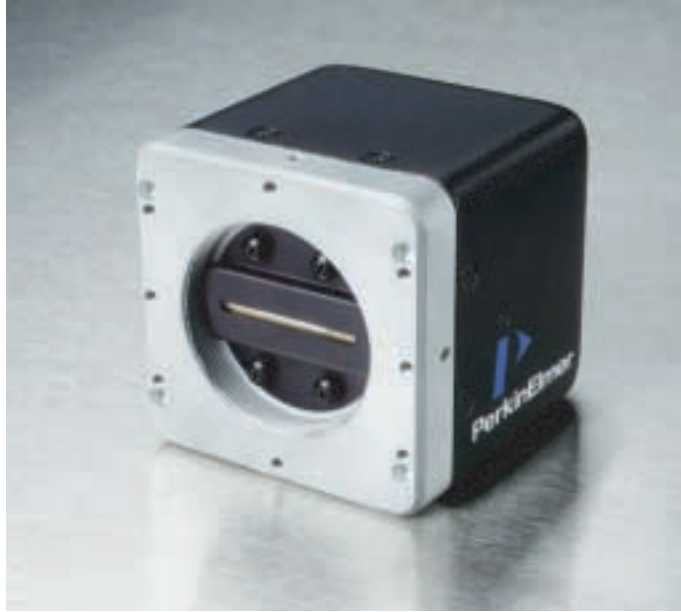


**RETICON**<sup>®</sup>**LD3500 Series** Low-Cost Digital Linescan Camera512, 1024 and 2048 Pixels, **CameraLink** and Parallel LVDS Outputs**Description**

In the LD3500-series digital linescan camera, PerkinElmer has combined the best features of photodiode array detection, high-speed charge-coupled scanning, and digital line scan camera technology to offer an uncompromising solution to the increasing demands of advanced imaging applications.

The LD3500-series are high performance, low-cost, digital linescan cameras. The LD3500 features a CameraLink™ or Parallel LVDS (RS-644) style video output with resolutions of 512, 1024 or 2048 pixels, which can achieve data rates of up to 20 or 40 MHz with exceptional noise immunity. The cameras are designed for volume applications where small size and low cost are required.

In order to allow the user to compensate for variations in illumination found in "real-world" application environments, the cameras feature adjustable gain levels. The LD3500-series cameras feature a geometrically precise photodiode CCD image sensor with 14µm photo-elements. State of the art

electronic design enables the LD3500-series to deliver consistent, reliable performance while the sturdy metal housing provides maximum protection in a variety of harsh environment and factory floor conditions.

The LD3500-series linescan cameras transform light imaged during a scene into a digital video signal. Antiblooming structures within the sensor ensure superior performance over a wide range of lighting conditions. User-defined control is possible for line rate, integration time and video data rate.

The LD3500 cameras may be interfaced to most frame grabber cards, allowing for a tested, plug and play solution. Typical high performance line scan applications include lumber processing, non-contact measurement, document scanning, dimensional gauging, biomedical imaging, bar code scanning and many other industrial and scientific applications.

**Features**

- 20 and 40 MHz output rate models
- Geometrically precise 14 µm square pixel linear CCD
- Small size: 2.5" H x 2.5" W x 3.2" L
- High dynamic range (250:1)
- CameraLink and Parallel LVDS video output models
- 8-bit grey scale resolution
- Antiblooming control
- Single power supply operation
- Electronic exposure control
- Adjustable gain levels
- CE mark certified
- Line scan rates to 68 kHz



# Digital Linescan Camera

## Sensor Description

The LD3500-series cameras contain a single output, high-performance, high-resolution line scan image sensor (PerkinElmer Optoelectronics Reticon® parts RL0512PAG, RL1024PAG, or RL2048PAG) featuring a pinned photodiode pixel. The spectral response of the sensor is shown in Figure 1a, with the sensor window transmission curve shown in Figure 1b.

