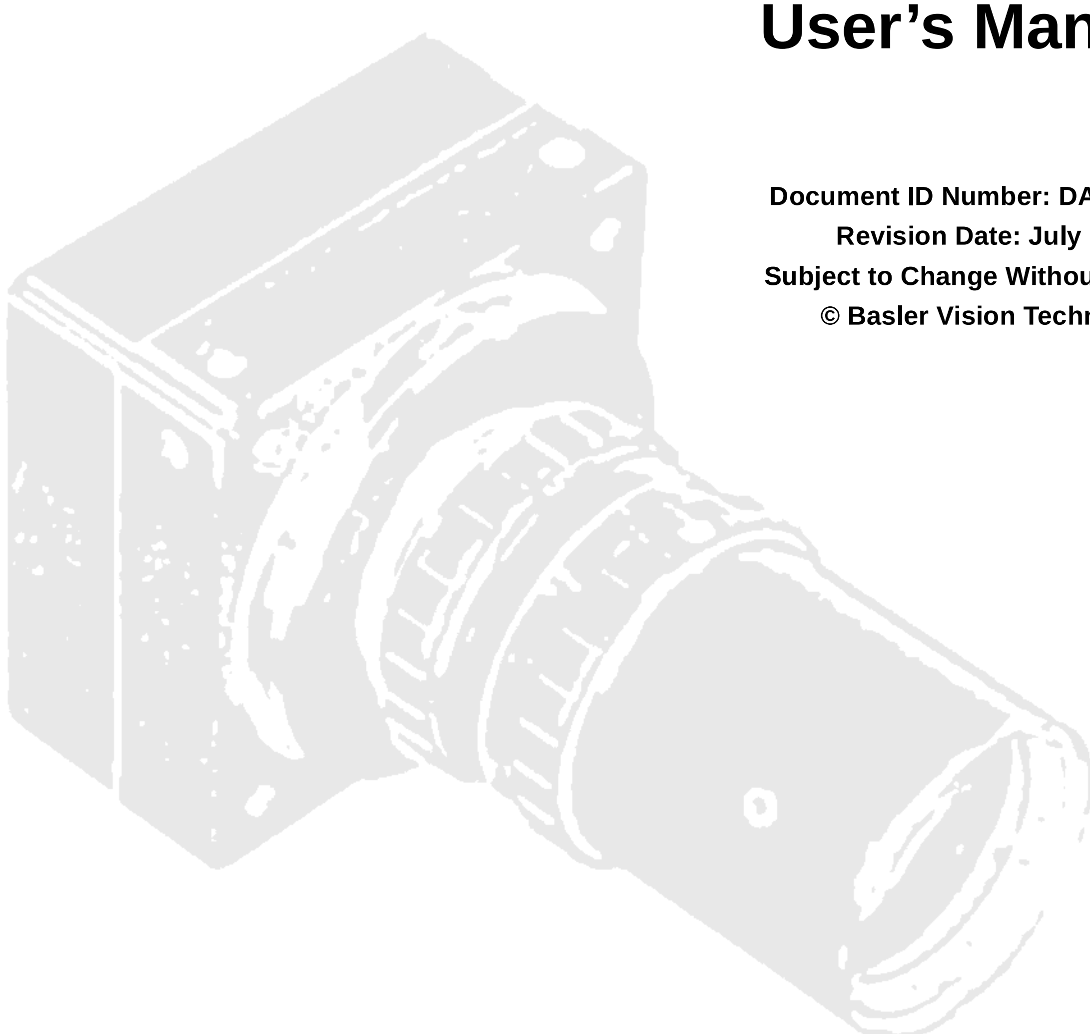
BASLER L100
Series
User's Manual



Document ID Number: DA 037002
Revision Date: July 10, 2001
Subject to Change Without Notice

Basler Support Worldwide:

Americas: +1-877-934-8472
vc.support.usa@baslerweb.com

Europe: +49-4102-463-500
vc.support.europe@baslerweb.com

Asia: +65-425-0472
vc.support.asia@baslerweb.com

www.basler-vc.com

For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment.

The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.

For customers in Canada

This apparatus complies with the Class A limits for radio noise emissions set out in Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes Classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life Support Applications

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Basler customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Basler for any damages resulting from such improper use or sale.

Warranty Note

Do not open the housing of the camera. The warranty becomes void if the housing is opened.

Table of Contents

1 Introduction

1.1 The Basler L100 Product Family

L100 series line scan cameras are versatile cameras designed for industrial use. Superb image sensing features are combined with a robust, high precision manufactured housing.

Important features are:

- High sensitivity
- Anti-blooming
- Electronic exposure time control
- High Signal-to-Noise ratio
- Single or dual video data output
- Programmable via an RS-232 serial port
- Industrial housing manufactured with high planar, parallel and angular precision
- Compact size

L100 series line scan cameras are available in different versions, varying in pixel clock frequencies. Each version of the camera is available with 1024 or 2048 sensor elements and with either single (8 bit) or dual (2 * 8 bit) output. Table 1-1 lists the product family cameras.

	L101	**L103**	**L104**
Pixel Clock			
Single Output:	20 MHz	40 MHz	62.5 MHz
Dual Output:	10 MHz	20 MHz	31.25 MHz

Table 1-1: **L100** Versions

1.1.1 Camera Name Change

In June 2000, several Basler camera models were renamed. Before June 2000, the **L101**, **L103**, and **L104** were known as the **L120**, **L140**, and **L160** respectively.

1.2 Performance Specifications

Specification	L101	L103	L104
Sensor Type	1024 pixel or 2048 pixel linear CCD		
Pixel Size	10 µm (H) x 10 µm (V), 10 µm pitch		
Lens Adapter 1024 Pixel CCD: 2048 Pixel CCD:	 F-mount or C-mount F-mount		
Fill Factor	100%		
Spectral Response	300 - 1000 nm, peak at 700 nm (see Figure 1-1)		
Anti-blooming	1:100 or better		
Fixed Pattern Noise	± 1 gray Value		
Photo Response Non-uniformity	typ: ± 5%		
Pixel Clock Single Output: Dual Output:	 20 MHz 10 MHz	 40 MHz 20 MHz	 62.5 MHz 31.25 MHz
Max. Line Rate 1024 Pixel CCD: 2048 Pixel CCD:	 18.35 kHz 9.42 kHz	 36.75 kHz 18.90 kHz	 57.45 kHz 29.56 kHz
Video Output	8 bit, RS-644 / 2 * 8 bit, parallel RS-644		
Synchronization	External via ExSync signal		
Exposure Time Control Modes	Edge-controlled, level-controlled, or programmable		
Gain and Offset	Programmable via RS-232		
Power Requirements	24 VDC (± 15%), max. 6 W	24 VDC (± 15%), max. 7 W	24 VDC (± 15%), max. 8 W
Max. Cable Lengths RS-232: RS-644: Single Output RS-644: Dual Output	 15 m 20 m 20 m	 15 m 11 m 18 m	 15 m 5 m 15 m
Conformity	CE, FCC		
Housing Size (without adapter)	45 mm x 62 mm x 62 mm (L x W x H)		
Weight	with C-mount adapter: ~ 290 g with F-mount adapter: ~ 385 g		

Table 1-2: L100 Series Performance Specifications

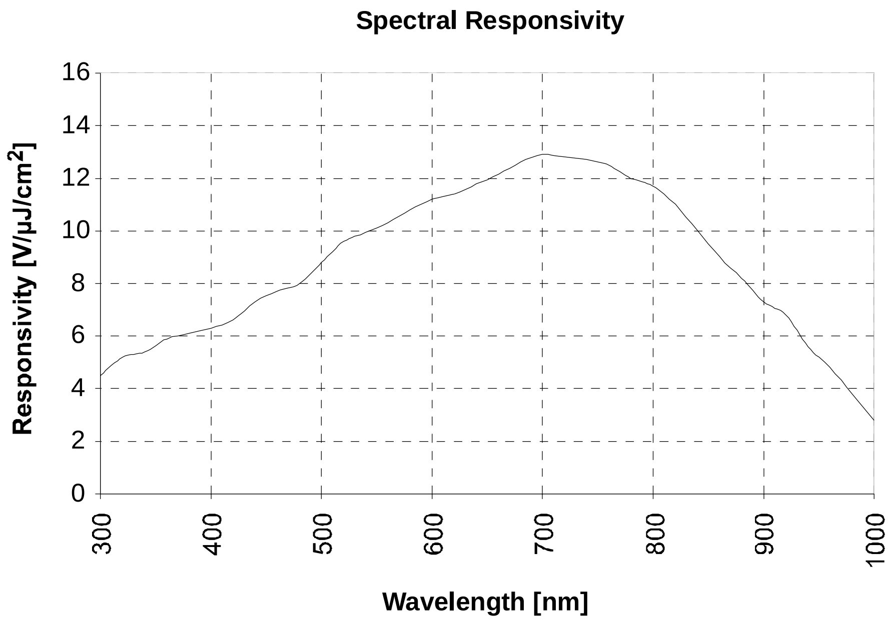


Figure 1-1: **L100** Spectral Responsivity

1.3 Precautions

Read the manual

Read the manual carefully before using the camera.

Keep foreign matter outside of the camera

Do not open the casing. Touching internal components may damage them.

Be careful not to allow liquid, flammable, or metallic material inside the camera housing. If operated with any foreign matter inside, the camera may fail or cause a fire.

Ventilation

Allow sufficient air circulation around the camera or provide additional cooling to prevent internal heat build-up.

> **Warning!**
>
> Without sufficient cooling the camera can get hot enough during operation to cause burning when touched.

Environmental Requirements

Operation temperature:	+ 5° C … +40° C (+ 41° F … +104° F)
Operation humidity:	5% … 85%, relative, non-condensing
Storage temperature:	-10° C … + 70° C (+ 14° F … +158° F)
Storage humidity:	5% … 95%, relative, non-condensing

Electromagnetic Fields

Do not operate the camera in the vicinity of strong electromagnetic fields. Avoid electrostatic charging.

Transporting

Only transport the camera in its original packaging. Do not discard the packaging.

Cleaning

Avoid cleaning the surface of the CCD sensor if possible. If you must clean it, use a soft, lint free cloth dampened with a small quantity of pure alcohol. Do not use methylated alcohol.
Because electrostatic discharge can damage the CCD sensor, you must use a cloth that will not generate static during cleaning (cotton is a good choice).

To clean the surface of the camera housing, use a soft, dry cloth. To remove severe stains, use a soft cloth dampened with a small quantity of neutral detergent, then wipe dry.

Do not use volatile solvents such as benzine and thinners; they can damage the surface finish.

2 Camera Interface

2.1 Connections

2.1.1 General Description

L100 series line scan cameras are interfaced to external circuitry via three connectors located on the back of the camera. Figure 2-1 shows the connector types used on the camera and Figure 2-2 provides a general description of the function of each connector.

As shown in Figure 2-2, there are also two status LEDs on the back of the camera which indicate signal integrity and power OK.

