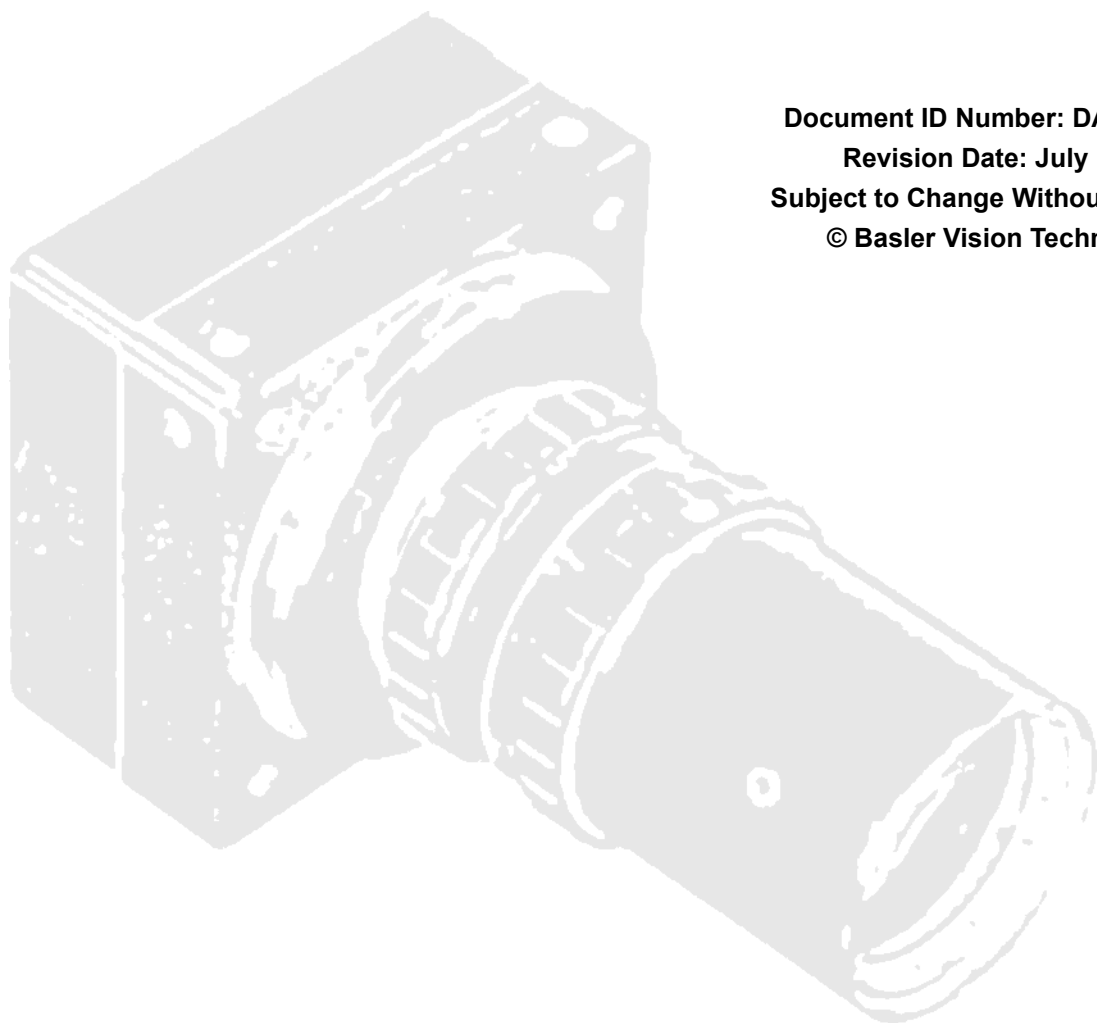

BASLER L301_{bc}

User's Manual



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Life Support Applications

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Warranty Note

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

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Revision History i

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1 Introduction

The **BASLER L301bc** line scan camera is a versatile camera designed for industrial use. Superb image sensing features are combined with a robust, high precision manufactured housing.

Important features are:

- Tri-linear Color Array
- High sensitivity
- Electronic exposure time control
- High S/N-ratio
- Programmable via an RS-232 serial port
- Industrial housing manufactured with high planar, parallel, and angular precision
- Super compact size

1.1 Performance Specifications

Specifications	BASLER L301bc
Sensor	Tri-linear CCD Image Sensor
Pixels	2098 pixels X 3
Pixel Size	14 μm x 14 μm (14 μm pitch)
Center-to-center spacing between color channels	112 μm
Fill Factor	100%
Spectral Response	See Figure 1-1
Output Sensitivity	11.5 $\mu\text{V/e}$
Saturation Signal Charge	170k electrons
Photo Response Non-uniformity	$\pm 5\%$ typical
Pixel Clock Speed	20 MHz (in 8 Bit RGB output mode) 40 MHz (in Dual 8 Bit output mode) 60 MHz (in Single 8 Bit or 10 Bit output mode)
Maximum Line Rate	9.20 kHz
Video Output Type	Channel Link LVDS (RS-644 LVDS when the camera is used with the optional Basler Interface Converter)
Video Output Formats	Single 8 Bit, Single 10 Bit, Dual 8 Bit, or 8 Bit RGB
Synchronization	Via external ExSync signal or free-run
Exposure Time Control	Edge-controlled, level-controlled, or programmable
Gain and Offset	Programmable via a serial link
Connector	One, 26 pin, high-density, D-Sub plug
Power Requirements	12 VDC ($\pm 10\%$), max 6 W
Lens Adapter	F-mount
Housing Size (L x W x H)	without lens adapter: 38.1 x 62 x 62 mm with F-mount adapter: 69.6 x 62 x 62 mm
Weight	without lens adapter: ~ 155 g with F-mount adapter: ~ 265 g

Table 1-1: L301bc Performance Specifications

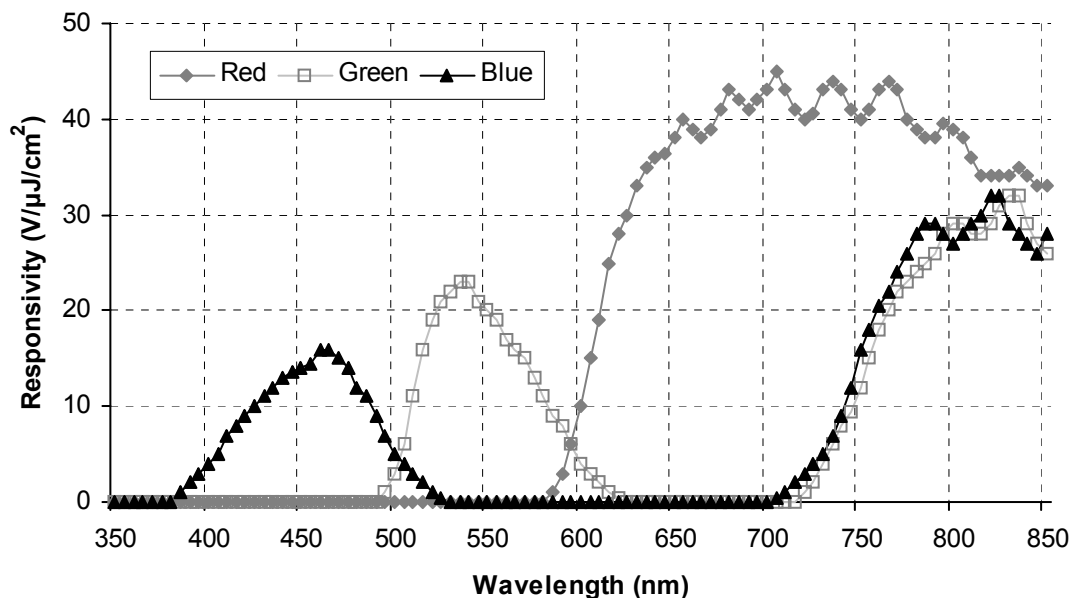


Figure 1-1: L301bc Spectral Responsivity



Color filter arrays become transparent after 700 nm. To maintain spectral balance and optimum MTF, use of a suitable IR cut filter is recommended.

1.2 Environmental Requirements

1.2.1 Temperature and Humidity

Housing temperature during operation: 0° C ... + 50° C (+ 32° F ... + 122° F)

Humidity during operation: 20% ... 80%, relative, non-condensing

1.2.2 Ventilation

Allow sufficient air circulation around the camera to prevent internal heat build-up in your system and to keep the camera housing temperature during operation below 50° C. Provide additional cooling such as fans or heat sinks if necessary.



Warning!

Without sufficient cooling, the camera can get hot enough during operation to cause burning when touched.

1.3 Precautions

Power



Caution!

Be sure that all power to your system is switched off before you make or break connections to the camera. Making or breaking connections when power is on can result in damage to the camera.

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 liquids, flammable, or metallic material inside the camera housing. If operated with any foreign matter inside, the camera may fail or cause a fire.

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

The **L301bc** is interfaced to external circuitry via a single, high density, 26 pin D-Sub plug located on the back of the camera. Figure 2-1 shows the plug and the two status LEDs which indicate signal integrity and power OK.

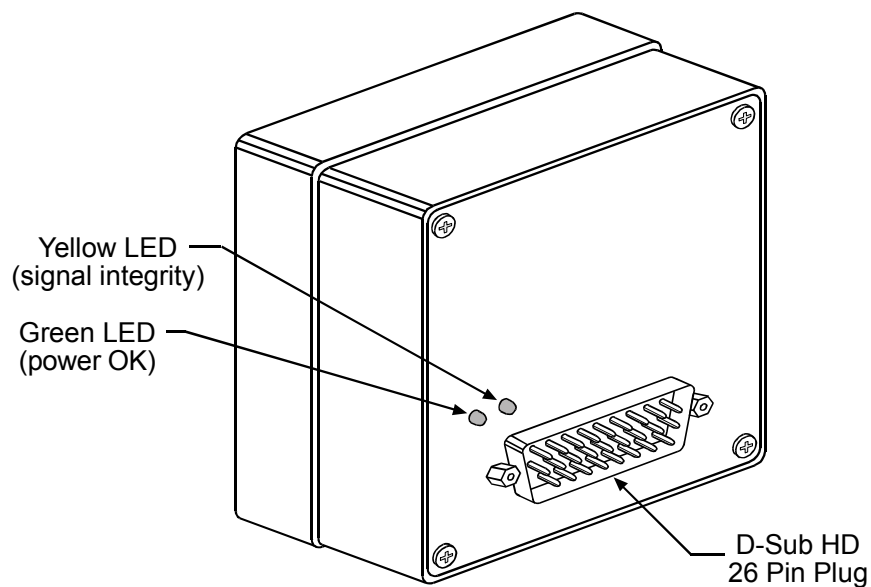


Figure 2-1: **L301bc** Connector and LEDs

2.1.2 Pin Assignments

The pin assignments for the D-Sub HD 26 plug used to interface video data, control signals, and power are shown in Table 2-1.

Pin Number	Signal Name	Direction	Level	Function
1, 9, 18, 19, 25, 26 ¹	DC Gnd	Input	Ground	DC Ground
2, 20 ²	+12 VDC	Input	12 VDC \pm 10%	DC Power
22	RxD	Input	RS-232	RS-232 Serial Communication Data Receive
24	TxD	Output	RS-232	RS-232 Serial Communication Data Transmit
21, 23 ¹	Signal Gnd	Input	Ground	Signal Ground
11	ExSync+	Input	RS-644 LVDS	External Trigger
10	ExSync-			
13	Reserved+	Input	RS-644 LVDS	Reserved LVDS Input
12	Reserved-			
17	TxClkOut+	Output	Channel Link LVDS	Transmit Clock from Channel Link Transmitter
16	TxClkOut-			
8	TxDataOut3+	Output	Channel Link LVDS	Data from Channel Link Transmitter
7	TxDataOut3-			
6	TxDataOut2+	Output	Channel Link LVDS	Data from Channel Link Transmitter
5	TxDataOut2-			
15	TxDataOut1+	Output	Channel Link LVDS	Data from Channel Link Transmitter
14	TxDataOut1-			
4	TxDataOut0+	Output	Channel Link LVDS	Data from Channel Link Transmitter
3	TxDataOut0-			

¹ Pins 1, 9, 18, 19, 25, 26, 21 and 23 are all tied together inside of the camera.

² Pins 2 and 20 are tied together inside of the camera.

Table 2-1: **L301bc** Pin Assignments for the D-Sub HD 26-pin Plug



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

The camera has no reverse power protection. Therefore, always observe the polarity as indicated in Table 2-1.

The camera has no overvoltage protection. Therefore, always observe the power requirements as described in Section 2.7.

