrique

Options : Electronique et Automatique
Informatique et Télématique

SCIENCES ET TECHNIQUES INDUSTRIELLES

Durée : 6 heures

Documentation technique

Laminage à froid : Objet technique : détection de trous

CL-C6 High Sensitivity Line Scan Cameras

FEATURES

- 5 kHz line rate @ 10 MHz data rate
- 38:1 high aspect ratio
- exposure and antiblooming control
- uses TURBOSENSOR™ IL-C6-2048
- 2048 elements
- Single output video
- Optional output processing modules

DESCRIPTION

DALSA's CL-C6 high sensitivity line scan camera provides valid video on a single BNC output for low noise, high speed performance and excellent dynamic range. The camera incorporates the IL-C6 image sensor which is currently available with 2048 elements.

Image Sensor characteristics are the major factor affecting the performance of CCD cameras. DALSA designs and manufactures its own image sensors and this is one of the reasons for the superior performance of the CL-C6 camera series. For instance, the high speed of operation is due to the high quality CCD operation of the sensor itself, providing excellent MTF response with high CTE for better resolution. The CL-C6 camera is similar to the CL-CX camera series. The pinout is identical and the functionality of the signals are also consistent. The major differences is due to image sensor architecture. The IL-C6 image sensor provides the 2048 pixels on a single output (instead of dual output).

The CL-C6 camera offers higher sensitivity due to the larger pixel size of the IL-C6 sensors (V:H = 38:1 aspect ratio) plus the additional features of antiblooming and exposure reduction.

The CL-C6 cameras support two internal expansion slots for optional output signal processing boards or user defined circuits. DALSA provides option boards for:

- Analog-to-Digital conversion
- Sample-and-Hold processing
- Developer's Module

APPLICATIONS

CL-C6 line scan cameras are used in applications such as:

- Spectroscopy

The CL-C6 series, with its 38:1 aspect ratio, is ideally suited for spectroscopy applications. By spreading the visible spectrum over the entire aperture of the sensor, each pixel would represent ½ nm of spectral light.
(2048 pixels x ½ nm = 1024 ∴ 100 → 1100 nm range).

- Triangulation

The CL-C6 is a high sensitivity camera with a large aperture, and this enables the camera to detect very faint light sources. This makes it suitable for laser triangulation methods.

Some applications require small modifications to the clock timing or number of pixels. If a different configuration is required please contact one of DALSA's applications engineers. One such modification is described below.

- Binning Modification

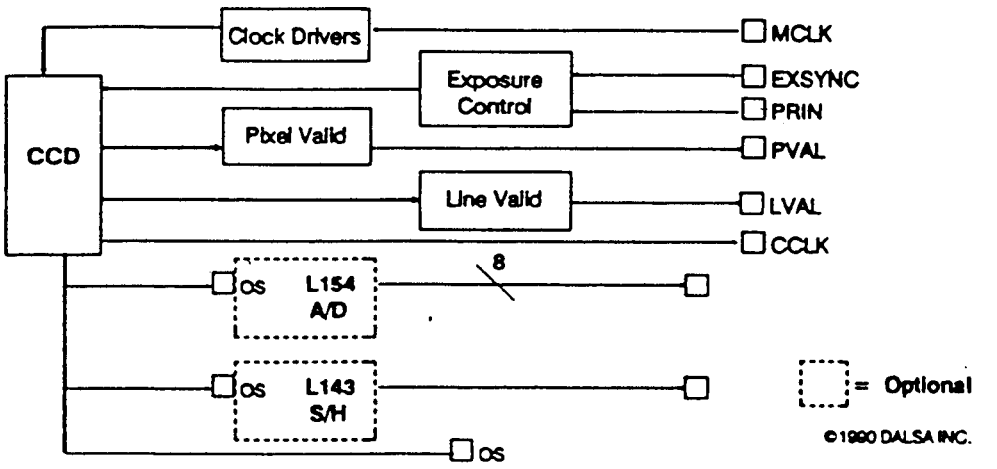
By summing adjacent pixels at the output structure, effective pixel sizes can be increased. This option increases sensitivity and reduces the camera's pixel count. Contact DALSA for pricing and availability of this modification.