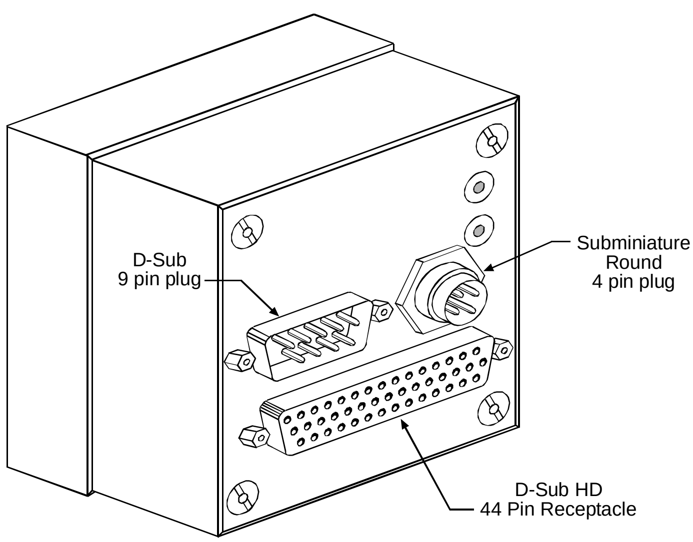


Figure 2-1: **L100** Connector Types

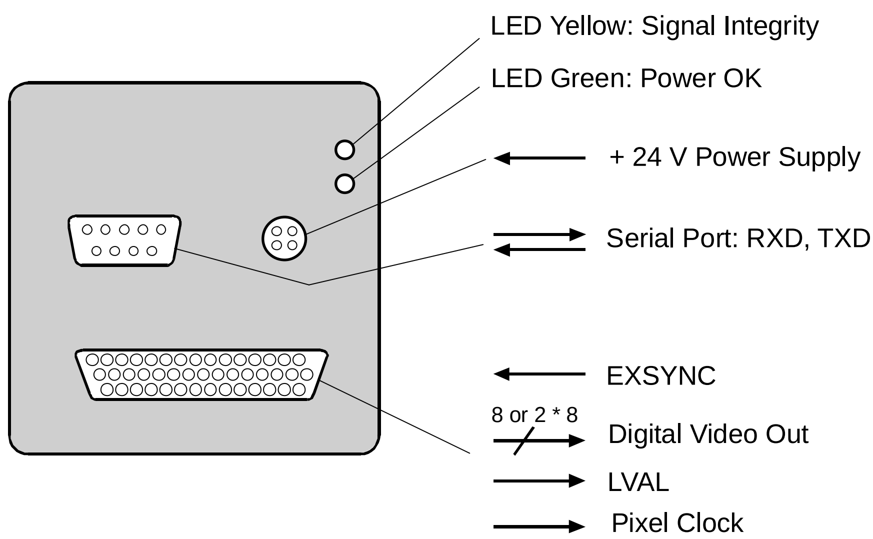


Figure 2-2: **L100** Connectors and Signals

2.1.2 Pin Assignments

The D-Sub HD 44 pin receptacle is used to interface video data and control signals. The pin assignments for the receptacle are shown in Table 2-1.

The pins assigned to DOUT 8 - DOUT 15 are not connected in the single output version.

Pin	Signal	Pin	Signal
1	DOUT 0	23	/DOUT 7
2	DOUT 1	24	/DOUT 8
3	DOUT 2	25	/DOUT 9
4	DOUT 3	26	/DOUT 10
5	DOUT 4	27	/DOUT 11
6	DOUT 5	28	/DOUT 12
7	DOUT 6	29	/DOUT 13
8	DOUT 7	30	/DOUT 14
9	DOUT 8	31	DOUT 15
10	DOUT 9	32	/DOUT 15
11	DOUT 10	33	LVAL
12	DOUT 11	34	/LVAL
13	DOUT 12	35	PIXEL CLOCK
14	DOUT 13	36	/PIXEL CLOCK
15	DOUT 14	37	ExSync
16	/DOUT 0	38	/ExSync
17	/DOUT 1	39	Not connected
18	/DOUT 2	40	Not connected
19	/DOUT 3	41	Not connected
20	/DOUT 4	42	Not connected
21	/DOUT 5	43	Shorted to pin 44 internally
22	/DOUT 6	44	DC Gnd[1]

/ means an inverted signal with the LOW signal being active

[1] Pin 44 on the 44 pin receptacle, pin 5 on the 9 pin plug and pin 1 on the 4 pin plug are tied together inside of the camera to ensure that the grounds are all at the same potential.

Table 2-1: **L100** Pin Assignments, D-Sub HD 44 Pin Receptacle

The camera housing is not grounded and is electrically isolated from the circuit boards inside of the camera.

The D-Sub 9 pin plug is used for RS-232 communication between the host computer and the camera. The pin assignments for the plug are shown in Table 2-2.

Pin	Signal	Pin	Signal
1	Not connected	6	Shorted to pin 4 internally
2	RxD	7	Shorted to pin 8 internally
3	TxD	8	Shorted to pin 7 internally
4	Shorted to pin 6 internally	9	Not connected
5	DC Gnd[1]		

[1] Pin 5 on the 9 pin plug, pin 44 on the 44 pin receptacle, and pin 1 on the 4 pin plug are tied together inside of the camera to ensure that the grounds are all at the same potential.

Table 2-2: **L100** Pin Assignments, RS 232, D-Sub 9 Pin Plug

The subminiature, round 4 pin plug is used for input power. The pin assignments for the plug are shown in Table 2-3.

Pin	Signal	Pin	Signal
1	DC Gnd[1]	3	+ 24 V
2	Shorted to pin 1 internally	4	Shorted to pin 3 internally

[1] Pin 1 on the 4 pin plug, pin 44 on the 44 pin receptacle, and pin 5 on the 9 pin plug are tied together inside of the camera to ensure that the grounds are all at the same potential.

Table 2-3: **L100** Pin Assignments, Subminiature Round 4 Pin Plug

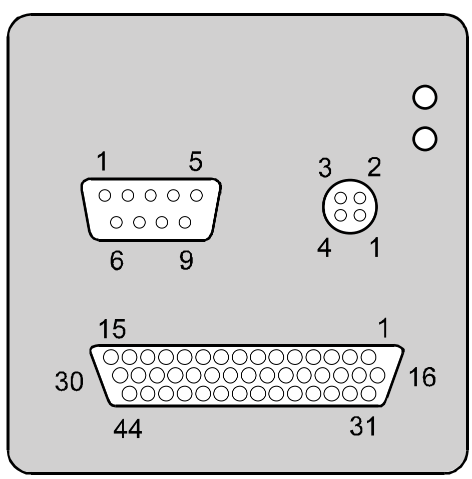


Figure 2-3: **L100** Pin Numbering

2.2 Cable Information

2.2.1 Video Data Cable Between the Camera and the Frame Grabber

The video data cable between the camera and the frame grabber must be made with 28 gauge AWG twisted pair wire and have a characteristic impedance of 100 ohms. The maximum length of the cable is shown in Table 2-4.

	L101	L103	L104
Single Output	20 m	11 m	5 m
Dual Output	20 m	18 m	15 m

Table 2-4: Video Data Cable Maximum Lengths

2.2.2 Camera to PC RS-232 Cable

The RS-232 cable between the camera and the PC can be a null modem cable or a simple three wire connection as illustrated in Figure 2-4. The maximum length of the cable is 15 meters.

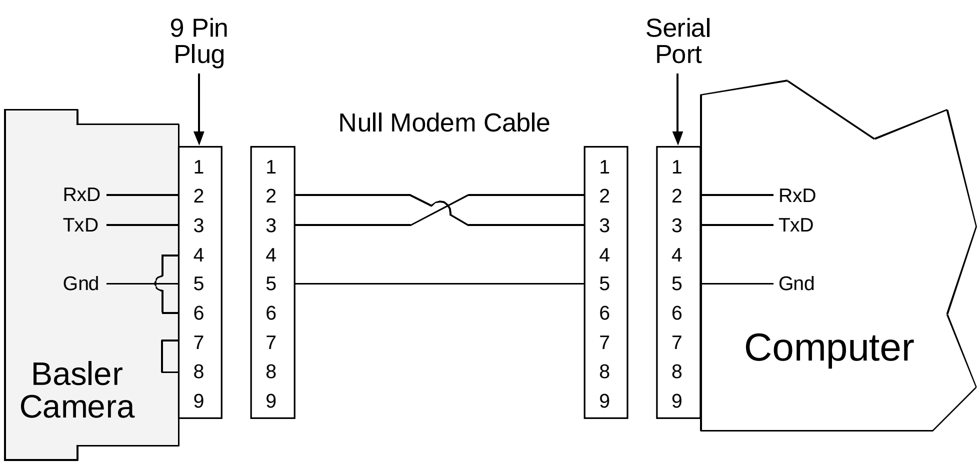


Figure 2-4: Camera to PC RS-232 Interface

	The cable between the camera and the PC must contain a twist so that pin 2 on the camera connects to pin 3 on the PC and pin 3 on the camera connects to pin 2 on the PC.

2.3 Video Data and Control Signals

All video data and control signals on **L100** series cameras use LVDS technology as specified for RS-644. Detailed information on RS-644 appears in Section 2.3.3.

2.3.1 Input Signals

2.3.1.1 ExSync: Controls Line Readout and Exposure Time

The camera can be programmed to function in one of three exposure time control modes. In these modes, edge-controlled, level-controlled and programmable, an external trigger (ExSync) signal is used to control exposure time and line read out. For more detailed information on the three modes, see Section 3.3.

ExSync can be a periodic or non-periodic function. The frequency of the ExSync signal determines the camera's line rate.

Minimum high and low level time for the ExSync signal is 3 Pclk (pixel clocks). Note that ExSync is edge sensitive and therefore must toggle.

Note that exposure time may vary by 2 Pclk because ExSync must synchronize internally with the pixel clock.

2.3.2 Output Signals

2.3.2.1 LVAL: Indicates a Valid Line

LVAL indicates a valid line of data as illustrated in Figures 2-5 and 2-6 for the single output version and in Figures 2-7 and 2-8 for the dual output version. Video data is valid when LVAL is high.

2.3.2.2 Pixel Clock: Indicates a Valid Pixel

Pixel clock indicates a valid pixel of data as illustrated in Figures 2-5 and 2-6 for the single output version and in Figures 2-7 and 2-8 for the dual output version. The LVAL and the pixel clock signals are used to clock the digital video output data into external circuitry. Digital data is valid on the rising edge of the pixel clock signal with LVAL high. The pixel clock frequencies for the single and dual output versions are shown in Table 2-5

	L101	L103	L104
Single Output	20 MHz	40 MHz	62.5 MHz
Dual Output	10 MHz	20 MHz	31.25 MHz

Table 2-5: Pixel Clock Frequencies

2.3.2.3 Video Data

Depending on the camera version, **L100** cameras output pixels either as a single data stream as shown in Figures 2-5 and 2-6 or as two data streams as illustrated in Figures 2-7 and 2-8. For a single data stream, the pixels are in sequential order, starting with the first valid pixel and ending with the last pixel. No further sorting is required. In the dual output version, odd and even pixels are transferred as pairs. The pairs are made up of an odd and the next following even pixel. The low byte b_7 - b_0 transfers the odd pixels, the high byte b_{15} - b_8 the even pixels.