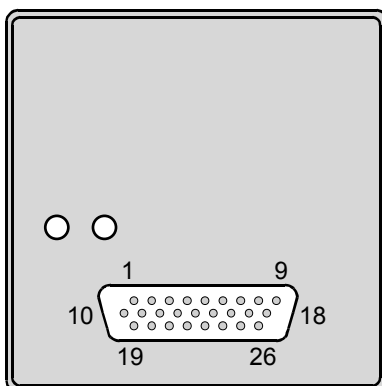


Figure 2-2: L301bc Pin Numbering

2.1.3 Plug Source Information

At the time this manual was published, Basler's sources for the 26 pin, high density plug used on the camera are FCT Electronic (Part CT15-26P1-L228) and AMP (Part HDP-22 Size-2 26-Position). We will use plugs from either of these suppliers or the equivalent.

2.2 Cable Specification

The cable between the camera and the frame grabber must meet the specifications shown in Table 2-2.

Characteristic	Specification
Maximum Length	10 meters ¹
Individually Shielded Twisted Pair Characteristic Impedance	100 ± 10 Ω
Conductor Size	28 AWG Stranded

¹ The maximum cable length was tested with a Sumitomo IEE6-99135 cable. It will decrease when used in an area with severe ambient electromagnetic interference.

Table 2-2: Cable Specifications

2.3 Input Signals

The ExSync input signal can be used to control the **L301bc**. ExSync is an LVDS signal as specified for RS-644. Section 2.3.1 describes the ExSync input signal.

2.3.1 ExSync: Controls Line Readout and Exposure Time

The camera can be programmed to function under the control of an externally generated sync signal in either of two exposure time control modes. In these modes, level-controlled and programmable, the ExSync signal is used to control exposure time and frame read out. For more detailed information on the two modes, see Section 3.2.

ExSync can be a periodic or non-periodic function. The frequency of the ExSync signal determines the camera's frame rate. Note that ExSync is edge sensitive and therefore must toggle. Minimum high time for the ExSync signal is 1 μ s.

The **L301bc** uses a National Semiconductor DS90LV048A differential line receiver to receive the ExSync input signal. A detailed spec sheet for this RS-644 LVDS device is available at the National Semiconductor web site (www.national.com).

Figure 2-3 shows a basic schematic for the input stage of the **L301bc**.

2.3.1.1 RS-644/RS-422 Compatibility

The input voltage tolerance for the RS-644 receiver used in the **L301bc** is 0.0 V to 3.9 V. On typical RS-422 transmitters, the output voltage can range as high as 4.0 V. As you see, the output voltage of a typical RS-422 transmitter can exceed the input voltage tolerance of the RS-644 receiver in the **L301bc**. Therefore, RS-422 signals should not be input directly into the **L301bc**.

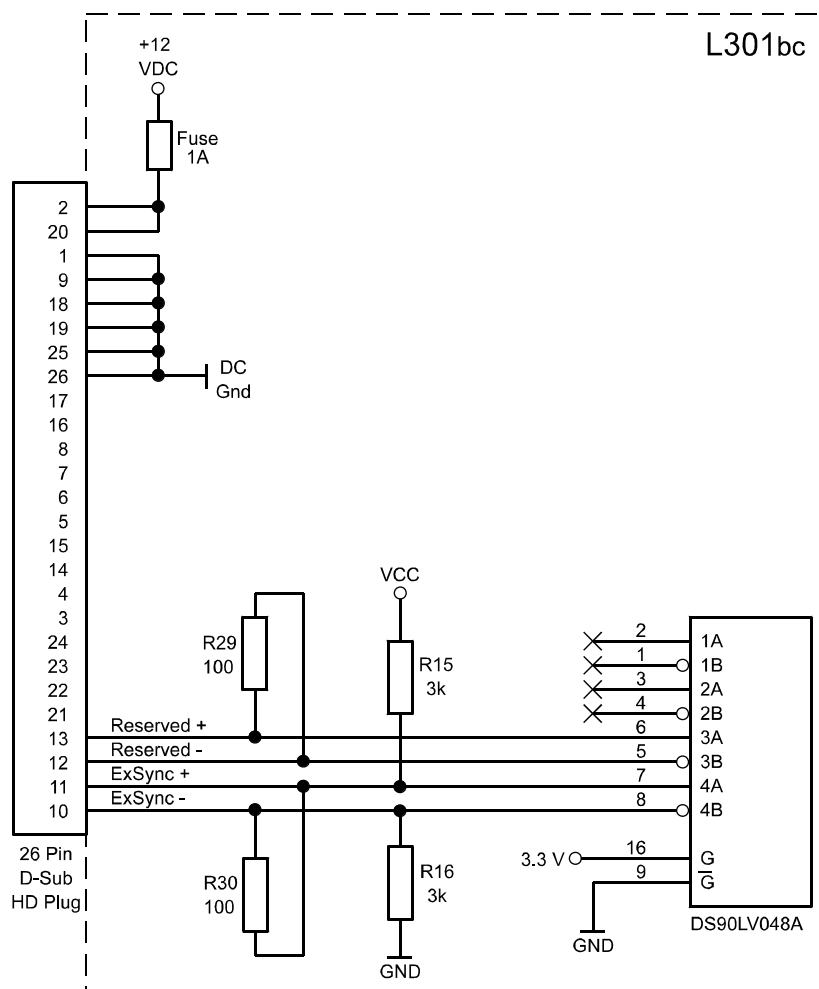


Figure 2-3: L301bc DC Power and RS-644 Input Connections

2.4 Output Signals

Data is output from the **L301bc** using Channel Link LVDS technology.

2.4.1 Channel Link Basics

Channel Link is an LVDS (Low Voltage Differential Signaling) technology for transmitting digital data. Channel Link uses a parallel-to-serial transmitter and a serial-to parallel receiver to transmit data at rates up to 1.8 Gbps.

As shown in Figure 2-4, the Channel Link Transmitter converts 28 bits of CMOS/TTL data into four LVDS data streams. A phase-locked transmit clock is transmitted in parallel with the data streams over a fifth LVDS link. With each cycle of the transmit clock, 28 bits of input data are sampled and transmitted. The Channel Link receiver converts the data streams back into 28 bits of CMOS/TTL data.

Channel Link was developed by National Semiconductor and is a registered trademark of that company.

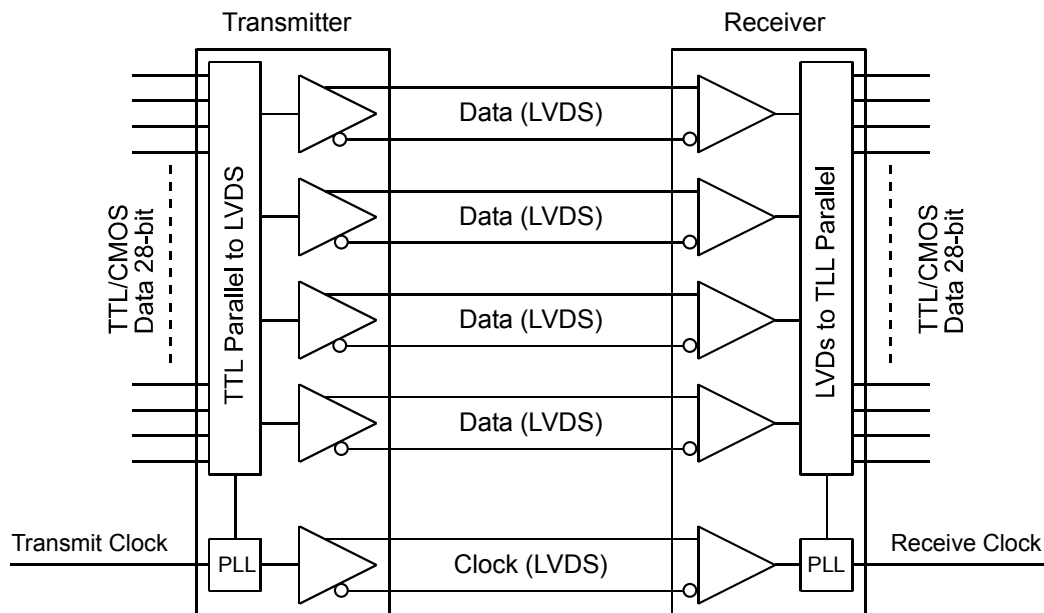


Figure 2-4: Channel Link Block Diagram

2.4.2 Channel Link Implementation in the L301bc

The **L301bc** uses a National Semiconductor DS90C383 as a Channel Link transmitter. For a Channel Link receiver, we recommend that you use the National Semiconductor DS90CF386, the National Semiconductor DS90CR288 or an equivalent. Detailed data sheets for these components are available at the National Semiconductor web site (www.national.com). The data sheets contain all of the information that you need to implement Channel Link, including application notes.

The schematic in Figure 2-5 shows the configuration of the output from the Channel Link transmitter on the **L301bc** and a typical implementation for the Channel Link receiver on a frame grabber. During normal operation, 28 bits of TTL data are input to the transmitter on TX inputs 0 through 27 and the pixel clock is input on TxCLKIN. After transmission, the 28 bits appear as TTL signals on the corresponding RX outputs of the receiver.



Note that the timing used for sampling the data at the Channel Link receiver in the frame grabber varies from device to device. On some receivers, TTL data must be sampled on the rising edge of the receive clock, and on others, it must be sampled on the falling edge. Also, some devices are available which allow you to select either rising edge or falling edge sampling. Please consult the data sheet for the receiver that you are using for specific timing information.

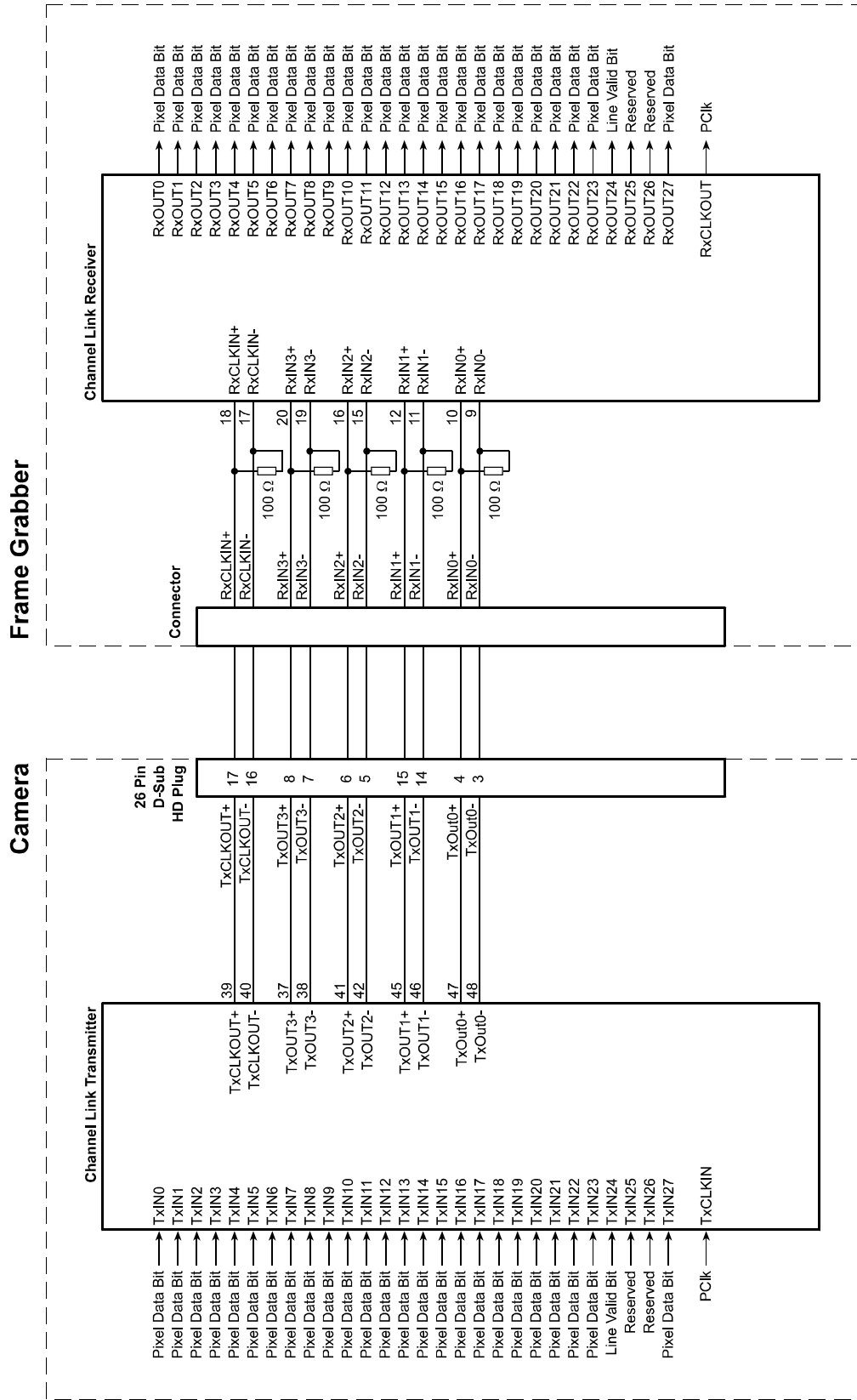


Figure 2-5: L30lbc Channel Link Outputs / Typical Frame Grabber Implementation

2.4.3 Pixel Clock

As shown in Figure 2-5 and in Table 2-3, the pixel clock is assigned to the TxClkIn (transmit clock) pin of the Channel Link transmitter. The pixel clock is used to time the sampling and transmission of pixel data as shown in Figures 2-6 through 2-11. The Channel Link transmitter used in the L301bc requires pixel data to be sampled and transmitted on the falling edge of the clock.