Table 1: Camera Configurations

Camera	Sensor	Aspect Ratio	Pitch (μm)	Aperture	Features
CL-C6-2048	IL-C6-2048	38:1	13	26.62mm x 500μm	High Sensitivity

CL-C6
TURBOSENSOR™ CAMERAS

Figure 1. CL-C6 Camera Functional Block Diagram



Functional Description

Within the CL-C6 camera, incident light is collected in the photoelements of the IL-C6 image sensor. When a line is to be read out the rising edge of the EXSYNC input signal generates a signal internal to the camera that causes the charge to be transferred from the photoelements into a CCD shift register. The charge from all photoelements is transferred at the same time.

The readout CCD shift registers then transfer the charge to the output node where the signal is converted into a voltage. This operation occurs automatically when an EXSYNC signal and a master clock signal (MCK) is applied to the camera.

The basic CL-C6 camera provides the output signal on one channel of video (OS). Video buffering is performed in order to provide current gain.

POWER SUPPLIES

All power requirements and clock signals for the CL-C6 camera flow through the rear-face DB-25 male connector shown in Figure 2. The pinout configuration accompanying Figure 2 indicates the signals and voltages that must be supplied to the camera for correct operation.

Although filters are incorporated into the camera, voltages indicated in Figure 2 should be well regulated to reduce noise in the video output signal. Separate ground leads to the connector should be provided for each power supply; do not use the shield conductor on a multi-conductor cable for power supply ground. All grounds should be connected at the power supplies.

The 15 Volt supply is used to generate CCD clocking and voltage biases and the 5 volt supply is used for digital logic within the camera. A -15V supply should be used to generate the substrate potential, although a supply as low as 0 V can be used without degrading performance if no option boards are installed. A -5V supply is necessary for all option boards.

OUTPUT SIGNALS

The image sensor in the camera provides buffered raw video, which is approximately 1.0 - 1.5VAC with an 8 - 9V D.C. offset. The output signals should be terminated with a 75 ohm A.C. termination.

OPTICAL CONSIDERATIONS

Exposure

Exposure requirements of your application is an important factor to consider when choosing a particular image sensor configuration for your camera. The exposure of the sensor is determined by the total integration time of the pixel times the light intensity.

Illumination

Two major considerations of illumination are sensitivity and contrast. The sensitivity requirements of your application can be determined by placing a photometer in the image plane which you plan to use. This will indicate the energy density in the image plane. Desired contrast for your application is determined by the camera/image sensor configuration, since the factors which affect this are sensor dynamic range and responsivity.

DALSA INC., Waterloo, Ontario, CANADA
Phone:(519)886-6000 FAX:(519)886-6023

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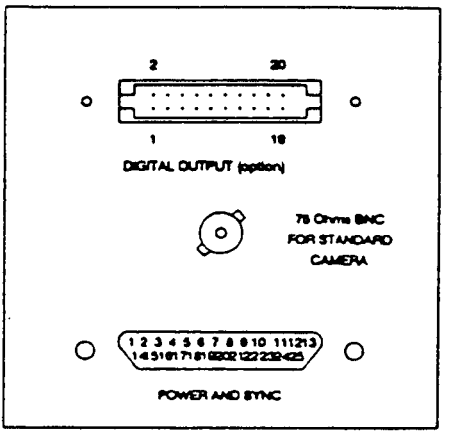
Figure 2. Rear View of Camera and Pin Functional Description

POWER SUPPLY

DESCRIPTION	SYMBOL	PIN
Digital Ground	VSSD	7
*Analog +5V	+5	8
Analog +15V	+15V	9
Future Use		10
Analog Ground	VSSA	11
*Digital -5V	-5V	12
Digital +5V	+5V	13
Digital Ground	VSSD	20
Analog + 15V	+15V	21
*Analog -5V	-5V	22
Future Use		23
Analog Ground	VSSA	24
Analog -15V	-15V	25



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OUTPUTS

DESCRIPTION	SYMBOL	PIN
(Master Clock) Out diff.	$\overline{CCLK}$	1
Line Valid Out diff.	LVAL	2
(Pixel Valid) Out diff.	$\overline{PV}$	3
Master Clock Out diff.	CCLK	14
(Line Valid) Out diff.	$\overline{LVAL}$	15
Pixel Valid Out diff.	PV	16

INPUTS

DESCRIPTION	SYMBOL	PIN
(Start of frame) Input diff.	$\overline{EXSYNC}$	4
Pixel Reset Input diff.	PRIN	5
Master Clock Input diff.	MCLK	6
Start of frame Input diff.	EXSYNC	17
(Pixel Reset) Input diff.	$\overline{PRIN}$	18
(Master Clock) Input diff.	$\overline{MCLK}$	19

* Necessary for optional processing boards only.