The camera's range of intensity includes 256 gray values. The digital gray value 0 corresponds to black and the digital gray value 255 to white.

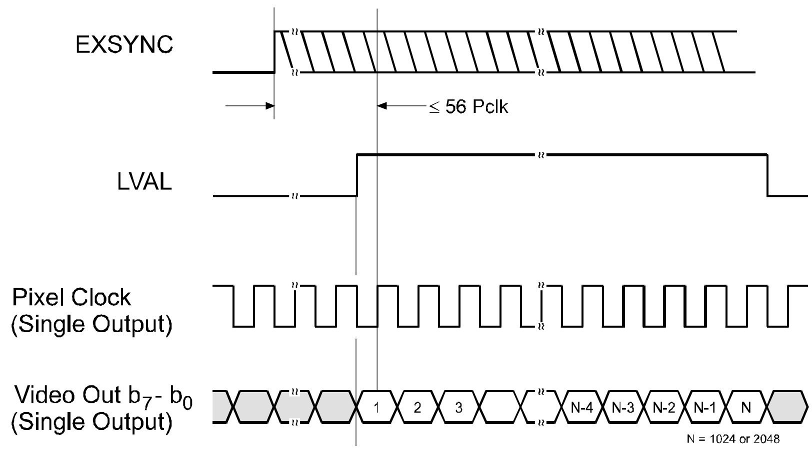


Figure 2-5: Pixel Timing, Single Output Version, Edge or Level-controlled Exposure Mode

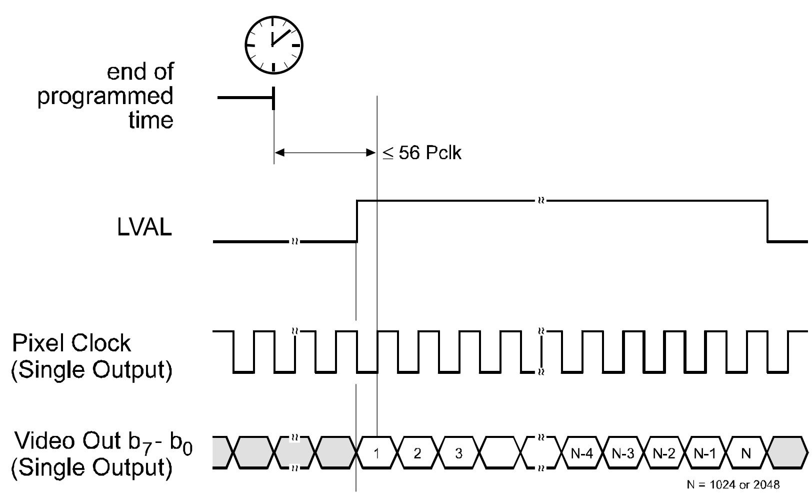


Figure 2-6: Pixel Timing, Single Output Version, Programmable Exposure Mode

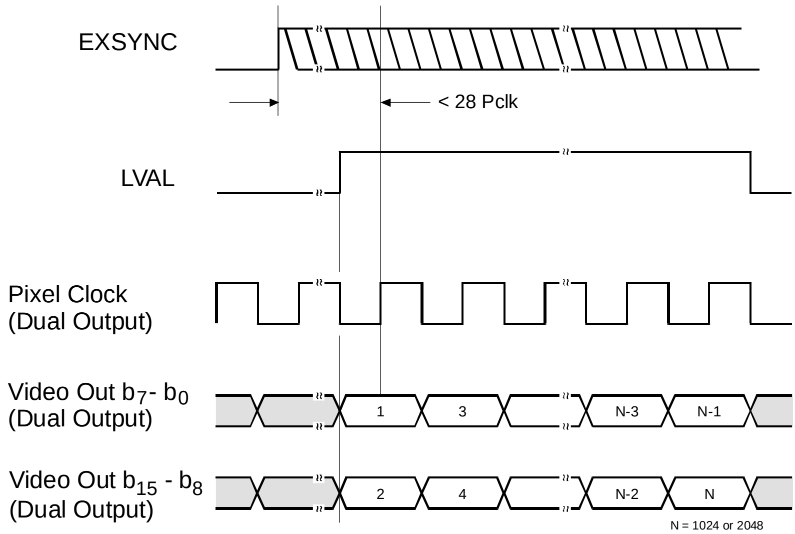


Figure 2-7: Pixel Timing, Dual Output Version, Edge or Level-controlled Exposure Mode

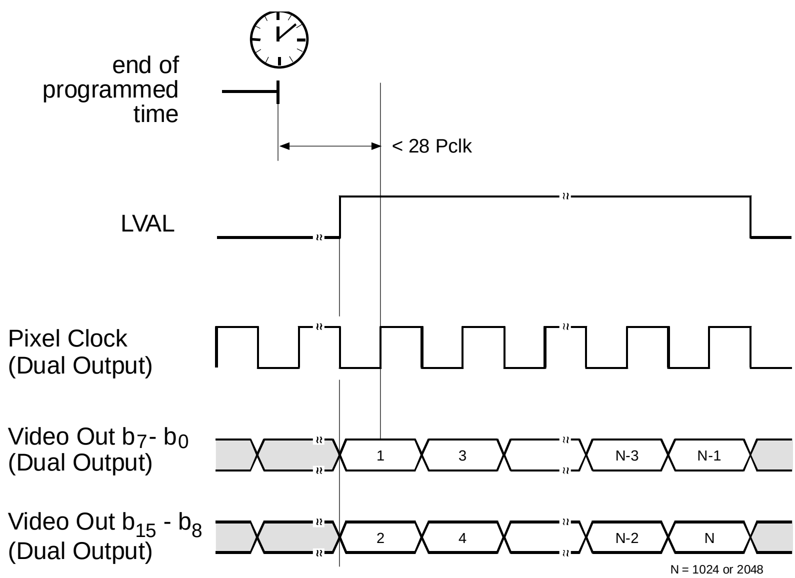


Figure 2-8: Pixel Timing, Dual Output Version, Programmable Exposure Mode

2.3.3 LVDS and RS-644 Information

All video data and control signals on **L100** series cameras use LVDS technology as specified for RS-644. Basic RS-644 characteristics are outlined in Table 2-6.

L100 series cameras use National Semiconductor DS90C031 differential line drivers to generate LVDS output signals and a National Semiconductor DS90C032 differential line receiver to receive LVDS input signals. Detailed spec sheets for these devices are available at the National Semiconductor web site (www.national.com).

Figure 2-9 shows a basic schematic for the input/output stage of **L100** series cameras.

	RS-644	**RS-422**
Low, High Voltage Level (min./max.)	1.0 V, 1.4 V	0.5 V, 4.0 V
Voltage Swing (typical)	± 0.35 V	± 3.0 V
Receiver Threshold	± 0.10 V	± 0.20 V
Receiver Input Voltage Tolerance	0.0 V to 5.0 V [1]	0.0 V to 5.0 V [1]
Termination	100 Ohm	100 Ohm
Max. Data Rate per Line Pair	655 MBits/s [2]	15 (<30) M/bits/s [3]
Max. Cable Length at 20 MHz [4] (typical)	20 m	5 m
Max. Cable Length at 40 MHz [4] (typical)	11 m	Not Possible
Power Requirements (transmitter + receiver) for 20 line pairs at 20 MBits/s (typical)	0.93 W	3.75 W

[1] Device-dependent, 5V devices handle this range

[2] Device-dependent

[3] Bit rates greater than 15 MBits/s are beyond the RS-422 standard

[4] Note that the frequency refers to the pixel clock and not the number of pixels transferred per clock cycle

Table 2-6: RS-644/422 Characteristics

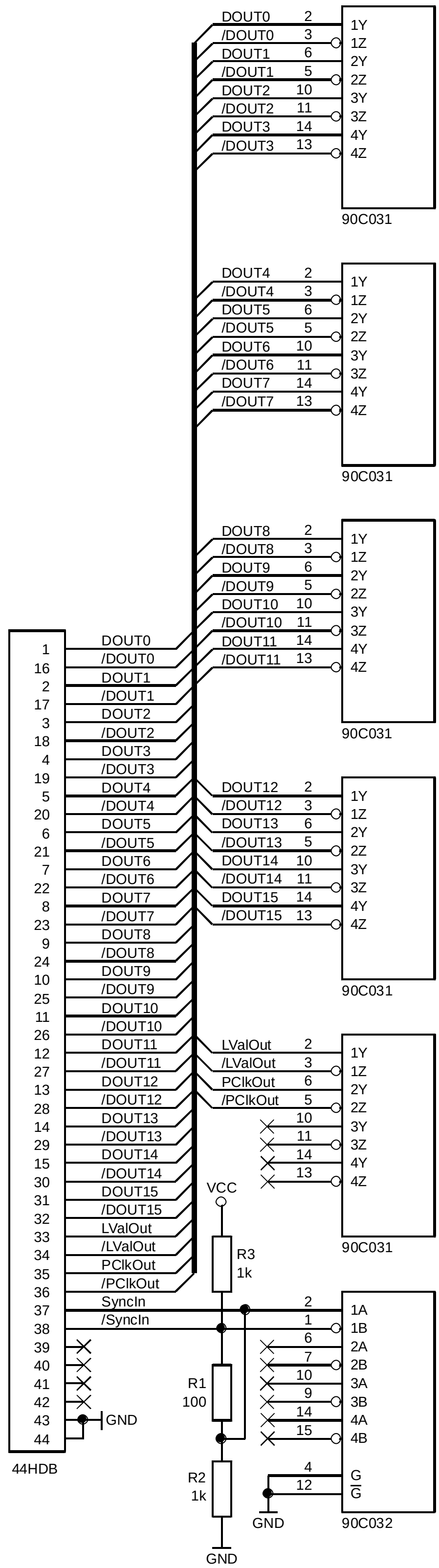


Figure 2-9: **L100** Series Input/Output Connections (Video Data and Control Signals)

2.3.3.1 RS-644/RS-422 Compatibility

Typically, RS-644 and RS-422 devices are compatible.

As shown in Table 2-6, the RS-422 receiver threshold is ± 0.20 V. This threshold is well within the RS-644 voltage swing of ± 0.35 V. For this reason, an RS-422 receiver can handle RS-644 inputs.

On the other side, because RS-644 receivers typically tolerate the voltages generated by RS-422 drivers, an RS-644 receiver can handle RS-422 signals as input.

With RS-422, cable length has a strong impact on signal integrity. Long cables should not be used.

2.3.3.2 Converting TTL to RS-422/644

In many cases, ExSync signals in RS-644 format are generated by a frame grabber board. In some situations, however, you may want to generate an ExSync signal directly from a TTL device such as a sensor. Figure 2-10 illustrates a simple circuit that can be used to convert TTL signals to RS-422/644 compatible signals.