The frequency of the pixel clock varies depending on the output mode of the camera. The available output modes are explained in detail in Sections 2.4.6.1 through 2.4.6.3.



Note that the timing used for sampling the data at the Channel Link receiver in the frame grabber varies from device to device. On some receivers, data must be sampled on the rising edge of the pixel clock (receive clock), and on others, it must be sampled on the falling edge. Also, some devices are available which allow you to select either rising edge or falling edge sampling. Please consult the data sheet for the receiver that you are using for specific timing information.

2.4.4 Line Valid Bit

As shown in Figures 2-6 through 2-11, the line valid bit indicates that a valid line is being transmitted. Pixel data is only valid when this bit is high.

2.4.5 Video Data

Table 2-3 lists the assignment of pixel data bits to the input pins on the Channel Link transmitter in the camera and the corresponding output pins on the Channel Link receiver in the frame grabber. As shown in the table, the bit assignments for pixel data varies depending on the output mode setting of the camera. The available output modes are explained in more detail in Sections 2.4.6.1 through 2.4.6.3.

Table 2-3 also shows the assignment for the line valid bit and the pixel clock. These assignments are constant for all output modes.

Camera	Frame Grabber	20 MHz 8 Bit RGB Output Mode	60 MHz Single 10 Bit Output Mode	60 MHz Single 8 Bit Output Mode	40 MHz Dual 8 Bit Output Mode
TxIN0	RxOUT0	Red Bit 0	Pixel Bit 0	Pixel Bit 0	Pixel A Bit 0
TxIN1	RxOUT1	Red Bit 1	Pixel Bit 1	Pixel Bit 1	Pixel A Bit 1
TxIN2	RxOUT2	Red Bit 2	Pixel Bit 2	Pixel Bit 2	Pixel A Bit 2
TxIN3	RxOUT3	Red Bit 3	Pixel Bit 3	Pixel Bit 3	Pixel A Bit 3
TxIN4	RxOUT4	Red Bit 4	Pixel Bit 4	Pixel Bit 4	Pixel A Bit 4
TxIN5	RxOUT5	Red Bit 7 (Red MSB)	Pixel Bit 7	Pixel Bit 7 (MSB)	Pixel A Bit 7 (Pixel A MSB)
TxIN6	RxOUT6	Red Bit 5	Pixel Bit 5	Pixel Bit 5	Pixel A Bit 5
TxIN7	RxOUT7	Green Bit 0	Pixel Bit 8	Reserved	Pixel B Bit 0
TxIN8	RxOUT8	Green Bit 1	Pixel Bit 9 (MSB)	Reserved	Pixel B Bit 1
TxIN9	RxOUT9	Green Bit 2	Reserved	Reserved	Pixel B Bit 2
TxIN10	RxOUT10	Green Bit 6	Reserved	Reserved	Pixel B Bit 6
TxIN11	RxOUT11	Green Bit 7 (Green MSB)	Reserved	Reserved	Pixel B Bit 7 (Pixel B MSB)
TxIN12	RxOUT12	Green Bit 3	Reserved	Reserved	Pixel B Bit 3
TxIN13	RxOUT13	Green Bit 4	Reserved	Reserved	Pixel B Bit 4
TxIN14	RxOUT14	Green Bit 5	Reserved	Reserved	Pixel B Bit 5
TxIN15	RxOUT15	Blue Bit 0	Reserved	Reserved	Reserved
TxIN16	RxOUT16	Blue Bit 6	Reserved	Reserved	Reserved
TxIN17	RxOUT17	Blue Bit 7 (Blue MSB)	Reserved	Reserved	Reserved
TxIN18	RxOUT18	Blue Bit 1	Reserved	Reserved	Reserved
TxIN19	RxOUT19	Blue Bit 2	Reserved	Reserved	Reserved
TxIN20	RxOUT20	Blue Bit 3	Reserved	Reserved	Reserved
TxIN21	RxOUT21	Blue Bit 4	Reserved	Reserved	Reserved
TxIN22	RxOUT22	Blue Bit 5	Reserved	Reserved	Reserved
TxIN23	RxOUT23	Reserved	Reserved	Reserved	Reserved
TxIN24	RxOUT24	Line Valid	Line Valid	Line Valid	Line Valid
TxIN25	RxOUT25	Reserved	Reserved	Reserved	Reserved
TxIN26	RxOUT26	Reserved	Reserved	Reserved	Reserved
TxIN27	RxOUT27	Red Bit 6	Pixel Bit 6	Pixel Bit 6	Pixel A Bit 6
TxCLOCKIn	RxCLOCKOut	Pixel Clock	Pixel Clock	Pixel Clock	Pixel Clock

Table 2-3: Bit Assignments

2.4.6 Video Data Output Modes

The **L301bc** can operate in 20 MHz 8 Bit RGB mode, in 60 MHz Single 10 Bit mode, in 60 MHz Single 8 Bit mode, or in 40 MHz Dual 8 Bit mode. These modes are described in detail in Sections 2.4.6.1 through Sections 2.4.6.3.

2.4.6.1 Operation in 20 MHz 8 Bit RGB Mode

In 20 MHz 8 Bit RGB mode, the pixel clock operates at 20 MHz. On each clock cycle, the camera transmits 8 bits of data for a red pixel, 8 bits of data for a blue pixel, 8 bits of data for a green pixel, and a line valid bit. The assignment of the bits is shown in Table 2-3.

The pixel clock is used to time data sampling and transmission. As shown in Figures 2-6 and 2-7, the **L301bc** samples and transmits data on each falling edge of the pixel clock.

The line valid bit indicates that a valid line is being transmitted. Pixel data is only valid when this bit is high.



The data sequence outlined below, along with Figures 2-6 and 2-7, describe what is happening at the inputs to the Channel Link transmitter in the camera.

Note that the timing used for sampling the data at the Channel Link receiver in the frame grabber varies from device to device. On some receivers, data must be sampled on the rising edge of the pixel clock (receive clock), and on others, it must be sampled on the falling edge. Also, some devices are available which allow you to select either rising edge or falling edge sampling. Please consult the data sheet for the receiver that you are using for specific timing information.

Video Data Sequence

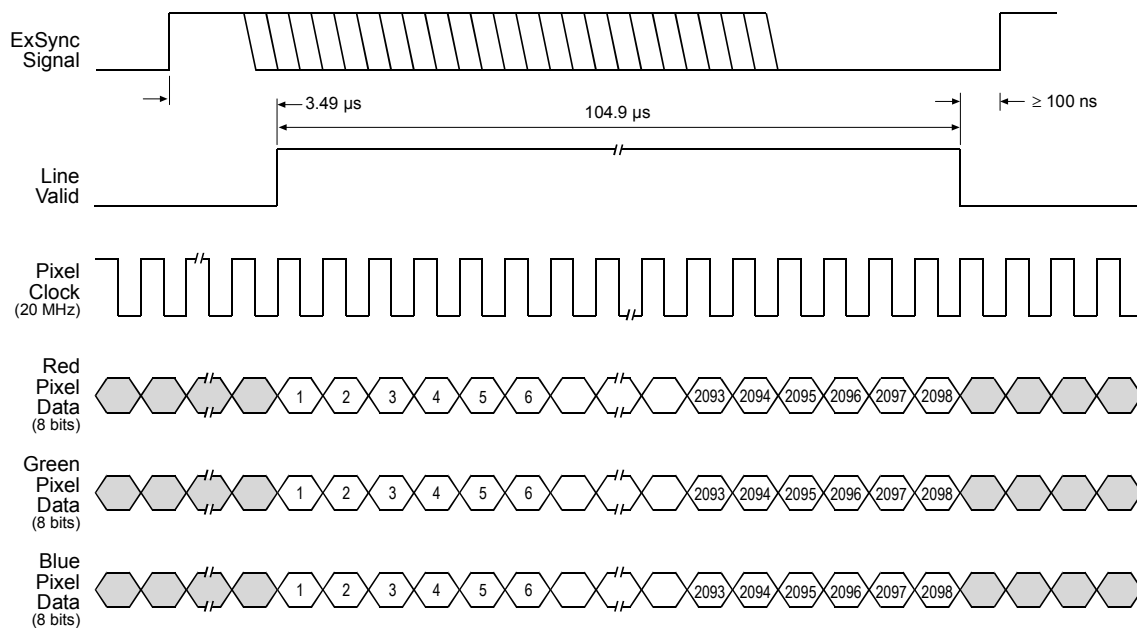
When the camera is not transmitting valid data, the line valid bit sent on each cycle of the pixel clock will be low. Once the camera has completed line acquisition, it will begin to send valid data:

- On the pixel clock cycle where valid line data transmission begins, the line valid bit will become high. Eight of the bits transmitted during this clock cycle will contain the data for pixel number one in the red line, eight of the bits will contain the data for pixel number one in the green line, and eight of the bits will contain the data for pixel number one in the blue line.
- On the next cycle of the pixel clock, the line valid bit will be high. Eight of the bits transmitted during this clock cycle will contain the data for pixel number two in the red line, eight of the bits will contain the data for pixel number two in the green line, and eight of the bits will contain the data for pixel number two in the blue line.

This pattern will continue for 2098 cycles of the pixel clock as the data for the 2098 pixels in the lines is transmitted.

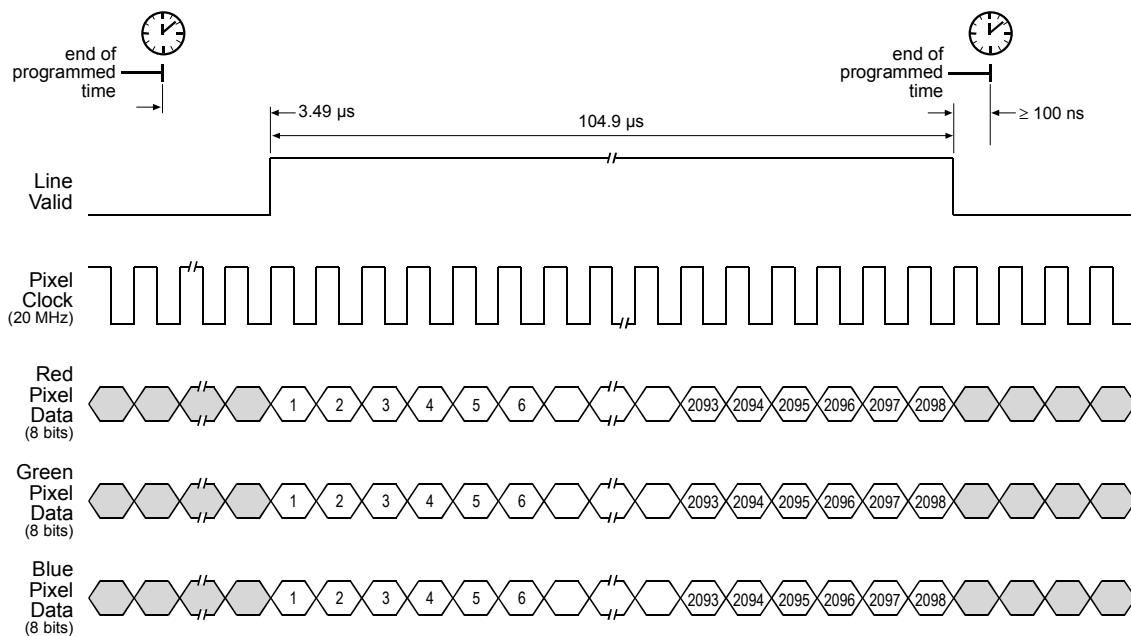
- After the data for all 2098 pixels in the lines has been transmitted, the line valid bit will become low indicating that valid line data is no longer being transmitted.

Figures 2-6 shows the data sequence when the camera is operating in edge-controlled or level-controlled exposure mode. Figure 2-7 shows the data sequence when the camera is operating in programmable exposure mode.



This diagram assumes that the area of interest feature is not being used. With the area of interest feature enabled, the number of pixels transferred could be smaller.

Figure 2-6: 20 MHz 8 Bit RGB Mode with Edge or Level Controlled Exposure



This diagram assumes that the area of interest feature is not being used. With the area of interest feature enabled, the number of pixels transferred could be smaller.

Figure 2-7: 20 MHz 8 Bit RGB Mode with Programmable Exposure

2.4.6.2 Operation in 60 MHz Single 10 Bit Mode or 60 MHz Single 8 Bit Mode

In 60 MHz Single 10 Bit mode, the pixel clock operates at 60 MHz. On each clock cycle, the camera transmits 10 bits of pixel data and a line valid bit. The assignment of the bits is shown in Table 2-3.