LENS OPTIONS

The CL-C6 camera comes configured with a NIKON bayonet format lens adapter. C-Mount format is available, but the sensor aperture should be considered before doing so. (13μm x 2048 = 26.6 mm). Available lenses are listed in Figure 9.

CLOCKING

All clocks (input and output) are RS422 format. It is recommended that 26LS31 and 26LS32 line drivers and receivers be used. All clock cabling should be twisted pairs.

Master Clock (MCLK)

The master clock is used to generate all internal timing, and is input at twice the desired frequency of the output signal. Both MCLK and its differential inverse $\overline{MCLK}$ must be provided. A copy of the master clock signal CCLK and its inverse $\overline{CCLK}$ are provided as an output to compensate for internal delays. The complete timing diagram is shown in Figure 3.

Photoelement Transfer

The start of line clock input EXSYNC and its differential inverse $\overline{EXSYNC}$ control the data parallel transfer from the photoelements to the CCD shift register. This signal is rising edge triggered.

After the start of a new line, valid video is signified by the LVAL signal, which remains high while video from the photoelements is being read out. After the array has been read out, the LVAL signal goes to a low state. The rising edge of EXSYNC should occur after the falling edge of LVAL.

Exposure Control

Exposure control for the CL-C6 cameras can be achieved by using the PRIN and $\overline{PRIN}$ signals. To shorten exposure time, PRIN should go low following the rising edge of the LVAL pulse for a period equal to the desired exposure time reduction. When PRIN goes high, exposure will begin.

Valid Pixel Video

In order to determine when the video signal is valid, output signals PV and $\overline{PV}$ are provided. The output from each pixel is valid on the rising edge of PV. If PV is used to trigger external circuitry then

sampling should occur in the middle of valid data. The position relative to the video signal will vary with cable length. The video signal frequency is half of the master clock frequency.

USER ADJUSTMENTS

NOTE: *No adjustments should be necessary. Please consult factory before removing box cover since this removes the product warranty.*

Timing and potentiometer settings are optimized during camera assembly. However, camera operation can be modified by adjusting the timing or varying the potentiometers available.

Antiblooming

The potentiometer labelled AB adjusts the antiblooming potential by increasing the low voltage of the PR clock. This decreases blooming under high light level conditions.

Set

The potentiometer labelled SET affects the speed of transfer into the output structure and the output signal swing. Increasing the SET voltage improves the transfer speed but reduces the signal swing. Decreasing the SET voltage increases the signal swing but reduces the speed of transfer.