The circuit produces a symmetric 200mV output. The 5V power required for the circuit can be found on many frame grabbers on the GPIO port. There is no significant time delay due to the TTL to RS-422/644 conversion.

A disadvantage to this circuit is the constantly existing DC current of approximately 5 mA.

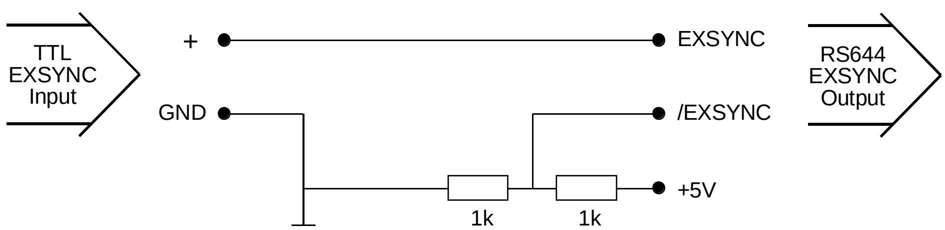


Figure 2-10: TTL to RS-644 Conversion

2.4 RS-232 Serial Port

L100 series cameras are equipped with an RS-232 serial port for programming operation modes and parameters. The data character format is 8N1 (8 data bits + no parity + 1 stop bit). Baud rate is 9600 bps, others are available upon request. See Section 2.2.2 for details on the RS-232 cable that must be used between your camera and your PC.

The Basler Camera Configuration Tool (CCT) can be used to change camera modes and parameters via the serial port. Refer to the CCT installation guide that was delivered with your camera for instructions on installing the configuration tool. See Section 4.1 and the configuration tool's on-line help file for instructions on using the tool.

Camera modes and parameters can also be changed by issuing programming commands using a terminal emulation program and the serial port. See Section 4.2.1 for instructions on setting up a terminal emulation program and Section 4.2 for details on changing settings with programming commands.

Programming commands can also be issued directly from your application via the serial port.

2.5 Power Supply

L100 series cameras require a 24 VDC (± 15%) power supply. The maximum wattage is 6 W / 7 W / 8 W for the **L101** / **L103** / **L104** respectively.

> Make sure that the voltage rises to at least 16 VDC within 20 ms after you apply power to the camera

2.6 Status LEDs

Green LED

When the green LED is lit, it indicates that power is OK.

Yellow LED

The yellow LED indicates signal integrity. In case of an error, blinking signals from the yellow LED indicate that an error condition is present. See Section 6.2 for further information.

3 Basic Operation and Features

3.1 Functional Description

L100 series line scan cameras employ CCD sensor chips which provide features such as electronic exposure time control and anti-blooming. Exposure time is controlled via an external ExSync signal. The ExSync signal facilitates asynchronous pixel readout.

Exposure time can be edge-controlled or level-controlled, which means it can be set to the full line period or be controlled by the ExSync signal. When exposure is controlled by the ExSync signal, a rising edge of ExSync triggers the readout of accumulated charges from the sensor elements to the CCD shift registers. Exposure time can also be programmed to a predetermined time period. In this case, accumulated charges are read out subsequent to the programmed exposure time.

At readout, accumulated charges are transported from the light-sensitive sensor elements to the CCD shift registers. The charges from even and odd pixels are processed separately in two channels as shown in Figure 3-1. The charges then move from the two lines of shift registers to the output amplifiers where they are converted to voltages proportional to the accumulated charges. The shift is clocked according to the camera's internal data rate. The overall output data rate is fixed to 20 / 40 / 62.5 MHz for the **L101** / **L103** / **L104** respectively. Other data rates are available upon request.

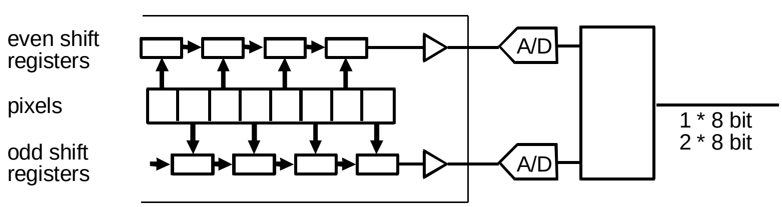


Figure 3-1: Even and Odd Channels

The voltages are digitized and transmitted by the camera. The video data is transmitted either as a single (8 bit) or dual (2 * 8 bit) video data stream depending on the camera version. All output signals use LVDS technology according to RS-644. For optimal digitization, gain and offset are programmable via an RS-232 serial port.

3.2 Configuration Sets

The camera's adjustable parameters are stored in configuration sets and each configuration set contains all of the parameters needed to control the camera. There are three different configuration sets: the Work Set, the User Set and the Factory Set. See Figure 3-2.

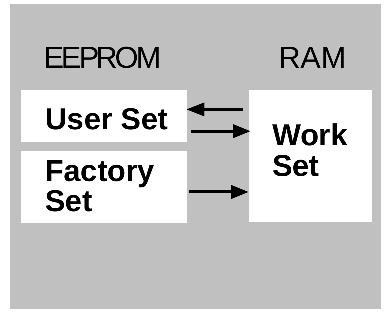


Figure 3-2: Config Sets

The Work Set contains the current camera settings and thus determines the camera's performance, that is, what your image looks like. The Work Set is stored in the camera RAM. The configuration parameters in the Work Set can be altered directly using the Camera Configuration Tool or programming commands.

The Factory Set and the User Set are stored in a non-volatile EEPROM in the camera. The Factory Set contains the camera's default configuration and cannot be changed.

The User Set initially contains factory settings but can be modified permanently by storing the Work Set into the User Set.

When power to the camera is switched off, the Work set in the RAM is lost. At the next power on, a Work Set is automatically loaded into the RAM using the settings from the User Set. If the User Set is corrupted, the settings from the Factory Set are copied into the Work Set.

3.3 Exposure Time Control Modes

The camera can be programmed to function in three basic exposure time control modes: edge-controlled, level-controlled or programmable. In these modes, an ExSync signal is used to control exposure time and line read out. Note that exposure time may vary by 2 Pclk because ExSync must synchronize internally with the pixel clock.

- In the edge-controlled mode, charge is accumulated over the full line period. The falling edge of ExSync is irrelevant. The line is read out and transferred with the rising edge of ExSync. See Figure 3-3.

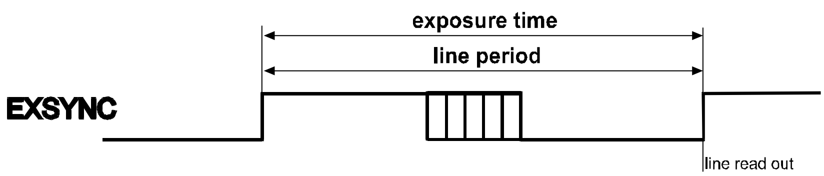


Figure 3-3: Exposure Time in Edge-controlled Mode

- In the level-controlled mode the exposure time of a line being read out is determined by the time between the rising edge and the preceding falling edge of ExSync. Charge is only accumulated when ExSync is low. The line is read out and transferred with the rising edge of ExSync. See Figure 3-4.

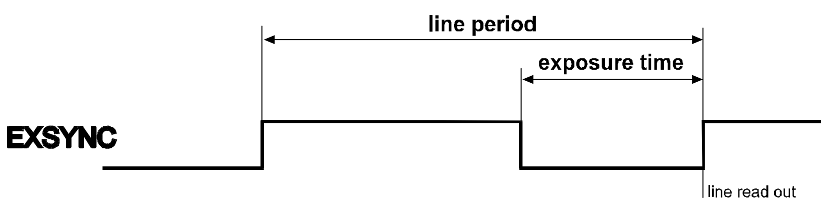


Figure 3-4: Exposure Time in Level-controlled Mode

- In the programmable mode the rising edge of ExSync triggers exposure for a time period programmed via the serial interface. The line is read out and transferred subsequent to the programmed time period. The falling edge of ExSync is irrelevant. See Figure 3-5.

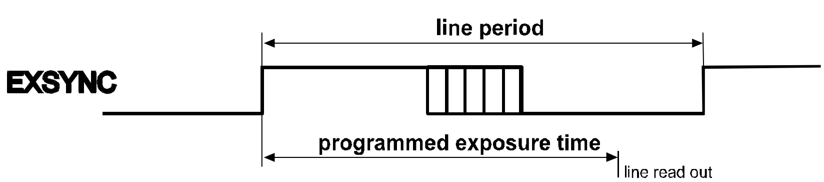


Figure 3-5: Exposure Time in Programmable Mode

The minimum recommended exposure time is 20 µs.

The exposure time must be less than the line period.

3.4 Gain and Offset

The major components in the camera electronics include: a CCD sensor, two amplifiers, and two ADCs (Analog to Digital Converters). The pixels in the CCD sensor output voltage signals when they are exposed to light. These voltages are amplified by the amplifiers and converted to digital output signals by the ADCs.

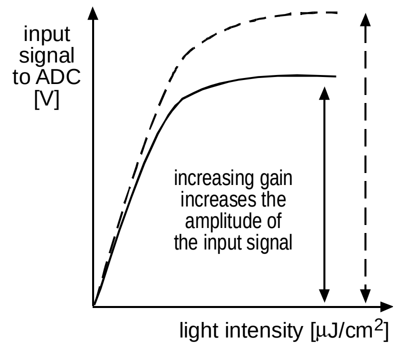


Figure 3-6: Gain

Two parameters, gain and offset are associated with each amplifier. As shown in Figure 3-6, increasing or decreasing the gain increases or decreases the amplitude of the signal that is input to the ADC. As Figure 3-7 shows, increasing or decreasing the offset moves the signal up or down the measurement scale but does not change the signal amplitude.

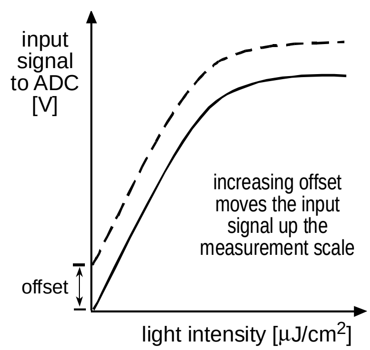


Figure 3-7: Offset

The factory default gain and offset are set so that with optimal lighting (see Section 4.2.8) and exposure, the linear output range of the CCD sensor maps to the input range of the ADC. Under these conditions, black will produce a gray value of 1 from the ADC and white will produce a gray value of 254. If your application does not result in an output of 1 with black and 254 with white, you should attempt to achieve these results by varying illumination and exposure rather than adjusting the gain. Increased gain results in increased noise and is not recommended.

Internally, **L100** cameras process odd and even pixels separately in two different data streams (see Figure 3-8). Consequently, gain and offset must be adjusted separately for the odd channel and for the even channel. Due to variations in the camera's electronics, the gain and offset needed to correctly map the even channel to the ADC may be different from the gain and offset needed on the odd channel. In addition, changes in gain induce variations in offset which must be compensated for. Gain alignment between the channels and compensation for the offset changes are important to maintain uniform output data with minimal gray value differences between odd and even pixels.