## Functional Description

The video signal from the sensor is processed through a single channel of sampled-and-held, raster order, digital video data. The video channel signal processing circuitry offers adjustable gain levels that allow users to customize of the camera to unique lighting applications

## Operating Modes

The LD3500 series cameras can operate in Master or Slave Mode. When the camera is set to Master Mode, the camera operates at its maximum line scan and data rate. When the camera is set to Slave Mode, the cameras scan and data rates are determined by the users input signals to the camera. The operating mode is set via the serial connection on the CameraLink models, and is auto-detected on the LVDS models. Auto-detection is accomplished by looking for either a Line Transfer (LT) and/or External Clock signal. If the camera receives a LT signal, but no external clock, it will continue to run at the maximum data rate, but will only initiate a LT upon signal. If the camera receives an external clock signal, it will run at that clock signal with either an internal or external LT signal.

## Input/Output Signal Specifications

The LD3500 camera requires a single DC supply (+12 to 24V) for operation. An internal oscillator sets the default data output rate to default model rate (20 or 40 MHz).

### CameraLink Models:

CameraLink allows for 4 manufacturer-defined camera control signals (CC1-CC4). CC1 is a Line Transfer (LT) signal. CC2 is a Line Reset (LR) signal. CC3 and CC4 are reserved for future assignment.

Figure 1a: Spectral Sensitivity Curve (1X Gain)

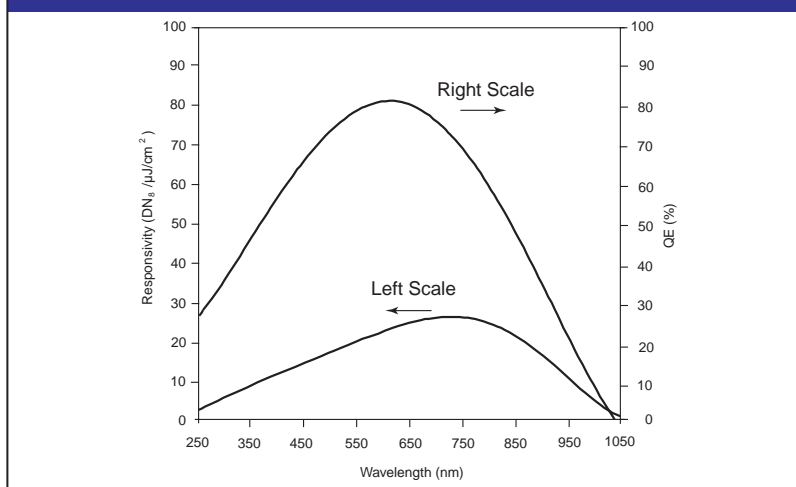
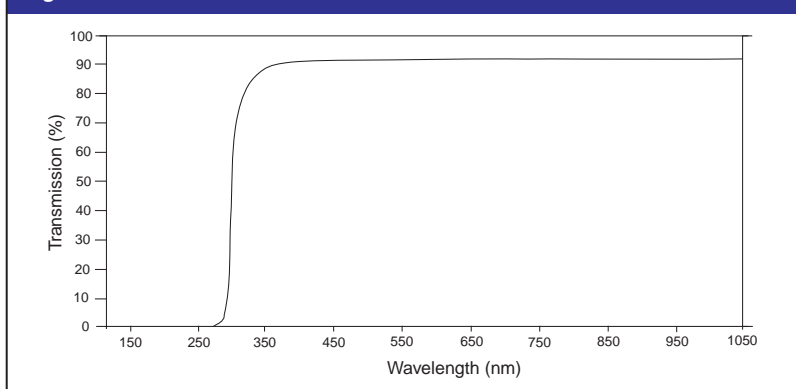


Figure 1b: Window Transmission Curve



The rising edge of the LT signal transfers the charge from each photosite to the readout registers. The readout registers, in turn, transport the charge from each photosite in succession to the video outputs. The exposure time of the camera can be externally controlled using the LR input. The LR input is active low (ON) in polarity and therefore, when not in use, must be held high or left unattended (OFF). In this condition, the exposure time is defined by the period of the LT signal.