Figure 3. Clock Timing for the CL-C6 Basic Camera

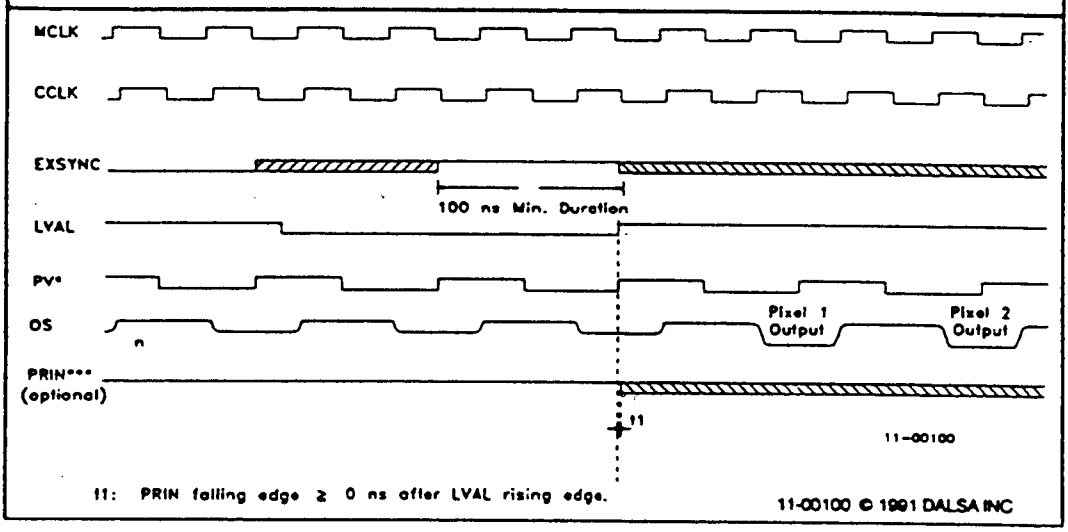

Figure 4. IL-C6-2048 Sensor Architecture

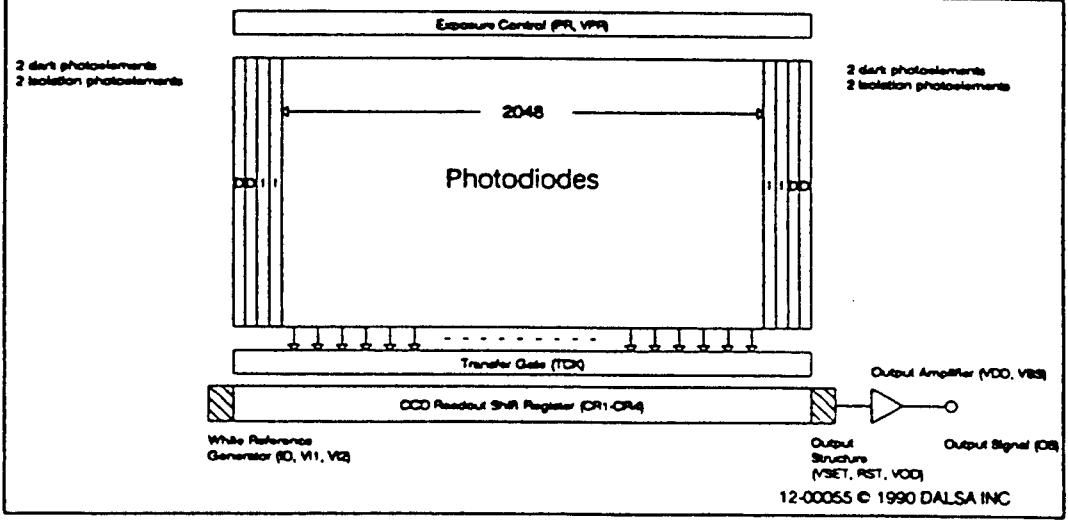

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Figure 5. Performance Characteristics of the CL-C6 Camera

The parameters listed below are preliminary specifications for the CL-C6-2048 camera, and these values are subject to change. Minimum performance requirements for special applications can be negotiated on an individual customer basis. Typical values may vary from maximum permitted specifications.

	Basic CL-C6	S/H	High Speed Digital
MCLK Setup Frequency	15 MHz	15 MHz	15 MHz
Output Format	unrestored video	DC restored S/H	8 bit TTL
Saturation Output Level	-1200 mV	-2.0 V [1]	F9 Hex [1]
Video DC offset	6.0 V	± 20 mV max.	05 Hex [1]
PRNU [3,5]	10% V_{SAT}	10%	15 levels
PRNU [4, 5]	15% V_{SAT}	15%	30 levels
FPN [3, 5]	5 mV	15 mV	03 Hex
FPN [4]	15 mV	45 mV	05 Hex
Video Output Impedance	75 Ohm [6]	75 Ohm	100 Ohm
Dynamic Range [7]	6,000:1	2,000:1	256:1
Reset Feedthrough between Ptixels	1.0 V	100 mV	N/A
Input Clock Format	RS422	RS422	RS422
Output Random RMS Noise Level	0.2 mV	1.0 mV	0.2 LSB
Supply Current + 15.0 V [8]	200 mA	350 mA	280 mA
Supply Current + 5.0 V [8]	600 mA	775 mA	800 mA
Supply Current - 5.0 V [8]	N/A	70 mA	240 mA
Supply Current - 15.0 V [8]	10 mA	50 mA	50 mA
Order Suffix	none	S/H - S	Digital - D

Notes:

1. Level adjustable.
2. Typical for 650 nm illumination; adjustable for all versions except basic cameras.
3. With exposure control disabled, excluding any deviations through cosmetic classification, excluding first 4 and last 4 pixels in sensor.
4. With exposure control enabled, excluding any deviations through cosmetic classification, excluding first 4 and last 4 pixels in sensor.
5. PRNU is measured at approximately 50% VSAT and is the difference between the pixels with the lowest and highest outputs, expressed as a percentage of VSAT.
6. Must be AC coupled or damage to the camera will result.
7. Dynamic Range provided is peak-peak output relative to RMS noise.
8. Combined for all supplies of same voltage level.

Test Conditions:

1. Data Rate is 7.5 MHz per output channel.
2. Operation is at room temperature (25°C).
3. Output is unterminated.
4. Illumination is provided by a broadband flourescent light source.