If you use the Camera Configuration Tool to adjust the gain, the tool will automatically compensate for the difference between the odd and even channels. Sections 4.2.6 through 4.2.8 explain how to change gain and offset with programming commands and describe a method for keeping the channels in balance when you change gain and offset with commands.

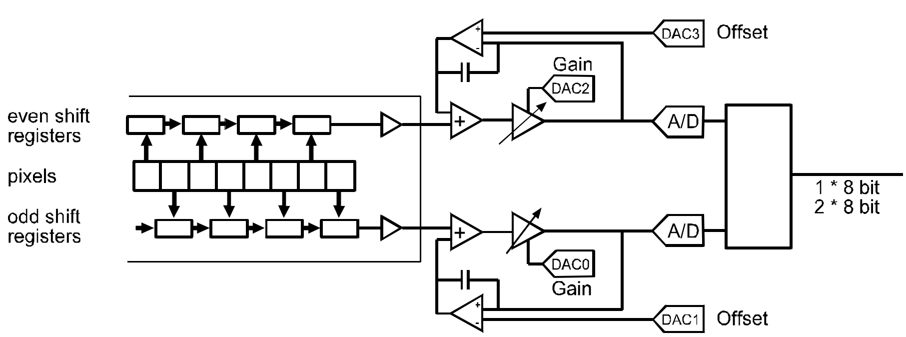


Figure 3-8: Camera Data Channels

> Because increasing gain increases both signal and noise, the signal to noise ratio does not change significantly when gain is increased.

3.5 Test image

The test image mode is used to check the camera's basic functionality and its ability to transmit an image via the video data cable. In test mode, the image is generated using a software program rather than the camera's optics and CCD sensor. The test image can be used for service purposes and for failure diagnostics.

The test image is formed with an odd/even gray scale gradient that ranges from 0 to 255 and repeats every 512 pixels as shown in Figure 3-9. The odd pixel gradient starts at 0 and steps up, that is, the gray value of pixel 1 is 0, the gray value of pixel 3 is 1, the gray value of pixel 5 is 2, and so forth. The even gradient starts at 255 and steps down, that is, the gray value of pixel 2 is 255, the gray value of pixel 4 is 254, the gray value of pixel 6 is 253, and so forth.

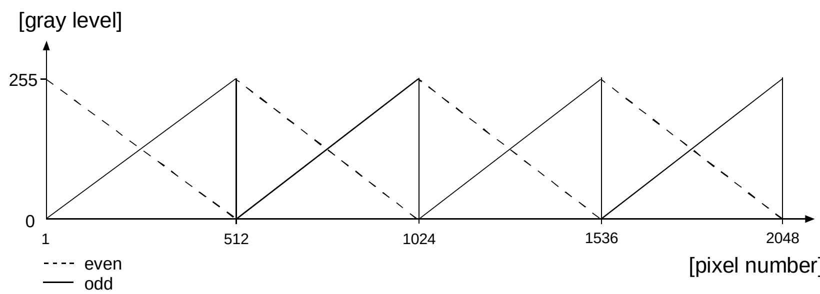


Figure 3-9: Formation of the Test Pattern

At pixels 256 and 257, the gray value for both pixels is 128. At pixels 511 and 512, a white odd pixel is next to a black even pixel. At pixels 513 and 514, a black odd pixel is next to a white even pixel. To the human eye, the gradient appears to be a varying gray field with a white vertical line every 512 pixels.

An ExSync signal is required to output a line on the test image and multiple transitions of the ExSync signal will produce a two dimensional test image as shown in Figure 3-10.

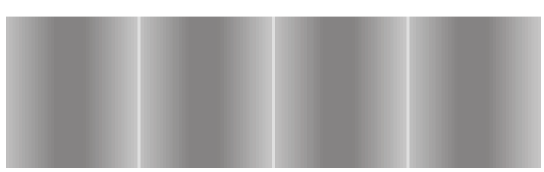


Figure 3-10: Test Image

When the test image is active, gain, offset and exposure settings have no effect on the image.

3.6 Extended Clamping

At higher line rates, the offset voltage and thus the black level is very stable. However, at low line rates, the offset voltage can drift causing a corresponding change in the black level. The L100 electronics derive an internal black level reference voltage for each line from a shaded black reference pixel. To avoid a voltage drift at very low line rates, the offset voltage can be kept close to optimum by using extended clamping.

Extended clamping does not work well for high line rates and should not be used in normal working conditions. Extended clamping should only be used if the time between lines exceeds 10 ms.

3.7 Camera Status

L100 series cameras monitor their status by performing a regular series of self checks. The current status of the camera can be viewed in several ways:

- with the Camera Configuration Tool. You can use the Status Tab (see Section 4.1 and the configuration tool's on-line help file) to check a list of several possible errors and an indication of whether those errors are present.
- with ASCII based programming commands. You can use the Camera Status command (see Section 4.2.5) to check if the camera has detected any errors.
- by checking the yellow LED on the back of the camera. If certain error conditions are present, the yellow LED will blink (see Section 6.2).

4 Configuring the Camera

L100 series cameras are programmable via the serial port. They come factory-set so that they will work properly for most applications with minor changes to the camera configuration. For normal operation, the following parameters are usually configured by the user:

- exposure time control mode
- exposure time (only for programmable mode)
- extended clamping (only for line rates < 100 Hz)

To customize operation for your particular application, the following parameters can also be configured:

- gain
- offset

Two methods can be used to program the camera. The first and easier approach is to change the camera settings using the Camera Configuration Tool (CCT). See Section 4.1 and the CCT's on-line help file for instructions on using the configuration tool.

You can also change the settings by programming the camera directly from a terminal program or from your application. For this purpose, a set of ASCII based commands are provided to read and modify the settings. Section 4.2 lists the commands and provides instructions for their use.

4.1 Configuring the Camera with the Camera Configuration Tool

The Camera Configuration Tool (CCT) is a Windows® based program used to easily change the camera's settings. The tool communicates via the serial interface and automatically generates the binary programming commands that are described in Section 4.2. For instructions on installing the tool, see the CCT installation guide that was delivered with your camera.

This manual assumes that you are familiar with Microsoft Windows® and that you have a basic knowledge of how to use programs. If not, please refer to your Microsoft Windows® manual.

4.1.1 Opening the Configuration Tool

1. Make sure that the serial interface is connected to your camera and that the camera has power.
2. Click **Start**, click **Basler Vision Technologies**, and then click **Camera Config Too**l (default installation).

   If start-up was successful, the Model Tab is displayed.

   If start-up was not successful, the Connection Tab or a Select Camera dialog box will appear. For possible causes, refer to the Camera Configuration Tool installation guide that was delivered with your camera.

4.1.2 Closing the Configuration Tool

Close the configuration tool by clicking on the button in the upper right corner of the window.

4.1.3 Configuration Tool Basics

The RAM memory in the camera contains the set of parameters that controls the current operation of the camera. This set of parameters is known as the Work Set (see Section 3.2). The Camera Configuration Tool is used to view the present settings for the parameters in the Work Set or to change the settings. The configuration tool organizes the parameters into related groups and displays each related group on a tab. For example, the Gain and Offset Tab contains all of the parameters related to setting the gain and the offset.

When the configuration tool is opened, it queries the camera and displays the current settings for the parameters in the Work Set.

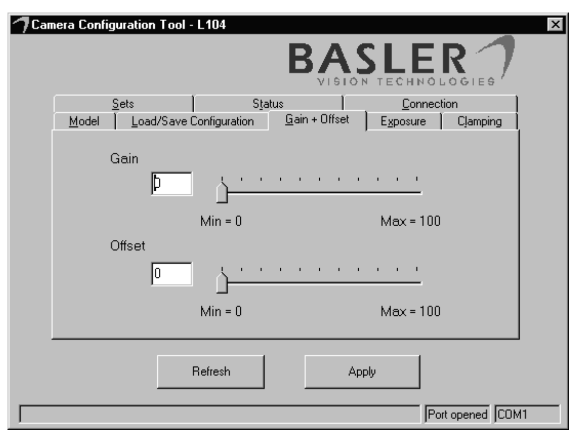


Figure 4-1: Gain and Offset Tab

Using the Refresh and Apply Buttons

Two buttons always appear at the bottom of the configuration tool window, the Refresh button and the Apply button.

Typically, if you make a change to one or more of the settings on a tab, you must click the **Apply** button for that change to be transmitted from the configuration tool to the camera's Work Set. Because the parameters in the Work Set control the current operation of the camera, when you click the Apply button, you will see an immediate change in the camera's operation.

The **Refresh** button can be used at any time to make sure that the configuration tool is displaying the current settings for the parameters in the Work Set. When you click the Refresh button, the configuration tool queries the camera to determine the current setting for each parameter in the Work Set and updates the display on each tab.

> Keep in mind that the Work Set is stored in a volatile memory. Any changes you make to the Work Set using the configuration tool will be lost when the camera is switched off. To save changes you make to the Work Set, go to the Sets Tab and save the modified Work Set into the User Set. The User Set is stored in non-volatile memory and will not be lost when the camera is switched off (see Section 3.2).

4.1.4 Configuration Tool Help

The Camera Configuration Tool includes a complete on-line help file which explains how to use each tab and how the settings on each tab will effect the camera's operation. To access on-line help, press the F1 key whenever the configuration tool is active.

4.2 Configuring the Camera with Programming Commands

Camera settings can be changed via the serial interface using a set of ASCII based programming commands. The commands can be issued from a terminal emulation program or from your application.

Section 4.2.1 describes how a terminal emulation program must be set up when it is used to issue commands to a Basler camera. Section 4.2.2 describes the general format that is used for commands. Sections 4.2.3 through 4.2.11 describe each command in detail and Section 4.2.12 lists all commands available.

4.2.1 Setting Up a Terminal Emulation Program

You can use a terminal emulation program (such as Windows® Hyperterminal) along with the ASCII based commands described below to change the camera's settings. If you will be using a terminal program, make sure that it has the following settings:

- Data character format 8N1 (8 data bits + no parity + 1 stop bit)
- Baud rate 9600 bps
- Local echo: On
- If a field is offered for a delay after LF, set it to 10 ms.
- Add line feeds after carriage returns: On
- No software or hardware protocols (XON/XOFF, RTS/CTS, ...)

4.2.2 Command Format

Communication via the serial port uses ASCII characters exclusively. A command to the camera starts with a colon and ends with a carriage return (CR) or line feed (LF), for example:

`:x01↵`

In the example above, the colon indicates that a command follows. The 'x' indicates the type of command and in this case, is followed by two hexadecimal numbers which represent a value. When sent via the serial interface, each of the 5 characters in the command would be ASCII coded. Leading zeros may not be omitted. The CR indicates the end of the command.

If the command is a query, the camera answers with data followed by a CR. Wait for the CR before you send the next command. If the camera is not able to process a command it returns a question mark and a CR.

> Note that the camera only accepts lowercase letters. If capitals are used, the camera replies with a '?'.