Output signals are compliant with CameraLink specifications.

### Parallel LVDS (RS-644) Models:

Parallel LVDS models of the LD3500 provide Master Clock (MCLK), Line Transfer (LT) and Line Reset (LR) input signals. The MCLK input determines the data rate frequency for values up to maximum clock of the camera. The MCLK input is optional, as the camera is preset to run off of the internal oscillator at the default maximum data rate.

Should a data rate slower than that default rate be necessary, an externally supplied master clock can be used. The data rate may be run from 2 MHz to cameras maximum clock rate. The Line Transfer input signal transfers the charge from each photosite to the readout registers. The readout registers, in turn, transport the charge from each photosite in succession to the video outputs.

The exposure time of a LD3500-series camera can be controlled by using the external LR input. The LR input is active low (ON) in polarity and therefore, when not in use, must be held high or left unattended (OFF). In this condition, the exposure time is defined by the period of the LT signal. When using the LR input signal, the exposure period is defined to be the time between the rising edge of LT to the rising edge of LR.

The LD3500-series camera provides two output synchronization signals: Camera Clock (CCLK) and Line

# Digital Linescan Camera

## Input/Output Signal Specifications (Continued)

Enable (LEN).

The Camera Clock (CCLK) operates at either the MCLK frequency or default camera frequency, and is synchronized to the analog video. The output of the CCLK signal can be used to capture digital video data by a frame grabber or digitizer.

The Line Enable (LEN) signal brackets the valid digital video. The signal becomes high one CCLK period before the first valid pixel and goes low one CCLK period before the last valid pixel.

In all modes of operation on the LVDS models, a single line delay is present due to the necessity of storing all video data into memory before the video is output.

### Video Gain

The LD3500-series camera features an adjustable video gain. This allows users to amplify the video signals for individual application needs. Photo Response Non-Uniformity (PRNU) remains linear with gain.

#### CameraLink Models:

Gain levels are set by serial communication through the CameraLink connector. Gain can be set from 0 to 24.5 dB in increments of 3.5 dB. Gain settings are not lost when the camera is powered down.

#### Parallel LVDS (RS-644) Models:

Gain levels are set by differential RS-644 gain control inputs on the camera connector. The gain levels can be set at 1, 2, 4 and 8X full-scale gain, allowing the user to easily configure the camera output to suit their application needs. Gain settings are not held after power down; proper input signals must be given at start-up, and held throughout operation for gain settings to remain at desired levels.

### Data and Power Connectors

#### CameraLink Models:

The communications connector on the LD3500-series camera is a 26-pin D-type male connector, common to all CameraLink applications. This 26-pin connector contains all communications and controls needed for camera operation. Power is provided to the LD3500 via a 6 pin,