The pixel clock is used to time data sampling and transmission. As shown in Figures 2-8 and 2-9, the **L301bc** samples and transmits data on each falling edge of the pixel clock.

The line valid bit indicates that a valid line is being transmitted. Pixel data is only valid when this bit is high.

Operation in 60 MHz Single 8 Bit mode is similar to 10 bit mode except that the two least significant bits output from each ADC are dropped and only 8 bits of data per pixel is transmitted.



The data sequence outlined below, along with Figures 2-8 and 2-9, describe what is happening at the inputs to the Channel Link transmitter in the camera.

Note that the timing used for sampling the data at the Channel Link receiver in the frame grabber varies from device to device. On some receivers, data must be sampled on the rising edge of the pixel clock (receive clock), and on others, it must be sampled on the falling edge. Also, some devices are available which allow you to select either rising edge or falling edge sampling. Please consult the data sheet for the receiver that you are using for specific timing information.

Video Data Sequence¹

When the camera is not transmitting valid data, the line valid bit sent on each cycle of the pixel clock will be low. Once the camera has completed line acquisition, it will begin to send valid data:

- On the pixel clock cycle where valid line data transmission begins, the line valid bit will become high. Ten of the bits transmitted during this clock cycle will contain the data for pixel number one in the red line.
- On the second cycle of the pixel clock, the line valid bit will be high. Ten of the bits transmitted during this clock cycle will contain the data for pixel number one in the green line.
- On the third cycle of the pixel clock, the line valid bit will be high. Ten of the bits transmitted during this clock cycle will contain the data for pixel number one in the blue line.
- On the fourth cycle of the pixel clock, the line valid bit will be high. Ten of the bits transmitted during this clock cycle will contain the data for pixel number two in the red line.
- On the fifth cycle of the pixel clock, the line valid bit will be high. Ten of the bits transmitted during this clock cycle will contain the data for pixel number two in the green line.
- On the sixth cycle of the pixel clock, the line valid bit will be high. Ten of the bits transmitted during this clock cycle will contain the data for pixel number two in the blue line.
- This pattern will continue for 6294 cycles of the pixel clock. (The camera must transmit data for 2098 pixels in each line and there are three lines; $3 \times 2098 = 6294$.)
- After the data for all 6294 pixels has been transmitted, the line valid bit will become low indicating that valid line data is no longer being transmitted.

Figure 2-8 shows the data sequence when the camera is operating in edge-controlled or level-controlled exposure mode. Figure 2-9 shows the data sequence when the camera is operating in programmable exposure mode.

¹ The data sequence assumes that the camera is operating in 10 bit mode. If the camera is operating in 8 bit mode, only 8 bits of data per pixel will be transmitted.

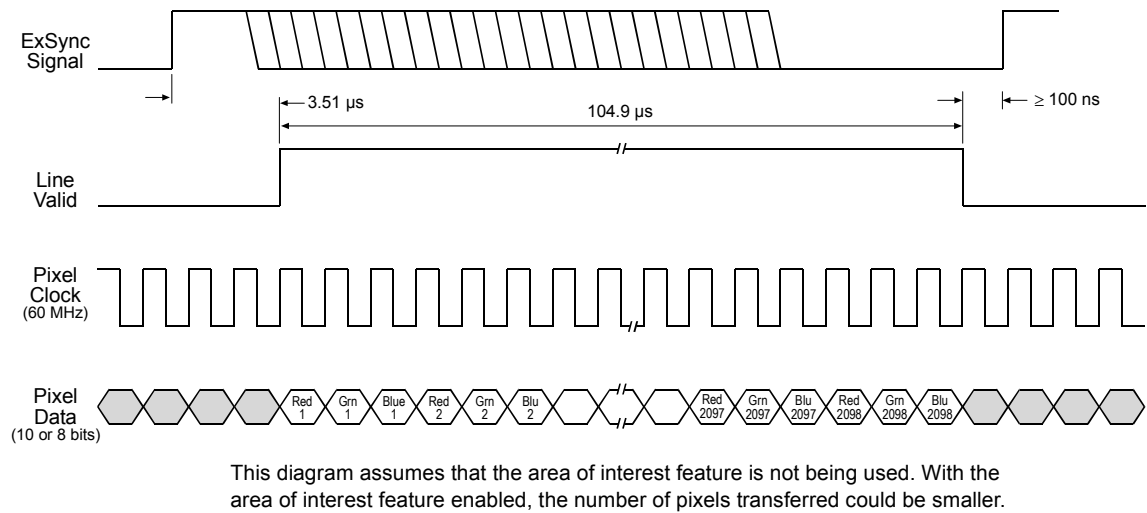


Figure 2-8: 60 MHz Single 10 Bit or Single 8 Bit Mode with Edge or Level Controlled Exposure

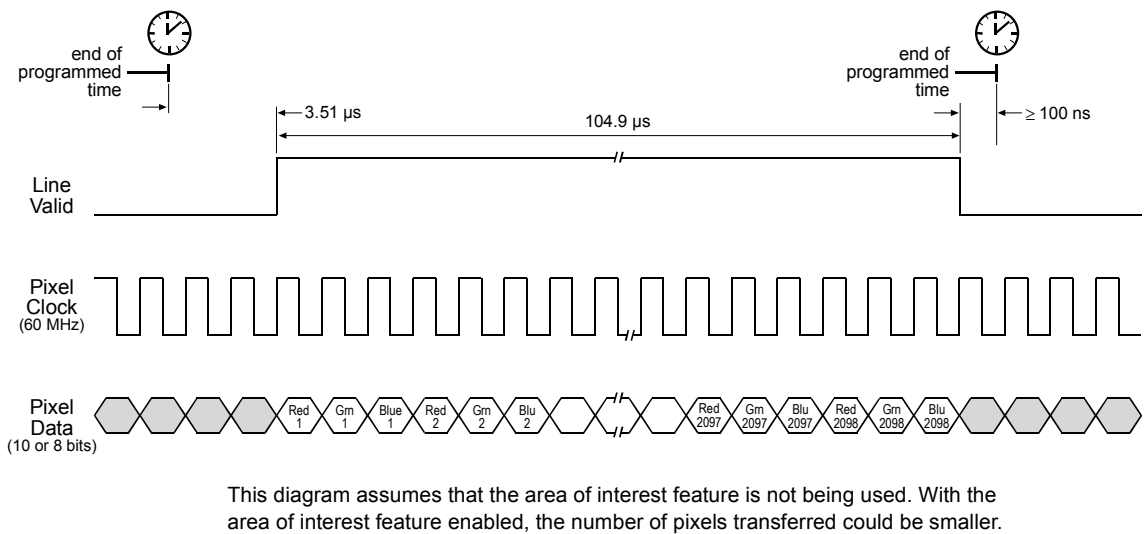


Figure 2-9: 60 MHz Single 10 Bit or Single 8 Bit Mode with Programmable Exposure

2.4.6.3 Operation in 40 MHz Dual 8 Bit Mode

In 40 MHz Dual 8 Bit mode, the pixel clock operates at 40 MHz. On each clock cycle, the camera transmits 8 bits of data for two pixels and a line valid bit. The assignment of the bits is shown in Table 2-3.

The pixel clock is used to time data sampling and transmission. As shown in Figures 2-10 and 2-11, the L301bc samples and transmits data on each falling edge of the pixel clock.

The line valid bit indicates that a valid line is being transmitted. Pixel data is only valid when this bit is high.



The data sequence outlined below, along with Figures 2-10 and 2-11, describe what is happening at the inputs to the Channel Link transmitter in the camera.

Note that the timing used for sampling the data at the Channel Link receiver in the frame grabber varies from device to device. On some receivers, data must be sampled on the rising edge of the pixel clock (receive clock), and on others, it must be sampled on the falling edge. Also, some devices are available which allow you to select either rising edge or falling edge sampling. Please consult the data sheet for the receiver that you are using for specific timing information.

Video Data Sequence

When the camera is not transmitting valid data, the line valid bit sent on each cycle of the pixel clock will be low. Once the camera has completed line acquisition, it will begin to send valid data:

- On the pixel clock cycle where valid line data transmission begins, the line valid bit will become high. The eight "Pixel A" bits transmitted during this clock cycle will contain the data for pixel number one in the red line and the eight "Pixel B" bits will contain the data for pixel number one in the green line.
- On the second cycle of the pixel clock, the line valid bit will be high. The eight "Pixel A" bits transmitted during this clock cycle will contain the data for pixel number one in the blue line and the eight "Pixel B" bits will contain dummy data which should be ignored.
- On the third cycle of the pixel clock, the line valid bit will be high. The eight "Pixel A" bits transmitted on this cycle will contain the data for pixel number two in the red line and the eight "Pixel B" bits will contain the data for pixel number two in the green line.
- On the fourth cycle of the pixel clock, the line valid bit will be high. The eight "Pixel A" bits transmitted during this clock cycle will contain the data for pixel number two in the blue line and the eight "Pixel B" bits will contain dummy data which should be ignored.

This pattern will continue for 4196 cycles of the pixel clock as the data for the 2098 pixels in the lines is transmitted.

- After the data for all 2098 pixels has been transmitted, the line valid bit will become low indicating that valid line data is no longer being transmitted.

Figure 2-10 shows the data sequence when the camera is operating in edge-controlled or level-controlled exposure mode. Figure 2-11 shows the data sequence when the camera is operating in programmable exposure mode.

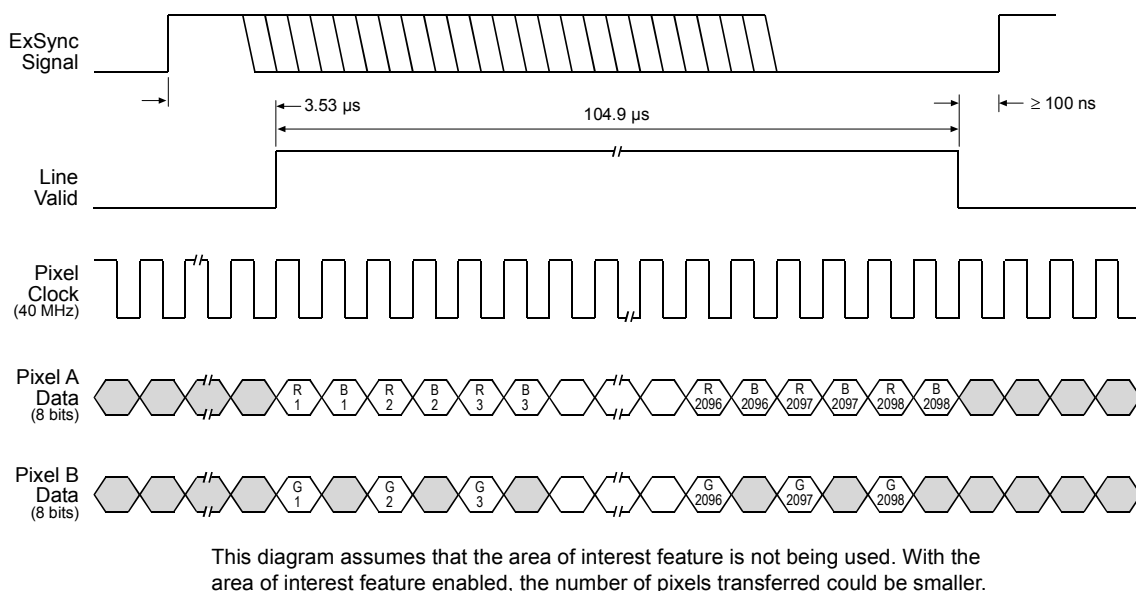


Figure 2-10: 40 MHz Dual 8 Bit Mode with Edge or Level Controlled Exposure

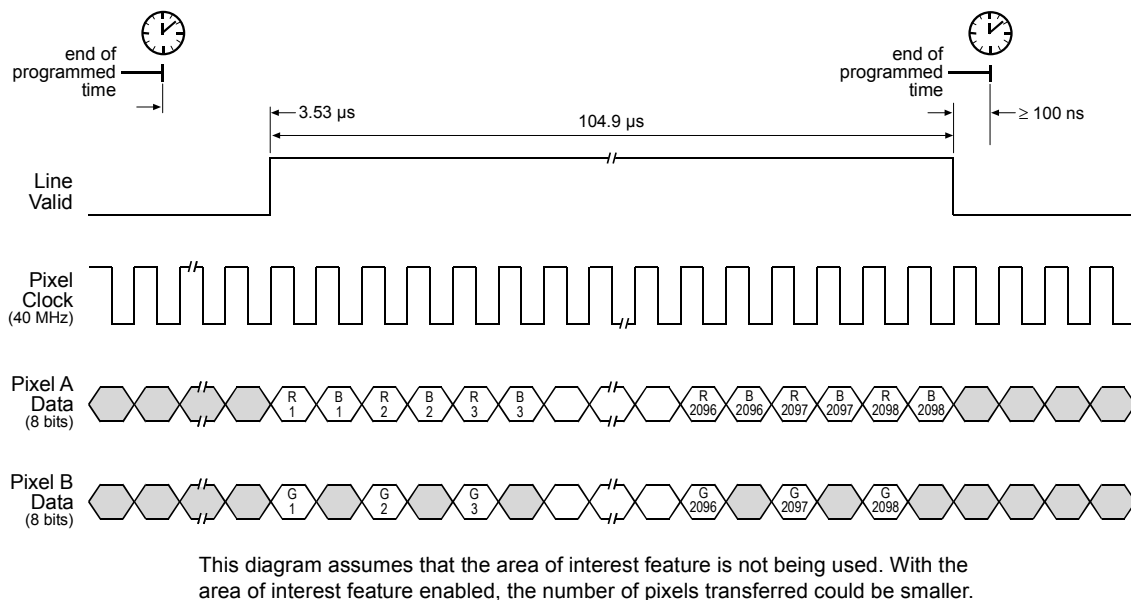


Figure 2-11: 40 MHz Dual 8 Bit Mode with Programmable Exposure

2.5 Spatial Correction

The CCD sensor used in the **L301bc** has three lines of light sensitive elements, a red line, a green line and a blue line. The light sensitive elements (pixels) that make up each line are $14\text{ }\mu\text{m}$ wide by $14\text{ }\mu\text{m}$ high. And the edge-to-edge pitch of the lines is $112\text{ }\mu\text{m}$ (see Figure 2-12).