At 9600Bd, each character in a command takes about 1 ms to be transmitted. So, for example, the command *:d0060↵* would take about 7 ms for transmission. Maximum time for a single command such as a changed gain to take effect is 1 ms after the camera has decoded the command. Loading and saving entire configuration sets takes approximately 500 ms.

4.2.3 Reading the Current Configuration Parameters

To list all current configuration parameters, use the `:?` query command. The camera replies with the current configuration of the Work Set. For example:

```
Model L104  Sn 123456123456  Id CF123456

ExpMode 01  ExpTime 0050  Flags 00

DAC0 7fa  LoDAC0 78a  HiDAC0 944

DAC1 677  LoDAC1 635  HiDAC1 661

DAC2 829  LoDAC2 77c  HiDAC2 93a

DAC3 6ac  LoDAC3 625  HiDAC3 65e
```

The first line displays:

- the camera model
- the camera's serial number
- a factory ID number

These settings can also be read individually using the `:?0`, `:?1`, and `:?2`, commands respectively. These settings do not effect the camera's performance.

The second line displays:

- the exposure time control mode
- the exposure time multiplier
- the flags indicating camera status

The `DAC0` and `DAC2` values show the current gain settings for the odd and even channels respectively.

The `DAC1` and `DAC3` values show the current offset settings for the odd and even channel respectively.

The `LoDAC` and `HiDAC` values are reference numbers that are used when you change the gain or offset (see Section 4.2.8).

All numbers except for those in the first line are hexadecimal.

4.2.4 Reading the Protocol and Firmware Version

The protocol version of the serial interface is viewed by using the `:?3` command. The camera replies with the interface version number, for example, `01`.

The firmware version can be viewed by using the `:?4` command. The camera replies with the firmware version number, for example, `0100`.

4.2.5 Checking Camera Status

To check the current status of the camera, use the `:f` command. The camera replies with the current status flags. See Section 6.2 for a more detailed explanation of status flags and a list of the flags.

> After any change is made that can effect the camera's status, the status flags can take several seconds to update. If you make a change that can effect the camera's status, wait at least 5 seconds before using the status command.

4.2.6 Gain Command

The format of the command used to change the gain on the odd channel is `:d0`$n_2n_1n_0$ where n_2, n_1 and n_0 are hexadecimal digits. The value of the hexadecimal digits can range from 000 to fff (0 to 4095 decimal).

The format of the command used to change the gain on the even channel is `:d2`$n_2n_1n_0$ where n_2, n_1 and n_0 are hexadecimal digits. The value of the hexadecimal digits can range from 000 to fff (0 to 4095 decimal).

> Before using these commands to change the gain, see Section 4.2.8. This section contains detailed information that you will need to know when changing the gain or offset.
>
> Because increasing gain increases both signal and noise, the signal to noise ratio does not change significantly when gain is increased.

Example of a gain Command:

Assume that you want to set the gain on the odd channel to the decimal value 2300.

1. Convert 2300 to a three digit hexadecimal value:

   2300 decimal = 8fc hex

2. Enter this command:

   `:d08fc`

Reading the Current Gain Settings

The `:d0` command reads the current odd channel gain setting and returns $n_2n_1n_0$ for the odd channel. The `:d2` command reads the even channel gain setting and returns $n_2n_1n_0$ for the even channel.

As explained in Section 4.2.3, the `:?` query command returns a list of all current parameter settings from the Work set. The `DAC0` $n_2n_1n_0$ entry shows the current setting for the odd channel gain. The `DAC2` $n_2n_1n_0$ entry shows the current setting for the even channel gain.

4.2.7 Offset Command

The format of the command used to change the offset on the odd channel is :d1$n_2n_1n_0$ where n_2, n_1 and n_0 are hexadecimal digits. The value of the hexadecimal digits can range from 000 to fff (0 to 4095 decimal).

The format of the command used to change the gain on the even channel is :d3$n_2n_1n_0$ where n_2, n_1 and n_0 are hexadecimal digits. The value of the hexadecimal digits can range from 000 to fff (0 to 4095 decimal).

> Before using these commands to change the offset, see Section 4.2.8. This section contains detailed information that you will need to know when changing the gain or offset.

Example of an Offset Command:

Assume that you want to set the offset on the odd channel to the decimal value 1690.

1. Convert 1690 to a three digit hexadecimal value:

   1690 decimal = 69a hex

2. Enter this command:

   `:d169a`

Reading the Current Offset Settings

The :d1 command reads the current odd channel offset setting and returns $n_2n_1n_0$ for the odd channel. The :d3 command reads the even channel offset setting and returns $n_2n_1n_0$ for the even channel.

As explained in Section 4.2.3, the :? query command returns a list of all current parameter settings from the Work set. The DAC1 $n_2n_1n_0$ entry shows the current setting for the odd channel gain. The DAC3 $n_2n_1n_0$ entry shows the current setting for the even channel gain.

4.2.8 Factors to Consider When Changing Gain and Offset

There are two major factors to keep in mind when changing gain and offset from the factory defaults:

1. The electronics in the camera's odd channel and even channel are slightly different. Due to this difference, a perfectly uniform exposure might lead to the camera reporting different gray values for the odd pixels and the even pixels. To compensate for this difference in electronics, different gain values need to be set for each channel and it is important to keep the two channels aligned whenever the gain is changed.
2. Offset is dependent on changes to the gain. Whenever gain is changed, offset must be changed accordingly.

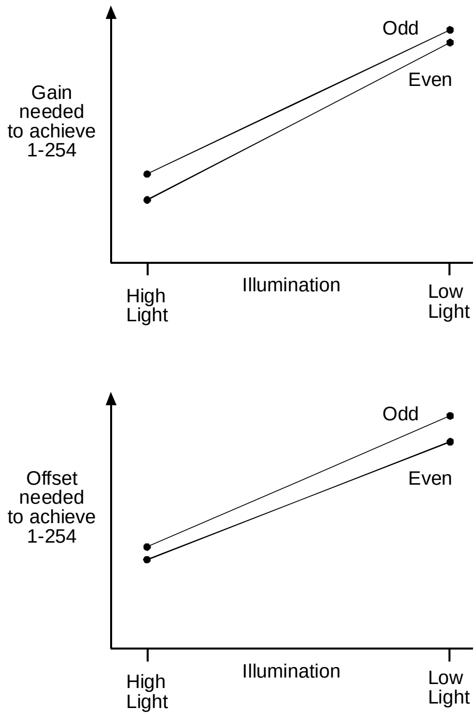
Basler performs a calibration procedure on each camera before it leaves the factory and the results of the procedure are stored in the camera. If you decide to change the camera's gain from the factory default, the results of the calibration procedure can be used to calculate correct gain/offset settings. The calibration procedure is performed as follows:

A standard black and white test pattern is placed in the camera's field of view.

The test pattern is illuminated with a very bright light source. The gain and offset on each pixel channel are set so that the camera returns a digital gray value of 1 for black and 254 for white. The gain settings are stored in the camera in the `LoDAC0` (odd channel) and `LoDAC2` (even channel) memory locations. The offset settings are stored in `LoDAC1` (odd channel) and `LoDAC3` (even channel) memory locations.

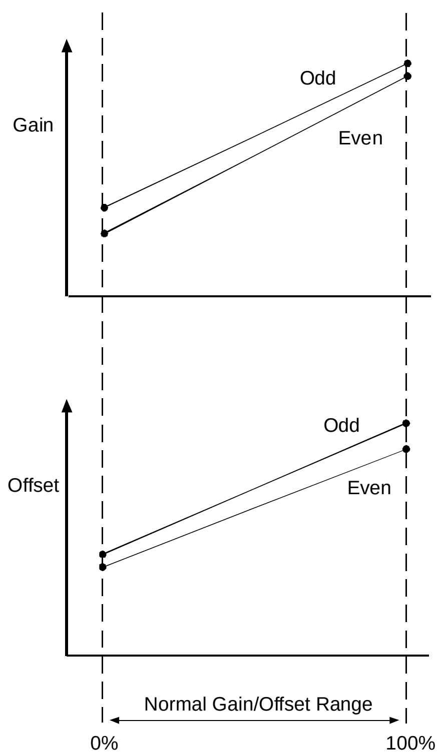
The test pattern is illuminated with a very dim light source. The gain and offset on the each pixel channel is set so that the camera returns a digital gray value of 1 for black and 254 for white. The gain settings are stored in `HiDAC0` (odd channel) and `HiDAC2` (even channel). The offset settings are stored in `HiDAC1` (odd channel) and `HiDAC3` (even channel).

The results of the calibration procedure are shown graphically in Figure 4-2. As you will notice, when the illumination is high, a low gain and offset are needed to achieve gray values of 1 and 254. And when the illumination is low, a high gain and offset are needed. Between these two extremes, the relationship between illumination and required gain/offset is assumed to be linear. The area between these extremes is defined as the normally available gain/offset range as shown in Figure 4-3.



Note: The difference between the odd and even channels is exaggerated so that they will show clearly on the graphs.

Figure 4-2: Odd and Even Channel Gain and Offset



Note: The difference between the odd and even channels is exaggerated so that they will show clearly on the graphs.

Figure 4-3: Normal Gain/Offset Range

If you want to change the gain using programming commands, you must select a percentage of the normally available gain/offset range and use the formula below to calculate the required settings for the odd channel gain and offset and for the even channel gain and offset. You then enter the calculated settings into the camera using the appropriate commands.

$$\text{DACn} = \frac{\text{Desired \% x (HiDACn - LoDACn)}}{100} + \text{LoDACn}$$

When you do the calculations, you are determining the gain and offset settings that will balance the odd and even channels so that they are both operating at the desired percentage of the normal range. Figure 4-4 illustrates in graphical terms what you must calculate if you want to set the gain and offset so that the camera will operate at 40% of the normally available gain/offset range. The example on the next page shows how to make the calculations.

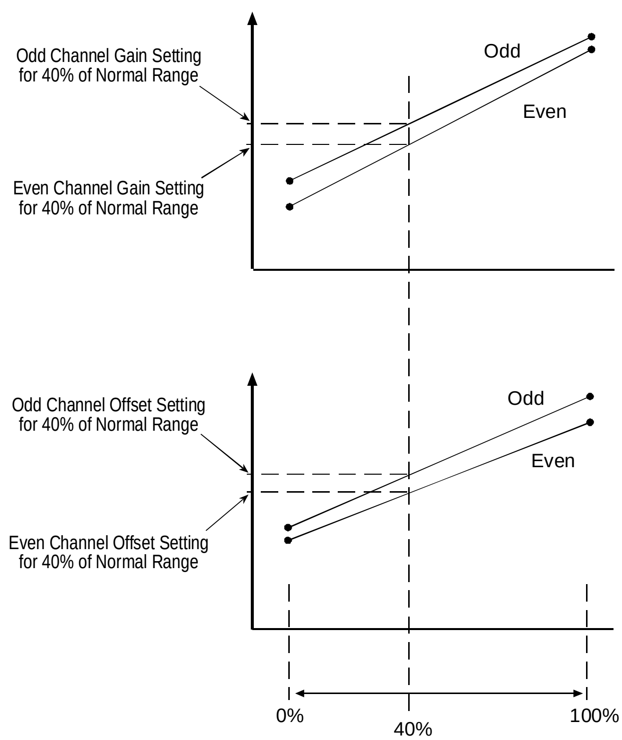


Figure 4-4: Settings at 40% of the Normal Range

Example of Setting the Gain and Offset:

To aid your understanding of the process for setting gain and offset, an example appears below. The example assumes that you want to set the gain to 40% of the normally available range.