Figure 2. Connector Diagram

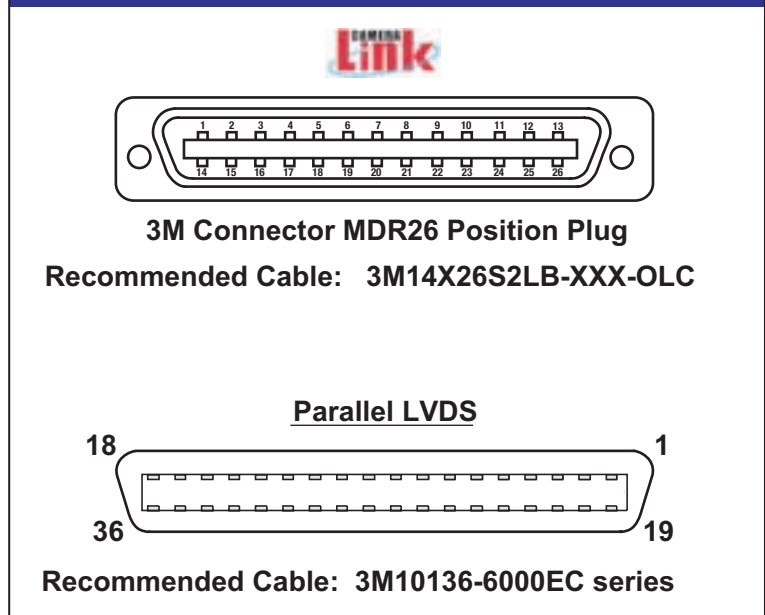


Figure 3. Power Connector Diagram

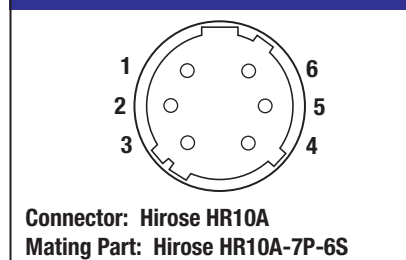


Table 2. Power Connector Pinout

Pin	Signal
1	12-24VDC
2	12-24VDC
3	Do not connect
4	Do not connect
5	Ground
6	Ground

**Note:**  
 The power connector and pinout are common to all CameraLink and Parallel LVDS models

Hirose HR10A circular jack. Refer to Table 1a for pinout of the communications and control connector. Figure 2 provides pinout locations for this connector.

# Digital Linescan Camera

## Data and Power Connectors (cont.)

### Parallel LVDS (RS-644) Models:

The communications connector on the LD3500 is a MDR36 (mini-D-shell) connector. This 36 pin connector provides all communications and controls needed for camera operation.

Power is provided to the LD3500 via a 6 pin, Hirose HR10A circular jack. Refer to Table 1b for pinout of the communications and control connector. Figure 2 provides pinout locations for this connector

### Camera Construction

The camera head is housed in a rugged, one piece deep drawn aluminum case, measuring 2.5" H x 2.5" W x 3.2" L (excluding lens mounts or connector extensions) specifically designed for industrial applications. The sensor is mounted on an aluminum plate that efficiently transfers heat to the camera case. The camera is provided with a standard 1/4"-20 UNC tripod mounting block, which can be attached to any of the four sides of the camera. The mounting holes used to attach the tripod block can also be used to mount the camera assembly. Additionally, the CCD sensor is thermally coupled to the faceplate of the camera, and the conductive cooling of this surface is useful in minimizing thermally generated dark current and noise of the camera system.

### Optical Interface

The LD3500-series cameras are equipped with a U-Mount lens interface (MA2-1-6H) that is aligned to the CCD sensor. These standard adapters allow the user to select the optimum lens to suit their particular application.

Table 1a. Camera Link Connector Pinout

Pin	Signal	Pin	Signal
1	Inner Shield	14	Inner Shield
2	X0-	15	X0+
3	X1-	16	X1+
4	X2-	17	X2+
5	Xclk-	18	Xclk+
6	X3-	19	X3+
7	SerTC+	20	SerTC-
8	SerTFG-	21	SerTFG+
9	CC1-	22	CC1+
10	CC2+	23	CC2-
11	CC3-	24	CC3+
12	CC4+	25	CC4-
13	Inner Shield	26	Inner Shield