Whenever the camera is capturing lines, on each exposure cycle, all three lines in the sensor are exposed and read out. Because of the physical separation between the lines, the red line, the green line and the blue line capture different areas of the image that is falling on the sensor.

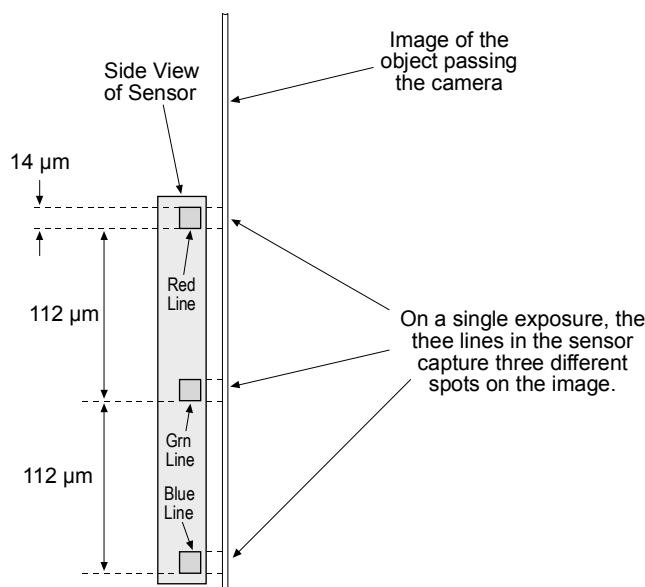


Figure 2-12: Side View of the **L301bc** Sensor

In order to capture full RGB data for a particular point on the image, you must combine the reading taken when the point is captured by the red line, with the reading taken when the point is captured by the green line and the reading when the point is captured by the blue line. The process of combining readings from several different exposures is called spatial correction.

In order to better understand the concept of spatial correction, let's consider an example. In our example, we will look at a single $14\text{ }\mu\text{m}$ wide point on the image passing the sensor and we will consider what must be done to capture full color information for that point. In our example we will refer to this as Point A. Our example will assume that the camera has been set up so that an exposure and line readout occurs each time Point A moves $14\text{ }\mu\text{m}$. Figure 2-13 shows illustrations of our example and you should refer to this figure as you read through the text below.

- To begin, assume that Point A is in front of the red line of pixels and that the camera has just completed an exposure and line read out. As you can see in Figure 2-13, on exposure/readout 1, the camera captured and transmitted the red data for point A.
- Now assume that Point A has moved $14\text{ }\mu\text{m}$ and that the camera has performed a second exposure/readout. As Figure 2-13 shows, Point A is not in front of a line. So the data captured and transmitted on this exposure does not apply to Point A.
- Assume that Point A has again moved $14\text{ }\mu\text{m}$ and that the camera has performed a third exposure/readout. As Figure 2-13 shows, Point A is still not in front of a line. So again, the data captured and transmitted on this exposure does not apply to Point A.

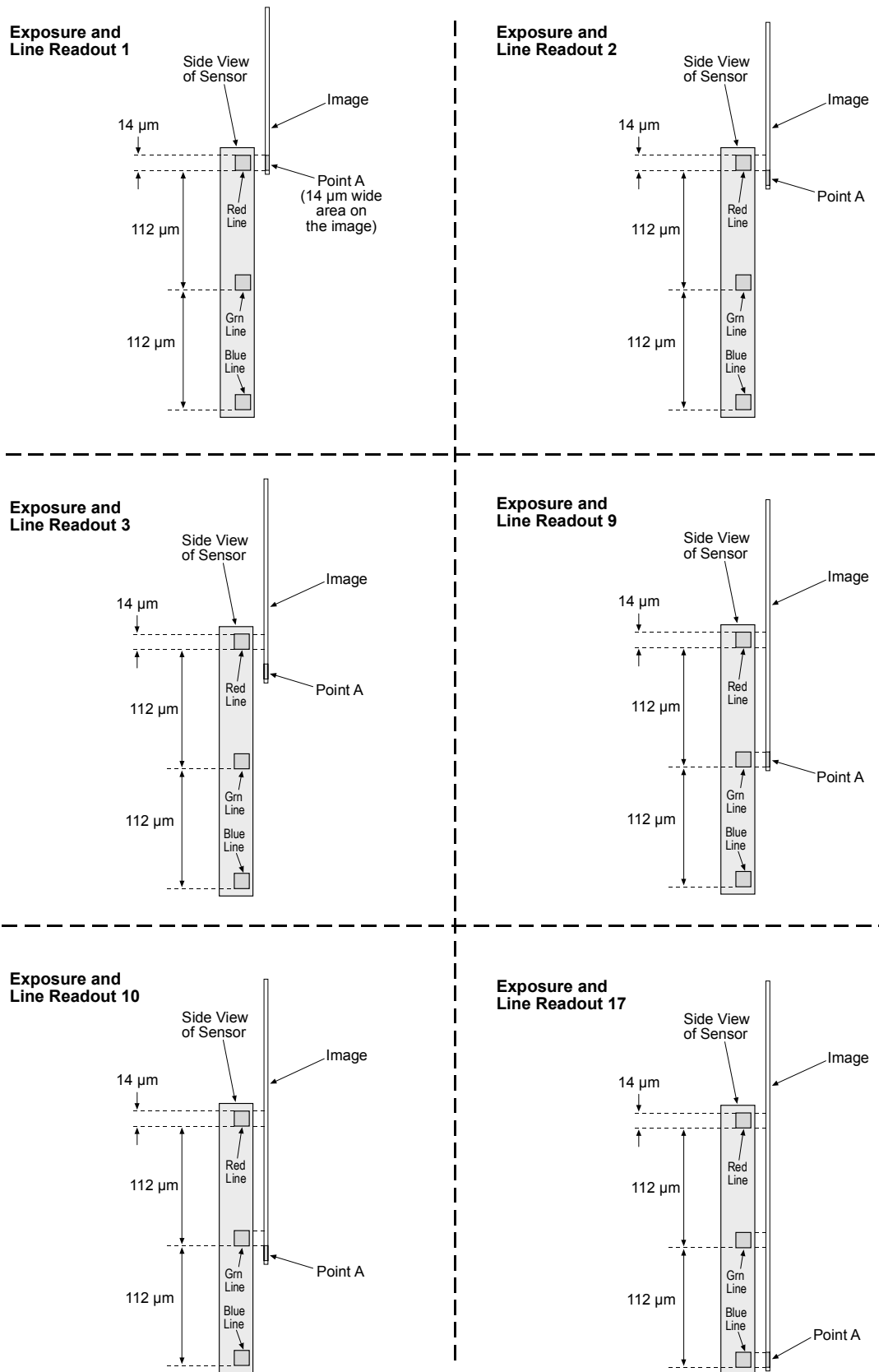


Figure 2-13: Spatial Correction

- Assume that this exposure and movement process has occurred several more times and that we are now up to exposure number nine. As shown in Figure 2-13, Point A will be positioned in front of the green line of pixels on exposure/readout number nine. On this exposure, the camera will capture and transmit the green data for Point A.
- Now assume that Point A has moved 14 more μm and that the camera has performed a tenth exposure/readout. As you can see in Figure 2-13, Point A is not in front of a line. So the data captured and transmitted on this exposure does not apply to Point A.
- Assume that the exposure and movement process has occurred several more times and that we are now up to exposure number 17. As shown in Figure 2-13, Point A will be positioned in front of blue line of pixels on exposure/readout number 17. On this exposure, the camera will capture and transmit the blue data for Point A.
- The transmitted data from exposure 1, exposure 9 and exposure 17 can be combined to get full color information for Point A.

As you may have noticed, the need for spacial correction means that sensor readings must be stored. In the case of our example, when the blue line readings from exposure 17 become available, they must be combined with the green line readings from exposure 9 and the red line readings from exposure 1 to get full color information for Point A.

The explanation given in our example seems to imply that we only need to store the data from two exposures in order to assemble full color images. But this is not actually the case. Consider the 14 μm area immediately following point A on the image. We will call this Point B (see Figure 2-14). The red pixel data for Point B will be captured on exposure number 2, the green information will be captured on exposure number 10 and the blue information on exposure number 18. So after exposure number 18 is complete, we must combine the blue data from exposure 18 with the green data from exposure 10 and the red data from exposure 2 to get full color information for Point B.

Our two examples illustrate that each time we do an exposure, we must take the information from the blue line of pixels and combine it the green data from 8 exposures earlier and the red data from 16 exposures earlier. In order to be able to do this, we must store information from the last 16 exposures. The data from the last 16 exposures would be stored either on the frame grabber or in the host computer. Also, the frame grabber or the host computer would require an algorithm to sort the pixel data and make sure that the correct red, green and blue pixel information is combined.

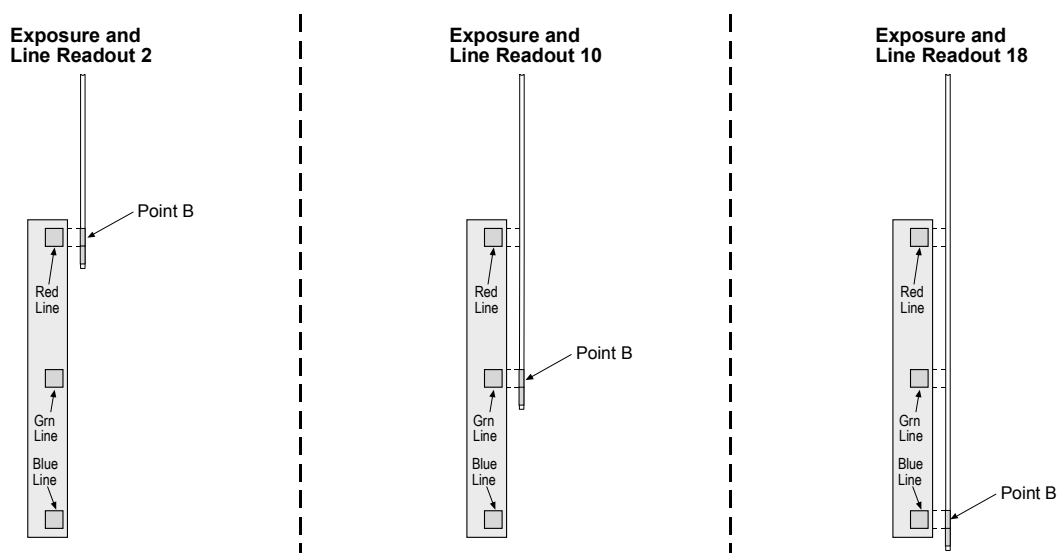


Figure 2-14: Spatial Correction

2.6 RS-232 Serial Communication

The **L301bc** is equipped for RS-232 serial communication. The RS-232 serial connection is used to issue commands to the camera for changing modes and parameters. The serial link can also be used to query the camera about its current setup.

The Basler Camera Configuration Tool is a convenient, graphical interface that can be used to change camera modes and parameters via the serial connection. The configuration tool is installed as part of the camera installation. A booklet describing how to install the configuration tool is shipped with the camera. Section 4.1 provides some basic information about the configuration tool. Detailed instructions for using the tool are included in the on-line help file that is installed with the tool.

Basler has also developed a binary command protocol that can be used to change camera modes and parameters directly from your application via the serial connection. See Section 4.2 for details on the binary command format.

2.6.1 Making the Serial Connection

You will use a serial port on your PC for RS-232 communication with the camera. Make sure that the following requirements are met:

- Make sure that pin 3 on the PC serial port is wired to pin 22 on the camera.
- Make sure that pin 2 on the PC serial port is wired to pin 24 on the camera.
- Make sure that pin 5 on the serial port is wired to pin 21 or 23 on the camera.
- Make sure that the port is set for 8N1 (8 data bits + no parity + 1 stop bit) and a baud rate of 9600 bps.