1. Use the :? command to query the camera. For our example, we will assume that the camera returned the following values:

```
LoDAC0  78a   HiDAC0  944
LoDAC1  635   HiDAC1  661
LoDAC2  77c   HiDAC2  93a
LoDAC3  625   HiDAC3  65e
```

2. The DAC values are in hex. Convert them to decimal:

```
LoDAC0  1930   HiDAC0  2372
LoDAC1  1589   HiDAC1  1633
LoDAC2  1916   HiDAC2  2362
LoDAC3  1573   HiDAC3  1630
```

3. Use the `LoDAC0` and `HiDAC0` values to calculate the gain setting for the odd channel:

$$DACn = \frac{40 \times (2372 - 1930)}{100} + 1930$$

DACn = 2106.8 (round to 2107)

4. Use the `LoDAC1` and `HiDAC1` settings to calculate the offset setting for the odd channel:

$$DACn = \frac{40 \times (1633 - 1589)}{100} + 1589$$

DACn = 1606.6 (round to 1607)

5. Use the `LoDAC2` and `HiDAC2` settings to calculate the gain setting for the even channel:

$$DACn = \frac{40 \times (2362 - 1916)}{100} + 1916$$

DACn = 2094.4 (round to 2094)

6. Use the `LoDAC3` and `HiDAC3` settings to calculate the offset setting for the odd channel.

$$DACn = \frac{40 \times (1630 - 1573)}{100} + 1573$$

DACn = 1595.8 (round to 1596)

7. Convert your results to hexadecimal:

   Odd channel gain setting of 2107 decimal = 83b hex.

   Odd channel offset setting of 1607 decimal = 647 hex

   Even channel gain setting of 2094 decimal = 82e hex

   Even channel offset setting of 1596 decimal = 63c hex

8. Use the terminal program to set the gain and offset to the values that you calculated:

   Use the command :d083b to set the odd channel gain

   Use the command :d1647 to set the odd channel offset

   Use the command :d282e to set the even channel gain

   Use the command :d363c to set the even channel offset

After you use the commands to enter the calculated values, the camera will be operating at 40% of the normally available gain/offset.

	Note: It is possible to extrapolate below 0% by entering a negative value for the desired % and to extrapolate above 100% by entering a value greater than 100 for desired %.

Checking the Dynamic Range:

After the gain and offset have been adjusted, your system should be checked for proper dynamic range using the following procedure:

1. Mount a lens cap on the camera and then check the gray values being reported by the camera. The gray values should be 1.
2. Remove the lens cap, place a white object in the camera's viewing area and then check the gray values being reported from the camera. The gray values should be 254.
3. If the gray values reported are not correct, increase or decrease the gain/offset as required.

Changing Gain and Offset Independently:

For special applications, gain and offset can be changed independently. If gain alone is changed, make sure that DAC0 and DAC2 are both set to the same percentage of the normally available range so that the gain on the odd and even channels remains aligned. For example, if you decided to increase the gain from 40% to 60% of the normally available range, make sure that both DAC0 and DAC2 are set to 60%.

If offset alone is changed, make sure that DAC1 and DAC3 are both set to the same percentage of the normally available offset.

	Making changes in the gain alone or in the offset alone may significantly reduce the image quality.

4.2.9 Programming Exposure Time Control

4.2.9.1 Exposure Mode Command

The exposure mode command is used to:

- set the time unit for exposure time
- select the exposure time control mode
- enable extended clamping
- enable the test image

The format of the exposure mode command is $:xn_1n_0$ where n_1 and n_0 are hexadecimal digits.

Time Unit for Exposure Time

The n_1 digit is used to select the time unit for exposure time. Table 4-1 lists the allowed settings for n_1 and the time unit that will be will be selected for each setting. For example, if n_1 is set to 2, the 1 µs time unit will be selected.

The time unit will only be used when the camera is in the programmable mode. It will be ignored with other modes. When the camera is operating in programmable mode, the exposure time is not determined solely by the selected time unit. As described in Section 4.2.9.2, the exposure time is determined by a combination of the time unit that you select with the exposure mode command and the multiplier that you select with the multiplier command.

n_1	Time Unit
0	250 ns
1	500 ns
2	1 µs
3	2 µs

Table 4-1: Settings and Time Unit Values

Exposure Time Control Mode, Test Image, Extended Clamping

The n_0 digit is used to select the exposure time control mode, to enable extended clamping and to enable the test image. Table 4-2 lists the allowed settings for n_0 and shows how the camera will operate for each setting. For example, if n_0 is set to 4, the camera will operate in the edge-controlled mode with extended clamping enabled.

When n_0 is set to 3, the test image will be enabled. When the camera is generating a test image, it does not use exposure time control or extended clamping.

n_0	Exp. Time Cont. Mode	Extended Clamping	Test Image
0	Edge-controlled	Disabled	Disabled
1	Level-controlled	Disabled	Disabled
2	Programmable	Disabled	Disabled
3	Disabled	Disabled	Enabled
4	Edge-controlled	Enabled	Disabled
5	Level-controlled	Enabled	Disabled
6	Programmable	Enabled	Disabled

Table 4-2: Settings and Modes

Example of an Exposure Mode Command:

Assume that you want to operate the camera in the programmable mode with extended clamping enabled and a time unit of 2 µs selected:

1. Check Table 4-1 and note that to select a time unit of 2 µs, n_1 must be set to 3.
2. Check Table 4-2 and note that to select programmable mode with extended clamping enabled, n_0 must be set to 6.
3. Enter this command:

   `:x36`

Reading the Current Exposure Mode Setting

The `:x` command reads the current exposure mode setting and returns n_1n_0.

As explained in Section 4.2.3, the `:?` query command returns a list of all current parameter settings from the Work set. The ExpMode n_1n_0 entry shows the current setting for the exposure mode.

4.2.9.2 Exposure Time Multiplier

When the camera is operating in programmable mode, an exposure time must be specified. The camera determines the exposure time by multiplying the time unit specified in the exposure mode command (see Section 4.2.9.1) by the exposure time multiplier. For example, if the time unit has been set to 2 µs and the exposure time multiplier is set to 1000 [hex 03e8], the exposure time would be 2000 µs.

The format of the command used to set the exposure time multiplier is `:t`$n_3n_2n_1n_0$ where n_3, n_2, n_1 and n_0 are hexadecimal digits. The value of the hexadecimal digits can range from 0000 to ffff (0 to 65535 decimal).

☝	A minimum exposure time of 20 µs is recommended. The exposure time must be less than the line period.

Example of a Multiplier Command:

Assume that you want to set the multiplier to the decimal value 1500:

1. Convert 1500 to a four digit hexadecimal value:

   1500 decimal = 05dc hex

2. Enter this command:

   `:t05dc`

Reading the Current Exposure Time Multiplier Setting

The `:t` command reads the current multiplier setting and returns $n_3n_2n_1n_0$.

As explained in Section 4.2.3, the `:?` query command returns a list of all current parameter settings from the Work set. The `ExpTime` $n_3n_2n_1n_0$ entry shows the current setting for the exposure time multiplier.

4.2.10 Storing a Modified Configuration

When you use commands to modify the gain, offset, exposure mode, etc., you are modifying the values stored in the camera's Work Set. To permanently store the changes you make to the Work set, use the `:z1` command. The `:z1` command copies the Work set into the camera's User Set. The User Set is stored in non-volatile memory on camera's EEPROM and will not be lost when power to the camera is switched off.

Storing a complete configuration set takes approximately 500ms.

Direct programming of configuration parameters in the User Set or the Factory Set is not possible.

4.2.11 Loading the User Set and Factory Set

The `:c1` command loads the User Set into the Work Set and the `:c2` command loads the Factory Set into the Work Set.

4.2.12 List of Commands

Description	Command
Reading camera configuration	
Read Work Set	`:?`
Read camera model	`:?0`
Read serial number	`:?1`
Read ID	`:?2`
Read serial interface protocol version	`:?3`
Read firmware version	`:?4`
Read camera status flags	`:f`
Loading / storing configuration sets	
Load User Set to Work Set	`:c1`
Load Factory Set to Work Set	`:c2`
Store Work Set as User Set	`:z1`
Gain	
Read odd LoDAC gain value	`:l0`
Read even LoDAC gain value	`:l2`
Read odd HiDAC gain value	`:h0`
Read even HiDAC gain value	`:h2`
Read odd channel gain value from Work Set	`:d0`
Read even channel gain value from Work Set	`:d2`
Write odd channel gain value to Work Set	`:d0`$n_2n_1n_0$
Write even channel gain value to Work Set	`:d2`$n_2n_1n_0$
Offset	
Read odd LoDAC offset value	`:l1`
Read even LoDAC offset value	`:l3`
Read odd HiDAC offset value	`:h1`
Read even HiDAC offset value	`:h3`
Read odd channel offset value from Work Set	`:d1`
Read even channel offset value from Work Set	`:d3`
Write odd channel offset value to Work Set	`:d1`$n_2n_1n_0$
Write even channel offset value to Work Set	`:d3`$n_2n_1n_0$
Exposure time control mode command	
Read exposure time control mode value from Work Set	`:x`
Write exposure time control mode value to Work Set	`:x`n_1n_0
Exposure time multiplier	
Read exposure time multiplier value from Work Set	`:t`
Write exposure time multiplier value to Work Set	`:t`$n_3n_2n_1n_0$

Table 4-3: List of Commands

5 Mechanical Considerations

5.1 Dimensions

The camera's sensor and electronics are housed in an aluminum case. Dimensions are shown in Figure 5-1. All dimensions are in mm.

5.2 Mounting Facilities

The **L100** series camera housing is manufactured with high precision. Planar, parallel and angular sides guarantee precise mounting with high repeatability.

L100 series cameras are equipped with four M4 mounting holes on the front plate and two M4 mounting holes on each side as indicated in Figure 5-1.

The M4 holes on the sides of the camera also serve as through holes for 70 mm long, M3 bolts as indicated in Figure 5-1. The through holes provide an additional mounting option for precise rotational camera adjustment about one axis. This can be accomplished by inserting an M3 bolt through one of the through holes and fixing the camera in the required position using bolts in the corresponding M4 holes.