Table 1b. Parallel LVDS (RS-644) Connector Pinout

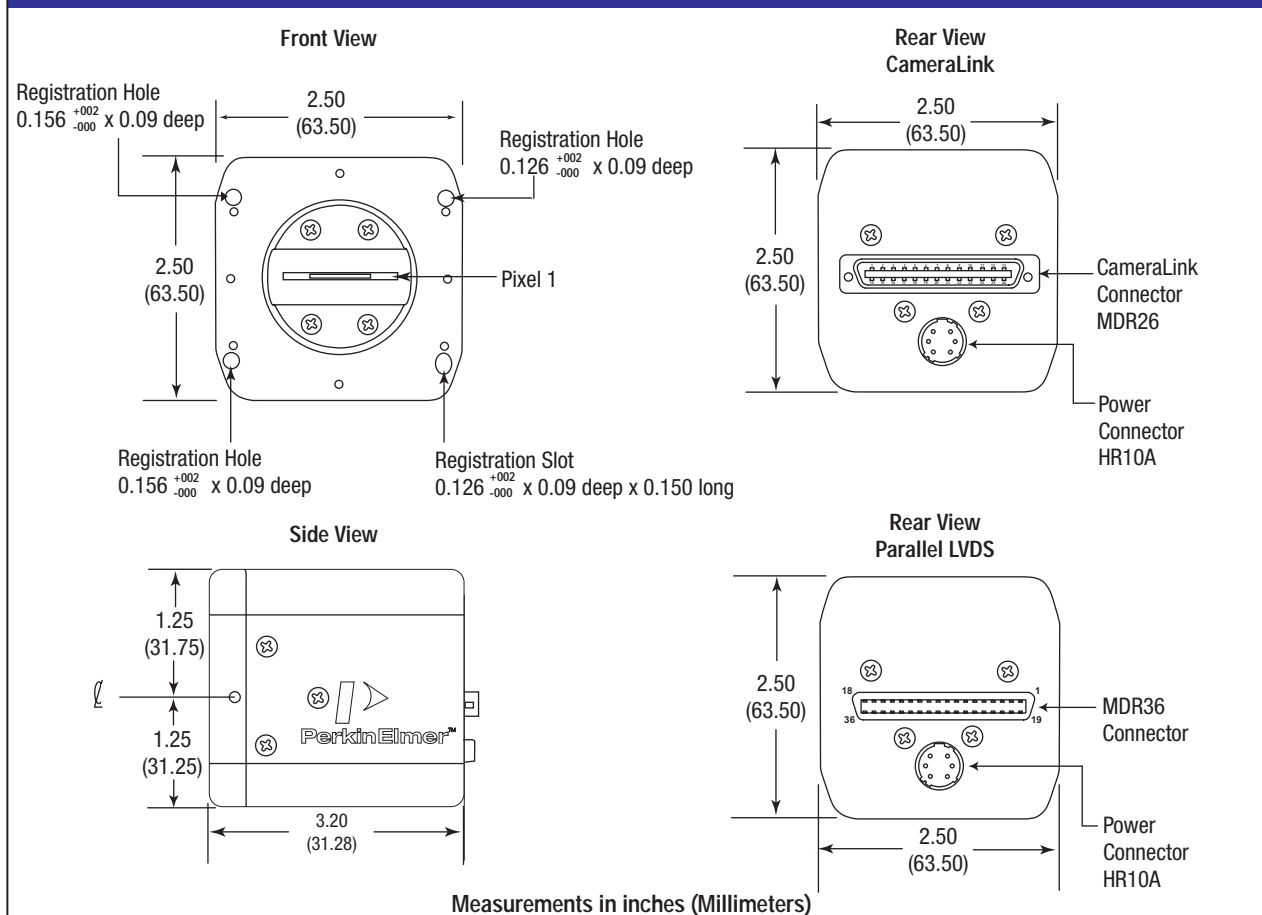
Pin	Signal	Pin	Signal
1	Do not connect	19	Do not connect
2	Gain 0+	20	Gain 0-
3	Inner Shield	21	Inner Shield
4	Gain 1+	22	Gain 1-
5	MCLK+	23	MCLK-
6	LR+	24	LR-
7	LT+	25	LT-
8	Do not connect	26	Do not connect
9	D7+	27	D7-
10	D6+	28	D6-
11	D5+	29	D5-
12	D4+	30	D4-
13	D3+	31	D3-
14	D2+	32	D2-
15	D1+	33	D1-
16	D0+	34	D0-
17	CCLK +	35	CCLK -
18	LEN+	36	LEN-