2.7 DC Power

The **L301bc** requires 12 VDC ($\pm 10\%$) power. The camera has no overvoltage protection. An input voltage higher than 14 VDC will damage the camera.

The camera's maximum power consumption is approximately 6 watts.

Ripple must be less than 1%.



The camera has no reverse power protection. Therefore, always observe the polarity as indicated in Table 2-1 on page 2.

2.8 Status LEDs

Green LED

When the green LED on the back of the camera is not lit, it means that no voltage or a voltage below 10.4 V is present. When the green LED is lit, it means that a voltage of 10.4 V or higher is present.

The camera has no overvoltage protection. Therefore, always observe the power requirements as described in Section 2.7.

Yellow LED

The yellow LED on the back of the camera indicates signal integrity. At power up, the LED will light for several seconds as the microprocessor in the camera boots up. If all is OK, the LED will then remain lit continuously.

If an error condition is detected at any time after the microprocessor boots up, the LED will begin to blink an error code. See Section 6 for details.

2.9 Converting Channel Link Video Output to RS-644 with a BIC

As mentioned in Section 2.4, video data is output from the **L301bc** in Channel Link LVDS format. The video output from the camera can be converted to RS-644 LVDS by using a Basler Interface Converter (BIC). The BIC is a small device which attaches to the **L301bc**. For complete information on installing and using the BIC, refer to Appendix A.

3 Basic Operation and Features

3.1 Functional Description

The **L301bc** is a high resolution camera which employs a tri-linear CCD-sensor chip designed for color scanning. The tri-linear sensor contains three lines of photosensitive elements (pixels) with 2098 pixels per line. One line is covered with a red filter, one line with a green filter and one line with a blue filter to provide spectral separation.

Exposure time is normally controlled via an externally generated trigger signal (ExSync). The ExSync signal facilitates periodic or non-periodic pixel readout.

When exposure is controlled by an ExSync signal, exposure time can be edge-controlled, level-controlled, or programmable. In edge-controlled mode, charge is accumulated over the full period of the ExSync signal and a rising edge of ExSync triggers the readout of accumulated charges from the sensor elements to the CCD shift registers. In level-controlled mode, charge is accumulated when the ExSync signal is low and a rising edge of ExSync triggers the readout of accumulated charges. In programmable mode, exposure time can be programmed to a predetermined period. In this case, exposure begins on the rising edge of ExSync and accumulated charges are read out when the programmed exposure time ends.

A free-run mode that allows the camera to operate without an ExSync signal is also available. In free-run mode, the camera generates its own internal control signal and the signal is used to control exposure and charge readout. When operating in free-run, the camera outputs lines continuously.

At readout, accumulated charges are transported from each line of pixels to a separate shift register (see Figure 3-1). As charges move out of the shift registers, they are converted to voltages proportional to the amount of accumulated charge. The shifts are clocked according to the camera's internal data rate.

The voltages moving out of each shift register are amplified by a Variable Gain Control (VGC) and then digitized by a 10 bit, Analog-to-Digital Converter (ADC). The digitized video data is transmitted from the camera to the frame grabber using a Channel Link LVDS transmission format (see Section 2.4 for details).

For optimal digitization, gain and offset are programmable via a serial port.

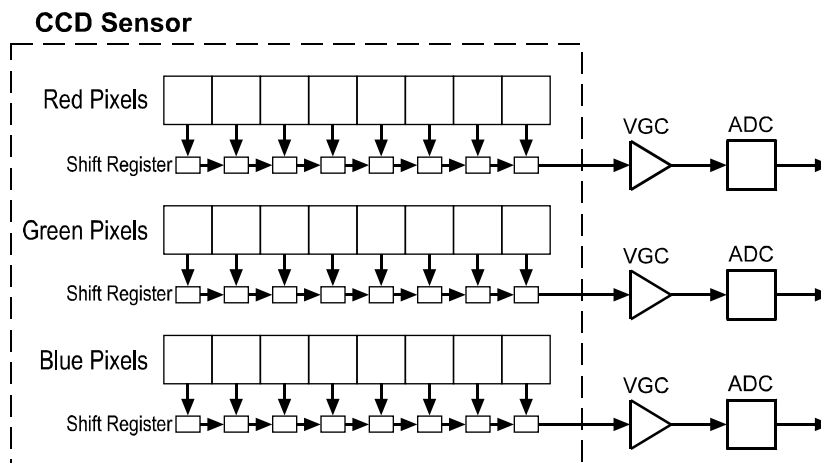


Figure 3-1: Pixels and Shift Registers

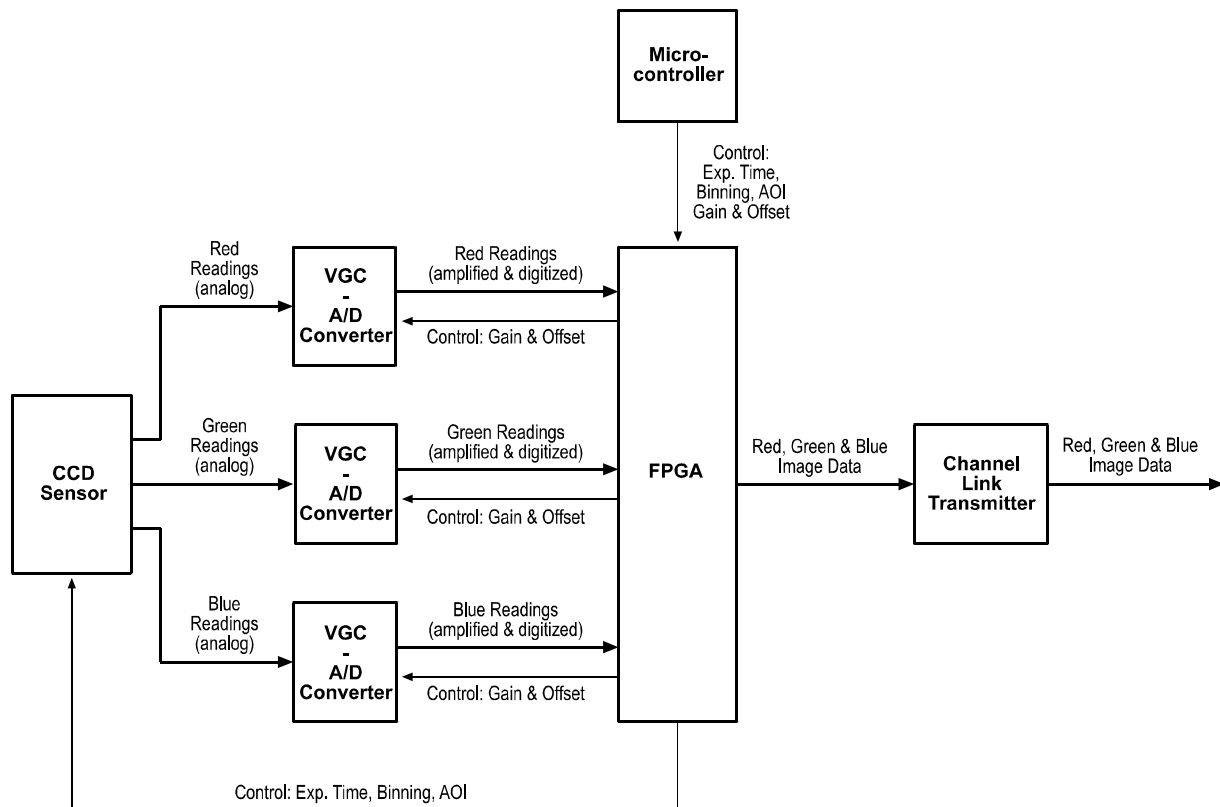


Figure 3-2: L301bc Block Diagram

3.2 Exposure Time Control Mode Basics

The L301bc can operate under the control of an external trigger signal (ExSync) or can operate in “free-run.” In free-run, the camera generates its own internal control signal and does not require an ExSync signal.

3.2.1 ExSync Controlled Operation

In ExSync operation, the camera’s line rate and exposure time are controlled by an externally generated (ExSync) signal. The ExSync signal is typically supplied to the camera by a frame grabber board. You should refer to the manual supplied with your frame grabber board to determine how to set up the ExSync signal that is being supplied to the camera.

When the camera is operating under the control of an ExSync signal, the length of the ExSync signal period determines the camera’s line rate. ExSync can be periodic or non-periodic.

When the camera is operating with an ExSync signal, it has three modes of exposure time control available: edge-controlled mode, level-controlled mode, and programmable mode.

- In **ExSync, edge-controlled** mode, the pixels are exposed and charge is accumulated over the full period of the ExSync signal (rising edge to rising edge). The falling edge of the ExSync signal is irrelevant. The line is read out and transferred on the rising edge of ExSync. (see Figure 3-3.)

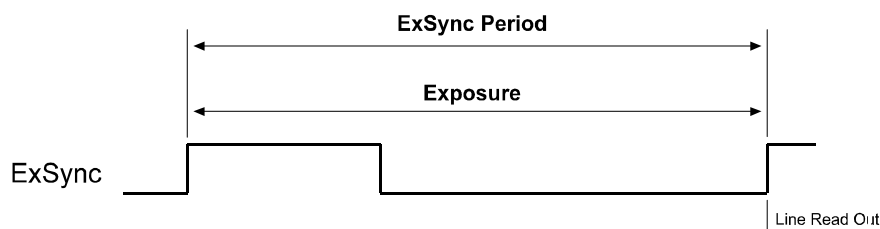


Figure 3-3: ExSync, Edge-Controlled Mode

- In **ExSync, level-controlled** mode, the exposure time is determined by the time between the falling edge of ExSync and the next rising edge. The pixels are exposed and charge is accumulated only when ExSync is low. The line is read out and transferred on the rising edge of the ExSync signal (see Figure 3-4).

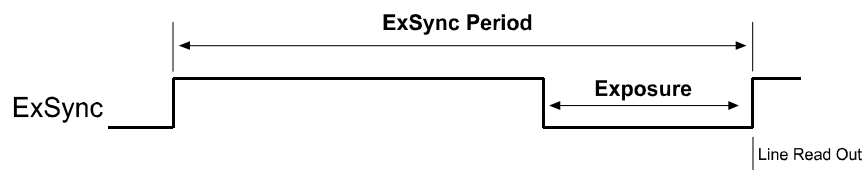


Figure 3-4: ExSync, Level-controlled Mode

- In **ExSync, programmable** mode, the rising edge of ExSync triggers exposure and charge accumulation for a pre-programmed period of time. The line is read out and transferred at the end of the pre-programmed period. The falling edge of ExSync is irrelevant (see Figure 3-5). A parameter called “Timer 1” is used to set the length of the pre-programmed exposure period.

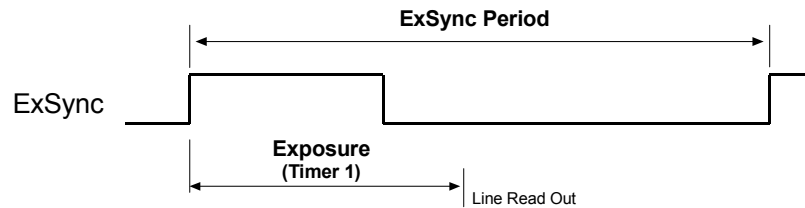



Figure 3-5: ExSync, Programmable Mode

You can set the camera to operate in one of the ExSync controlled exposure modes using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2).

With the Camera Configuration Tool, you use the Exposure Tab to set the camera for ExSync operation and to select the edge-controlled, level controlled or programmable exposure time control mode. If you select the programmable mode, you must also enter an exposure time. When you enter an exposure time, the configuration tool will automatically set the “Timer 1” parameter to the correct value.

With binary commands, you must use the Exposure Time Control Mode command to select ExSync edge-controlled, ExSync level-controlled or ExSync programmable mode. If you choose the programmable mode, you must also use the Timer 1 command to set the exposure time.

	<p>ExSync must toggle.</p> <p>The minimum ExSync period is 108.6 μs.</p> <p>The ExSync signal must remain high for at least 1.5 μs.</p> <p>There must be a minimum of 100 ns between the end of line transfer and readout of the next line (see Figures 2-6 and 2-7).</p> <p>The minimum exposure time is 1 μs.</p>
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3.2.2 Free Run

In **free-run**, no ExSync signal is required. The camera generates a continuous internal control signal based on two programmable parameters: “Timer 1” and “Timer 2.” Timer 1 determines how long the internal signal will remain low and Timer 2 determines how long the signal will remain high.

When the camera is operating in free-run, the length of the control signal period determines the camera’s line rate. (The control signal period is equal to Timer 1 plus Timer 2.)

When the camera is operating in free-run, it exposes and outputs lines continuously.

In free-run, two modes of operation are available: edge-controlled and programmable.

- In **free-run, edge-controlled mode**, the pixels are exposed and charge is accumulated over the full period of the internal control signal (rising edge to rising edge). The falling edge of the control signal is irrelevant. The line is read out and transferred on the rising edge of the internal control signal. See Figure 3-6.