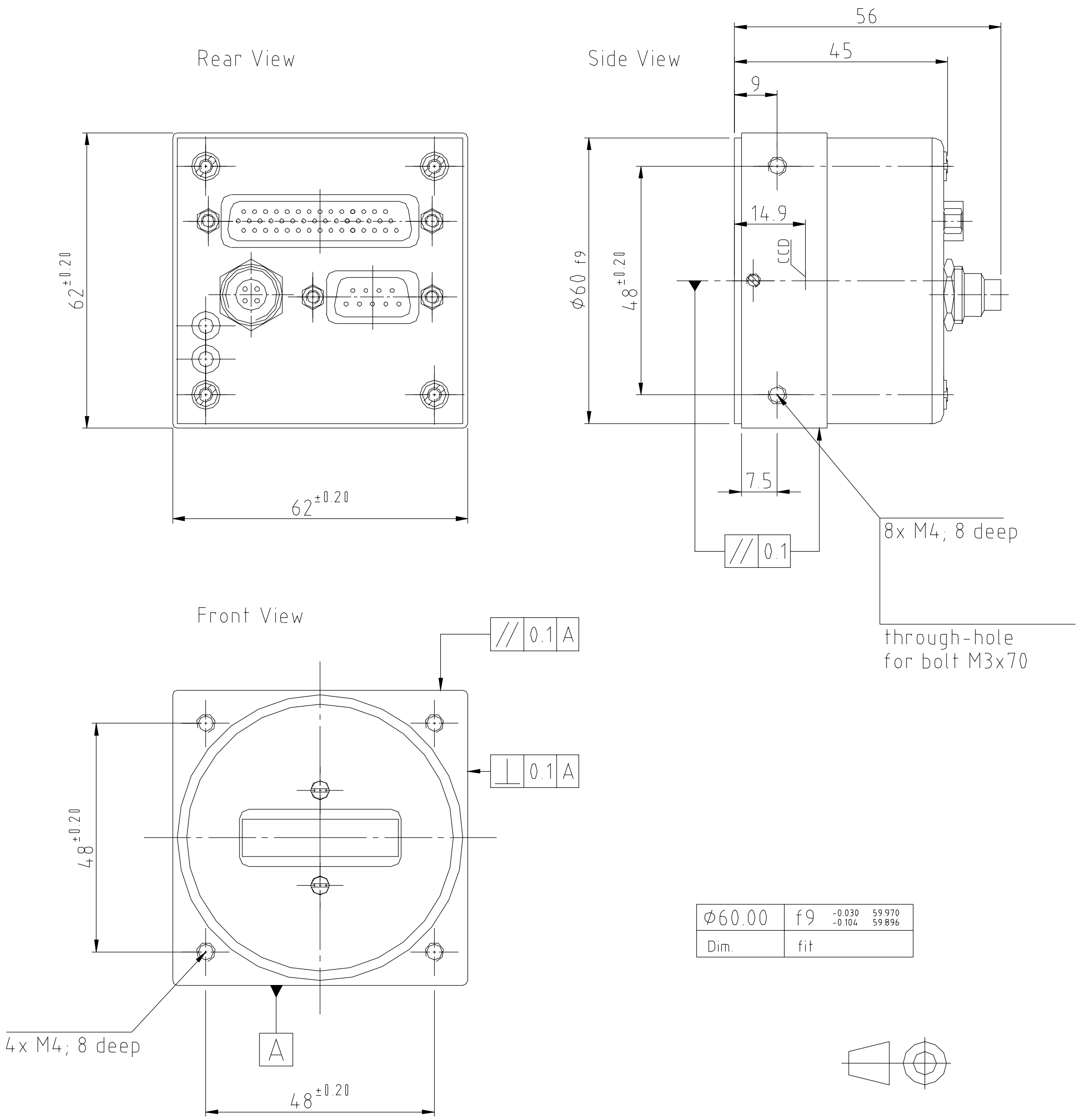


Figure 5-1: Mechanical Dimensions [in mm]

5.3 Positioning Accuracy of the Sensor Chip

Positioning accuracy of the sensor chip in the horizontal and vertical direction is ± 0.3 mm. Rotational positioning accuracy is as shown in Figure 5-2. Reference position is the center of the camera housing.

Since the translatory and rotational positioning tolerance depend on each other, the worst case of maximum rotational and horizontal/vertical mis-positioning cannot occur at the same time.

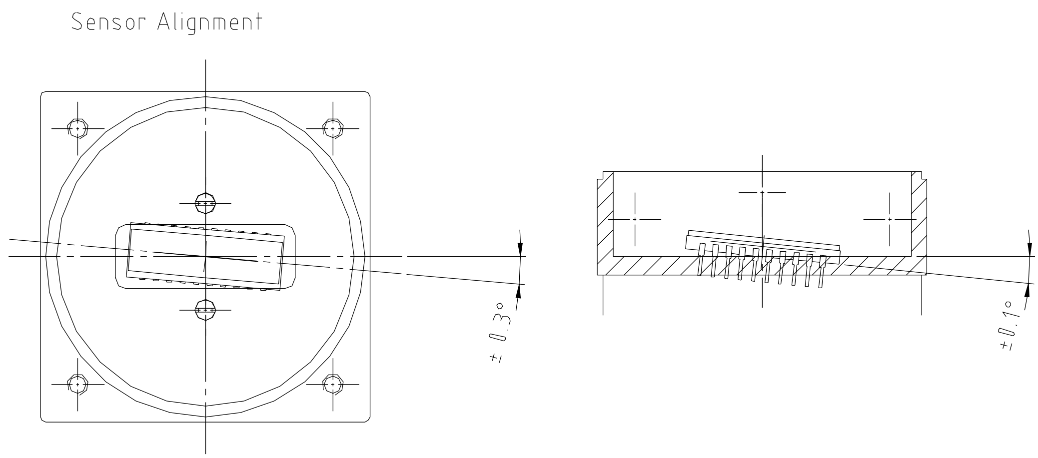


Figure 5-2: Sensor alignment

5.4 Optical Interface

L100 series cameras have special adapters for direct lens mounting. F-mount adapters are available for all camera versions. For cameras with 1024 pixels, adapters for C-mount lenses are available as well.

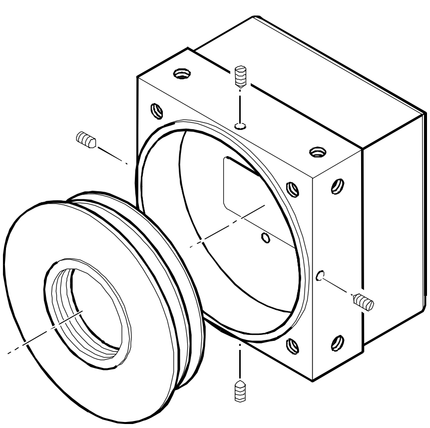
When choosing a lens, ensure that the image circle diameter of the lens is at least as great as the length of the photosensitive sensor area. That is 10.24 mm for L100 cameras with 1024 sensor elements and 20.48 mm for cameras with 2048 elements.

!	**Caution!** To avoid collecting dust on the sensor, mount a lens on the camera immediately after removing the dust cap.

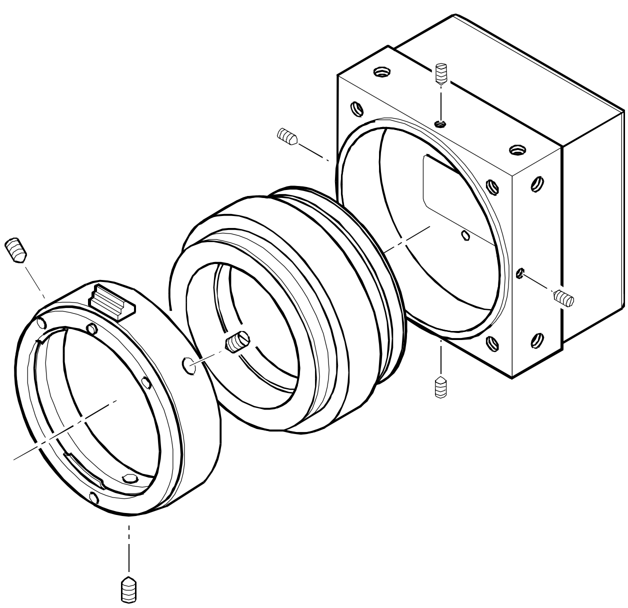
5.4.1 Adapter Mounting Feature

To turn the lens inscription to an appropriate rotary position required for your application:

1. Loosen the four screws that hold the adapter in the camera body.
2. Turn the adapter to the desired position.
3. Tighten the four screws.



C-mount



F-mount

6 Troubleshooting

6.1 Quick Checklist

If you are having trouble with the operation of your camera, make a quick check of the following items:

- Power is applied to the camera and it meets the specifications shown in section 2.5.
- You are using the correct data cable for your frame grabber.
- The data cable is plugged into the camera and the frame grabber.
- The RS-232 cable:

  is plugged into the camera.

  is plugged into the proper serial port on the PC.

  is wired according to the drawing shown in Section 2.2.2.

- The serial port's settings are correct (8, N, 1 with a baud rate of 9600 bps).
- The correct serial port is selected:

  If you are using the Camera Configuration Tool, make sure that the port selected on the Connection Tab matches the port that the camera is plugged into.

  If you are using a terminal emulation program, make sure that the emulation program's settings are as shown in Section 4.2.1. Also make sure that the port selected in the emulation program's settings and the port that the camera is plugged into are the same.

6.2 Fault Finding Using Camera Flags

L100 series cameras regularly perform self tests. Detected errors are signaled by blinking of the yellow LED on the back of the camera. The number of pulses indicates the detected error. If several error states are present, the LED outputs the error codes in succession.

To get more information about an error, use the `:f` command to determine which camera flag has been set. Each flag is given as a hexadecimal number. For example, if the ExSync signal has not changed state in five seconds or longer, the `:f` command would return 10.

If more than one error is present, the values of the flags are added, for example, if the camera was just switched on and the User Set could not be loaded, the `:f` command would return 41.

See Table 6-1 for the description of the pulses and the flags.

LED	Flag	Description
On Continuous	00	The camera is OK.
On Continuous	40	This is the normal state after power on. The flag is reset to 00 once the `:?` or the `:f` command has been issued. The flag can be used to recognize a camera reset.
3 pulses	10	ExSync has not changed state for 5 seconds or longer. If you are not supplying an ExSync signal to the camera, this is a normal condition and should be ignored. Otherwise check the cable and the ExSync generating device.
5 pulses	04	The Work Set could not be stored into the User Set. Please contact Basler technical support.
6 pulses	01	The User Set could not be loaded. Please contact Basler technical support.
6 pulses	02	The Factory Set could not be loaded. Please contact Basler technical support.

Table 6-1: Camera Status

6.3 Fault Finding Using the Configuration Tool

If you are using the Camera Configuration Tool, select the Status Tab to view a general description of the camera status. You can also use the Presence Check feature on the Connection Tab to view the camera flags.

Revision History

Doc. ID Number	Date	Changes
DA 037001	15-June-2001	Initial release.
DA 037002	10-July-2001	Made revisions required by new Camera Configuration Tool: Removed the installation chapter from this manual. Placed the installation information in a separate camera installation guide and a separate Camera Configuration Tool installation guide. Removed the detailed instructions for using the Camera Configuration Tool. These detailed instructions are now contained in the configuration tool's on-line help. Removed references the the L102. This version of the camera is no longer available.

Index

R

S

T

U

V

W