# Digital Linescan Camera

**Table 3. LD3500 Camera Specifications**

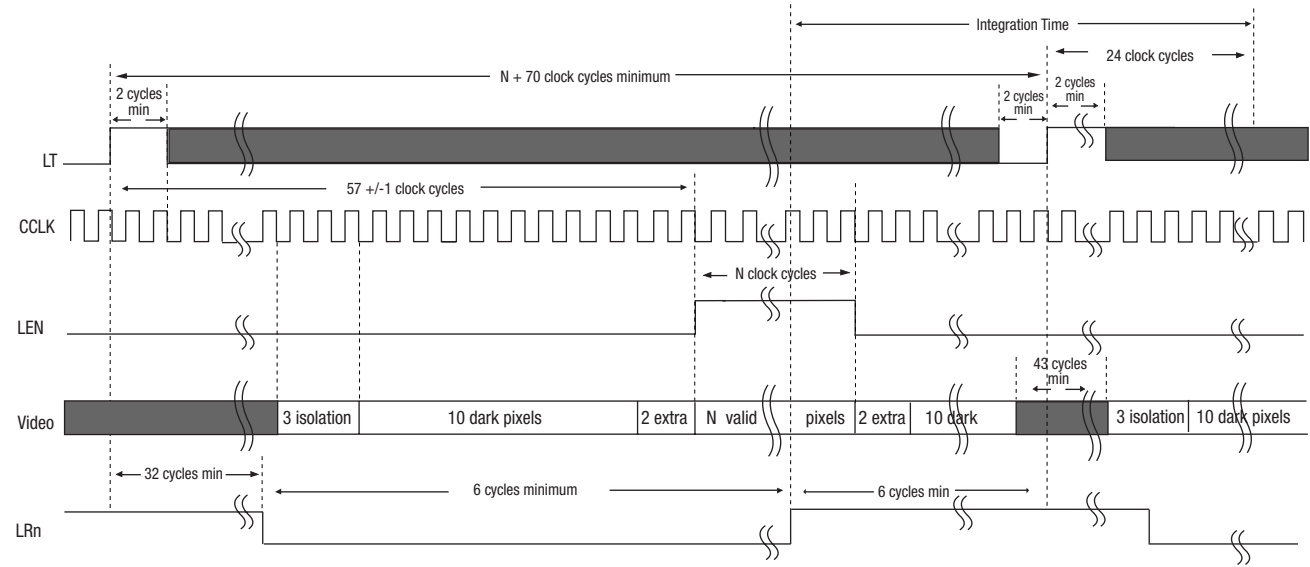
Camera Characteristics	Value	Camera Characteristics	Value
Number of Active Pixels	512, 1024, or 2048	Adjustable Gain Range	0 to 24.5 dB (LD35xxPGK-011) 1, 2, 4, 8X (LD352xPGL-011)
Pixel Size	14µm x 14µm	PRNU	+/-10%
Spectral Response	250-1000 nm	Dynamic Range	250:1
Sensor Window	Glass	Maximum Output Rate	20 MHz (LD352xPGx-011) 40 MHz (LD354xPGK-011)
Exposure Control	Yes	Lens Mount	U Mount
Antiblooming	Yes	Temperature Requirements	
Camera Operation Features		Operating Temperature	-20 to 55 C
Number of Outputs	1	Storage Temperature	-40 to 80 C
Communications Protocol	CameraLink (LD35xxPGK-011) Parallel LVDS (LD35xxPGL-011)	Power Requirements	
Output Depth	8 bit	Input voltage	12 to 24 VDC