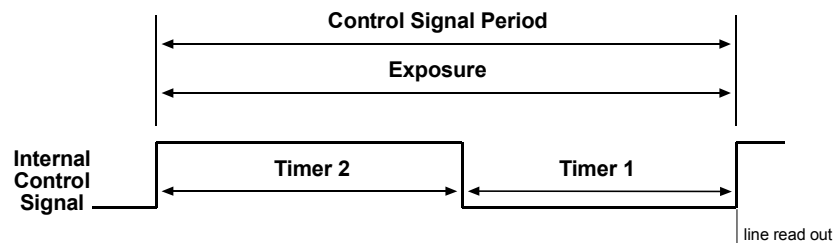


Figure 3-6: Free-run, Edge-controlled Mode

- In **free-run, programmable mode**, the pixels are exposed and charge is accumulated when the internal control signal is low. The line is read out and transferred on the rising edge of internal control signal. See Figure 3-7.

In this mode, the exposure time can be programmed as desired by varying the setting of the “Timer 1” parameter.

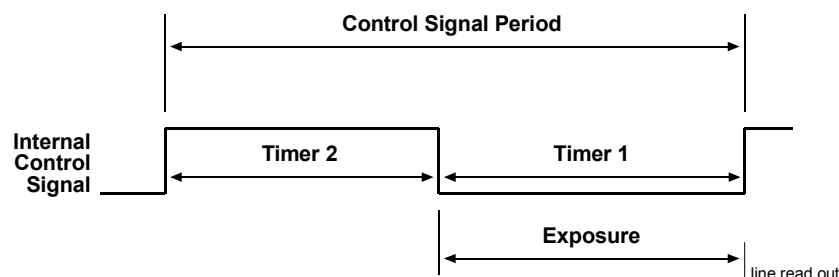


Figure 3-7: Free-run, Programmable Mode

You can set the camera to operate in free-run using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2).

With the Camera Configuration Tool, you use the Exposure Tab to set the camera for free-run and to select the edge-controlled or programmable exposure time control mode. If you choose to

operate the camera in free-run, the configuration tool will require you to enter a line rate; if you are using the programmable mode, you must also enter an exposure time. The configuration tool will automatically set the Timer 1 and Timer 2 parameters based on the values that you enter on the Exposure Tab.

With binary commands you must use the Exposure Time Control Mode command to select the free-run, edge-controlled or free-run, programmable mode. You must also use the Timer 1 command to set Timer 1 and the Timer 2 command to set Timer 2.



In the free-run mode, the period of the internal control signal is equal to the sum of Timer 1 plus Timer 2. The sum of the Timer 1 setting plus the Timer 2 setting must be at greater than 108.6 μ s.

The minimum exposure time is 1 μ s.

3.3 Video Data Output Modes

The **L301bc** can output video data using three different modes: 20 MHz 8 Bit RGB mode, 60 MHz Single 10 Bit mode, 60 MHz Single 8 Bit mode, or 40 MHz Dual 8 Bit mode. These modes of operation are described in detail in Section 2.4.6.1, Section 2.4.6.2 and Section 2.4.6.3.

You can select the video data output mode using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2). With the Camera Configuration Tool, you use the Output Version Tab to select the data output mode and with binary commands you use the Video Data Output Mode command.

3.4 Gain and Offset

The major components in the camera electronics include: a CCD sensor with three lines of pixels, a variable gain control (VGC) for each line, and an analog to digital converter (ADC) for each line (see Figure 3-1). The pixels in each line of the CCD sensor output an analog voltage signal when exposed to light. The analog voltage output from each line is amplified by a VGC and transferred to an ADC which converts the output to a digital signal.

Two parameters, gain and offset, are associated with each VGC. As shown in Figures 3-8 and 3-9, increasing or decreasing the gain increases or decreases the amplitude of the signal that is input into the ADC. Increasing or decreasing the offset moves the signal up or down the measurement scale but does not change the signal amplitude.

The default gain and offset are set so that with optimal lighting 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 (in 8 bit output modes) or 1023 (in 10 bit output mode).

For most applications, black should have a gray value of 1 and white should have a gray value of 254 (in 8 bit output modes) or 1023 (in 10 bit output mode). Attempt to achieve this by varying exposure and illumination rather than changing the camera's gain. The default gain is the optimal operating point (minimum noise) and should be used if possible.

Internally, the **L301bc** processes red, green and blue pixels using three different VGCs. If the white balance of the images produced by the camera is not correct for your application, you can change the white balance by adjusting the gain on the red, green or blue pixels.

You can set the gain and offset using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2).

With the Camera Configuration Tool, you use the slide controls on the Gain and Offset Tab to easily adjust gain and offset.

With binary commands, you must use the Gain command for each color to set the gain and the Offset command for each color to set the offset.

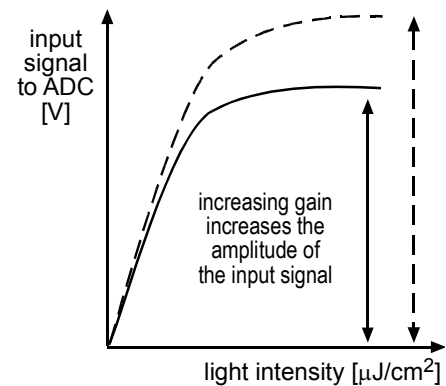


Figure 3-8: Gain

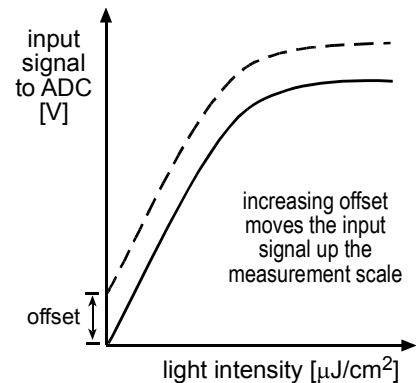


Figure 3-9: Offset



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

3.4.1 Gain Settings in More Detail

The output signals from the pixels in each line of the CCD sensor normally range from 0 Volts when the pixels are exposed to no light to 1.2 Volts when they are exposed to bright light. Within that range, the sensor characteristics are linear. Saturation starts at 1.2 Volts. Further exposure results in a higher sensor output signal but linearity is no longer guaranteed.

The default factory gain is set for an amplification factor of 1.7 (4.5 dB). At this setting, the sensor's normal linear output range of 0 V - 1.2 V is amplified to 0 V - 2.0 V. The peak-to-peak input voltage range of the ADC is 0 V - 2.0 V. Thus when the gain is at factory default, the amplified output of the sensor maps directly to the input voltage range of the ADC.

Gain is adjustable and can be programmed on a decimal scale that ranges from 0 to 319 (0x0000 to 0x013F). The settings result in the following amplification:

- 0 = 4.5 dB
- 319 = 34.5 dB
- In between, amplification in dB is linear.
- The gain can be adjusted in steps of 0.09 dB.

The desired 4.5 dB default gain is achieved when the gain is programmed to 0. You should find that the default gain setting on your camera is near to this value. Increasing the gain to more than 0 maps a smaller portion of the sensor's linear output range to the ADC's input.

If you know the decimal number setting for the gain on your camera, the equivalent decibel value can be calculated as follows:

$$\text{dB} = \left(\frac{34.5 - 4.5}{319} \times \text{DN} \right) + 4.5$$

If you know the decibels of gain that you want to achieve, the appropriate decimal number gain setting can be calculated as follows:

$$\text{DN} = \frac{319}{34.5 - 4.5} \times (\text{dB} - 4.5), \text{ with dB} > 4.5$$

3.5 Digital Shift

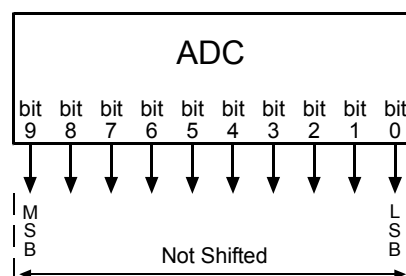
The “digital shift” feature allows you to change the group of bits that is output from each ADC. Using the digital shift feature will effectively multiply the output of the CCD sensor by 2 times, 4 times or 8 times. Section 3.5.1 describes how digital shift works when the camera is operating in 10 bit output mode and Section 3.5.2 describes how digital shift works when the camera is operating in an 8 bit output mode.

You can set digital shift using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2). With the Camera Configuration Tool, you use the Features Tab to set digital shift and with binary commands you use the Digital Shift command.

3.5.1 Digital Shift in 10 bit Output Mode

No Shift

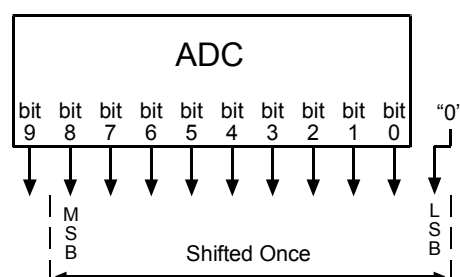
As mentioned in Section 3.1, the **L301bc** uses 10 bit ADCs to digitize the output from the CCD sensor. When the camera is operating in 10 bit output mode, by default, the camera transmits the 10 bits that are output from each ADC.



Shift Once

When the camera is set to shift once, the output from the camera will include bit 8 through bit 0 from each ADC along with a zero as an LSB.

The result of shifting once is that the output of the camera is effectively doubled. For example, assume that the camera is set for no shift, that it is viewing a uniform white target, and that under these conditions the reading for the brightest pixel is 100. If you changed the digital shift setting to shift once, the reading would increase to 200.

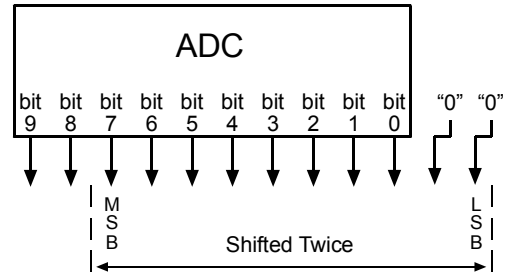


Note that if bit 9 is set to 1, all of the other bits will automatically be set to 1. This means that you should only use the shift once setting when your pixel readings in 10 bit mode with no digital shift are all below 512.

Shift Twice

When the camera is set to shift twice, the output from the camera will include bit 7 though bit 0 from each ADC along with two zeros as LSBs.

The result of shifting twice is that the output of the camera is effectively multiplied by four. For example, assume that the camera is set for no shift, that it is viewing a uniform white target, and that under these conditions the reading for the brightest pixel is 100. If you changed the digital shift setting to shift twice, the reading would increase to 400.

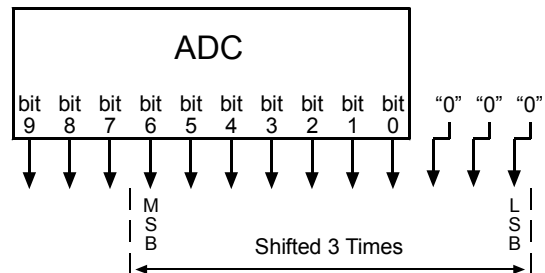


Note that if bit 9 or bit 8 is set to 1, all of the other bits will automatically be set to 1. This means that you should only use the shift twice setting when your pixel readings in 10 bit mode with no digital shift are all below 256.

Shift Three Times

When the camera is set to shift three times, the output from the camera will include bit 6 though bit 0 from each ADC along with three zeros as LSBs.

The result of shifting three times is that the output of the camera is effectively multiplied by eight. For example, assume that the camera is set for no shift, that it is viewing a uniform white target, and that under these conditions the reading for the brightest pixel is 100. If you changed the digital shift setting to shift three times, the reading would increase to 800.

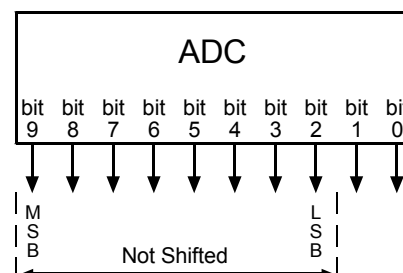


Note that if bit 9, bit 8 or bit 7 is set to 1, all of the other bits will automatically be set to 1. This means that you should only use the shift three times setting when your pixel readings in 10 bit mode with no digital shift are all below 128.

3.5.2 Digital Shift in 8 bit Output Modes

No Shift

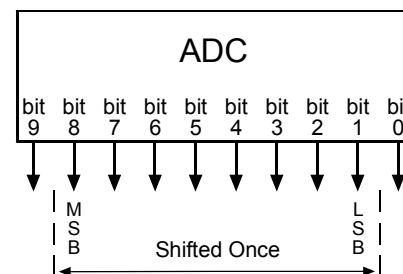
As mentioned in Section 3.1, the L301bc uses 10 bit ADCs to digitize the output from the CCD sensor. When the camera is operating in an 8 bit output mode, by default, it drops the least two significant bits from each ADC and transmits the 8 most significant bits (bit 9 through bit 2).