**Figure 4. Outline Drawings**

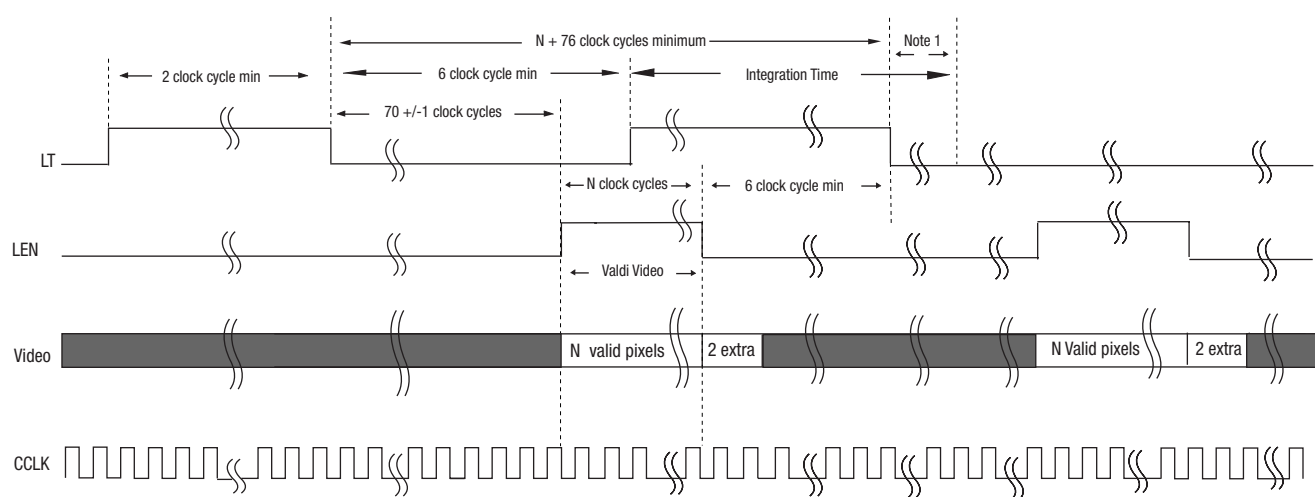


# Digital Linescan Camera

**Figure 5a. CameraLink Slave Mode Timing**



**Figure 5b. LVDS Slave Mode Timing (LRn=low)**



- Note:
1. 950 ns for the LD352x, 475 ns for the LD354x
  2. N is the number of active pixels on the sensor

# Digital Linescan Camera

Figure 6: LD3500 Camera Block Diagram

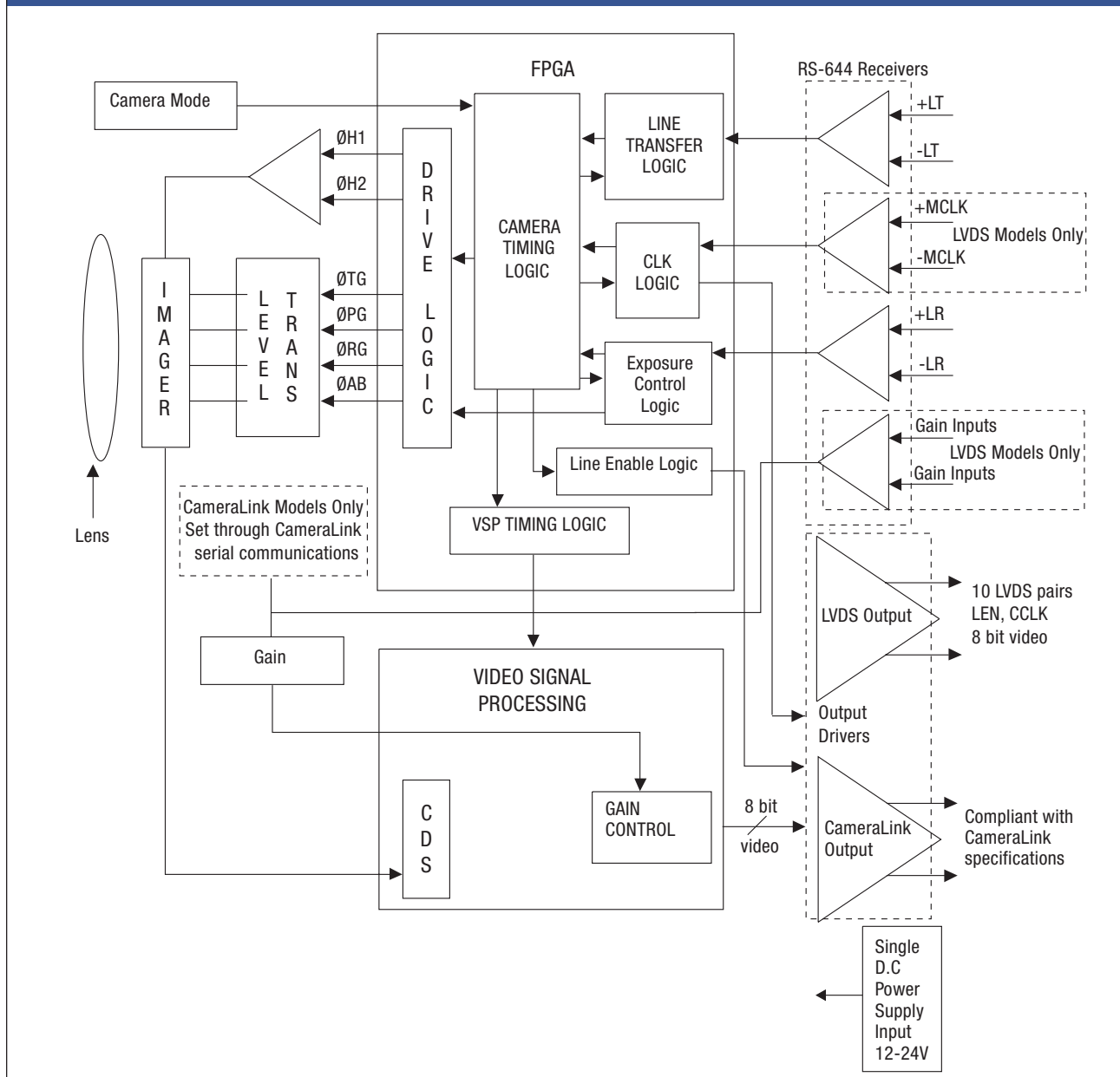


Table 5. LD3500 Camera Model Specifications

Model Number	Number of Pixels	Active Area Pixel Length	Max Output Speed	Max Line Rate
LD3521PGx	512	7.168 mm (0.28")	20 MHz	34 kHz
LD3522PGx	1024	14.336 mm (0.56")	20 MHz	18.2 kHz
LD3523PGx	2048	28.672 mm (1.13")	20 MHz	9.4 kHz
LD3541PGK	512	7.168 mm (0.28")	40 MHz	68 kHz
LD3542PGK	1024	14.336 mm (0.56")	40 MHz	36.4 kHz
LD3543PGK	2048	28.672 mm (1.13")	40 MHz	18.8 kHz

# Digital Linescan Camera

**Table 5. Stock Part Numbers**

Output	CameraLink		RS-644
Data Rate	20 MHz	40 MHz	20 MHz
Pixels			
512	LD3521PGK-011	LD3541PGK-011	LD3521PGL-011
1024	LD3522PGK-011	LD3542PGK-011	LD3522PGL-011
2048	LD3523PGK-011	LD3543PGK-011	LD3523PGL-011

## Ordering Information

While the information provided in this data sheet is intended to describe the form, fit and function for this product, PerkinElmer reserves the right to make changes without notice.

For more information e-mail us at [opto@perkinelmer.com](mailto:opto@perkinelmer.com) or visit our web site at [www.perkinelmer.com/opto](http://www.perkinelmer.com/opto). All values are nominal; specifications subject to change without notice.

**Table 6. Sales Offices**

Table 6. Sales Offices	
United States	<b>North America</b> PerkinElmer Optoelectronics 2175 Mission College Blvd. Santa Clara, CA 95054 Toll Free: 800-775-OPTO (6786) Phone: +1-408-565-0830 Fax: +1-408-565-0703
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Germany	
Japan	<b>Asia</b> PerkinElmer Optoelectronics NEopt. 18F, Parale Mitsui Building 8 Higashida-Cho, Kawasaki-Ku Kawasaki-Shi, Kanagawa-Ken 210-0005 Japan Phone: +81-44-200-9170 Fax: +81-44-200-9160 <a href="http://www.neopt.co.jp">www.neopt.co.jp</a>
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