Shift Once

When the camera is set to shift once, the output from the camera will include bit 8 through bit 1 from each ADC.

The result of shifting once is that the output of the camera is effectively doubled. For example, assume that the camera is set for no shift, that it is viewing a uniform white target and that under these conditions the reading for the brightest pixel is 20. If you changed the digital shift setting to shift once, the reading would increase to 40.

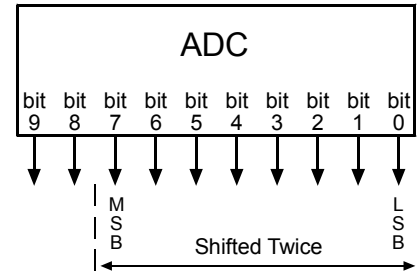


Note that if bit 9 is set to 1, all of the other bits will automatically be set to 1. This means that you should only use the shift once setting when your pixel readings in 8 bit mode with no digital shift are all below 128.

Shift Twice

When the camera is set to shift twice, the output from the camera will include bit 7 though bit 0 from each ADC.

The result of shifting twice is that the output of the camera is effectively multiplied by four. For example, assume that the camera is set for no shift, that it is viewing a uniform white target, and that under these conditions the reading for the brightest pixel is 20. If you changed the digital shift setting to shift twice, the reading would increase to 80.

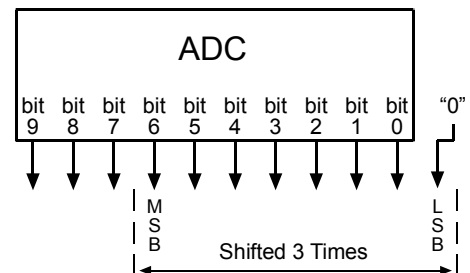


Note that if bit 9 or bit 8 is set to 1, all of the other bits will automatically be set to 1. This means that you should only use the shift twice setting when your pixel readings in 8 bit mode with no digital shift are all below 64.

Shift Three Times

When the camera is set to shift three times, the output from the camera will include bit 6 though bit 0 from each ADC along with a zero as the LSB.

The result of shifting three times is that the output of the camera is effectively multiplied by eight. For example, assume that the camera is set for no shift, that it is viewing a uniform white target and that under these conditions the reading for the brightest pixel is 20. If you changed the digital shift setting to shift three times, the reading would increase to 160.



Note that if bit 9, bit 8 or bit 7 is set to 1, all of the other bits will automatically be set to 1. This means that you should only use the shift once setting when your pixel readings in 8 bit mode with no digital shift are all below 32.

3.5.3 Precautions When Using Digital Shift

There are several checks and precautions that you must follow before using the digital shift feature. The checks and precautions differ depending on whether you will be using the camera in 10 bit output mode or in an 8 bit output mode.

If you will be using the camera in 10 bit output mode, make this check:

1. Use binary commands or the Output Version Tab on the configuration tool to put the camera in 10 bit output mode.
2. Use binary commands or the Features Tab to set the camera for no digital shift.
3. Check the output of the camera under your normal lighting conditions with no digital shift and note the readings for the brightest pixels.
 - If any of the readings are above 512, do not use digital shift.
 - If all of the readings are below 512, you can safely use the 2X digital shift setting.
 - If all of the readings are below 256, you can safely use the 2X or 4X digital shift setting.
 - If all of the readings are below 128, you can safely use the 2X, 4X or 8X digital shift setting.

If you will be using the camera in 8 bit output mode, make this check:

1. Use binary commands or the Output Version Tab on the configuration tool to put the camera in an 8 bit output mode.
2. Use the binary commands or the Features Tab to set the camera for no digital shift.
3. Check the output of the camera under your normal lighting conditions with no digital shift and note the readings for the brightest pixels.
 - If any of the readings are above 128, do not use digital shift.
 - If all of the readings are below 128, you can safely use the 2X digital shift setting.
 - If all of the readings are below 64, you can safely use the 2X or 4X digital shift setting.
 - If all of the readings are below 32, you can safely use the 2X, 4X or 8X digital shift setting.

3.6 Area of Interest (AOI)

The area of interest feature allows you to specify a portion of the CCD array and during operation, all pixels are transferred out of the camera but only the pixel information from the specified portion is signalled as valid to the frame grabber. Pixels outside the AOI are read out but signalled as invalid to the grabber.

The size of the area of interest is defined by declaring a starting pixel and a length in pixels (see Figure 3-10). For example, if you specify the starting pixel as 10 and the length in pixels as 15, the camera will output all pixels from the array but only pixels 10 through 24 will be valid.

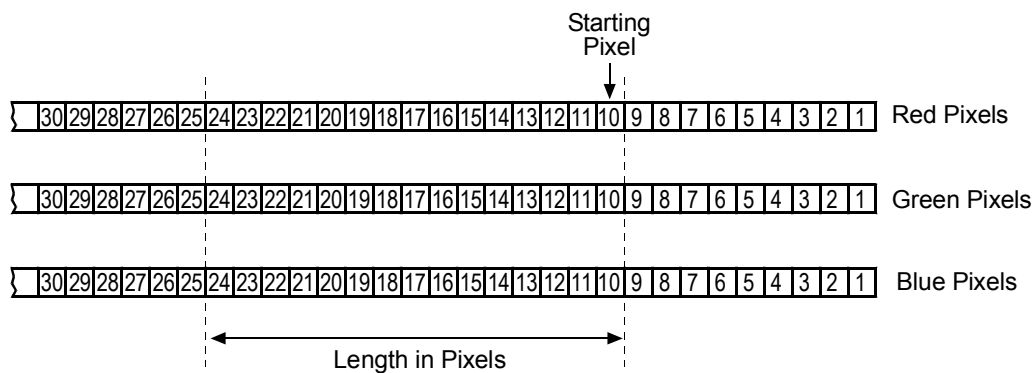


Figure 3-10: Area of Interest

The number of transferred pixels does not decrease when the area of interest feature is used.

The maximum achievable line rate does not increase when the area of interest feature is used.

Validity of pixels is signalled using the line valid bit.

On the pixel clock cycle where AOI data transmission begins, the line valid bit will become high. For example, if you specify the starting pixel as 5, the line valid bit will become high on the clock cycle where pixel 5 is transmitted (see Figure 3-11). After all of the pixels in the AOI have been transmitted, the line valid bit will become low indicating that valid line data is no longer being transmitted.

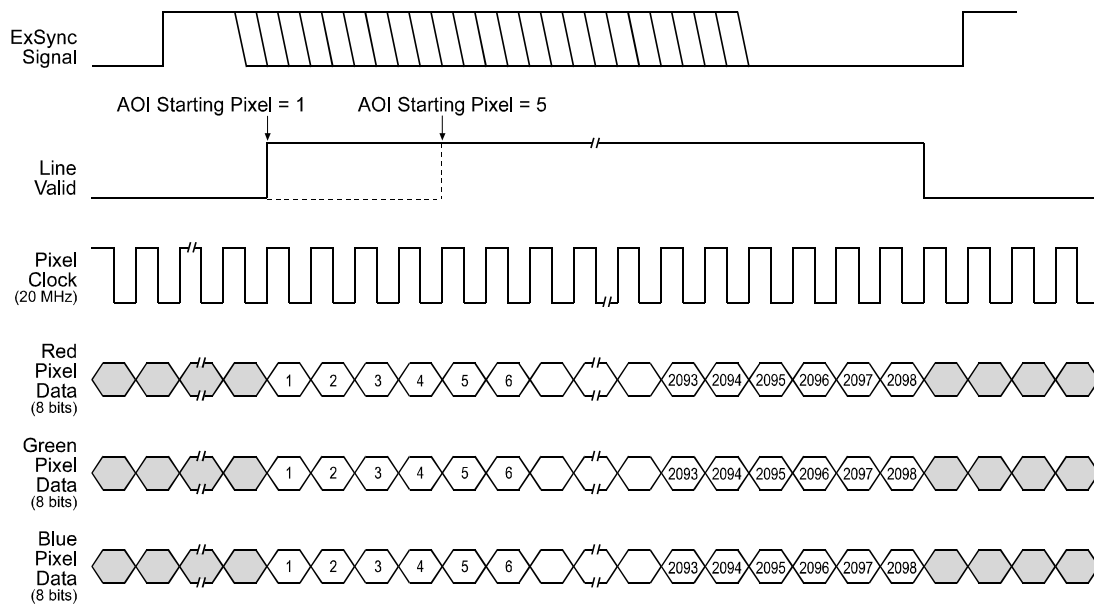




Figure 3-11: 20 MHz 8 Bit RGB Mode with Edge or Level Controlled Exposure

 If you use a frame grabber which does not take the falling edge of the line valid bit into account, you must also set the frame grabber to the number of pixels in the area of interest. For example, when you have an area of interest of 500 pixels, you must also set the grabber to 500 pixels. Otherwise, the grabber will show no effect.

 In normal operation, the camera is set to use all of the pixels in the array. To use all of the pixels, the starting pixel should be set to 1 and the length in pixels to 2098.

You can set the area of interest using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2). With the Camera Configuration Tool, you use the Features Tab to set the area of interest and with binary commands you use the Area of Interest Starting Pixel and Area of Interest length in Pixel commands.

3.7 Test Images

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 with a software program and the camera's digital devices and does not use the optics, CCD sensor, VGCs or ADCs. The test image can be used for service purposes and for failure diagnostics.

Four types of test image are available.

3.7.1 Test Image One (Gray Gradient)

Test image one is formed with repeated gray scale gradients ranging from 0 to 255. The first pixel in each line has a red value of 0, a green value of 0 and a blue value of 0. The second pixel has a red value of 1, a green value of 1, and a blue value of 1, and so on.

If the camera is set for an exposure mode that uses an ExSync signal, an ExSync signal is required to output a line on the test image. Multiple transitions of the ExSync signal will produce a two dimensional image as shown in Figure 3-12.

If the camera is set for free-run, each cycle of the camera's internal sync signal will trigger the output of a test image.

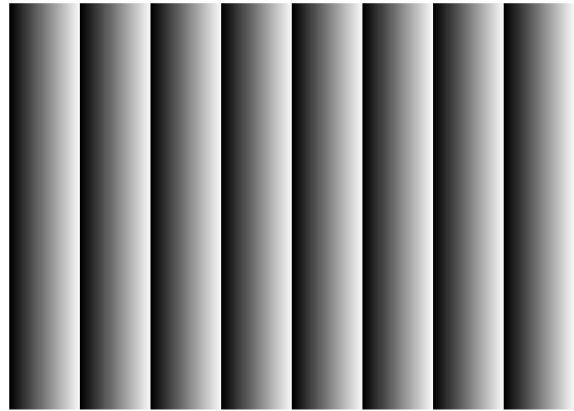


Figure 3-12: Test Image One

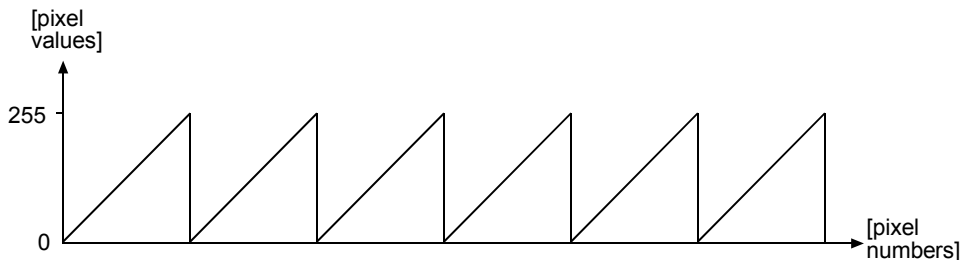


Figure 3-13: Formation of the Test Image

3.7.2 Test Image Two (Red Gradient)

Test image two is formed with repeated red gradients ranging from 0 to 255. The first pixel in each line has a red value of 0, a green value of 0, and a blue value of 0. The second pixel has a red value of 1, a green value of 0, and a blue value of 0. The third pixel has a red value of 2, a green value of 0, and a blue value of 0, and so on.

3.7.3 Test Image Three (Green Gradient)

Test image three is formed with repeated green gradients ranging from 0 to 255. The first pixel in each line has a red value of 0, a green value of 0, and a blue value of 0. The second pixel has a red value of 0, a green value of 1, and a blue value of 0. The third pixel has a red value of 0, a green value of 2, and a blue value of 0, and so on.

3.7.4 Test Image Four (Blue Gradient)

Test image four is formed with repeated blue gradients ranging from 0 to 255. The first pixel in each line has a red value of 0, a green value of 0, and a blue value of 0. The second pixel has a red value of 0, a green value of 0, and a blue value of 1. The third pixel has a red value of 0, a green value of 0, and a blue value of 2, and so on.



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

Digital shift makes the test image appear very light, therefore, digital shift should be disabled when the test image is active.

You can put the camera in test image mode using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2). With the Camera Configuration Tool, you use the Test Image Tab to select the test image. With binary commands you use Test Image command.

3.8 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 types of configuration sets: the Work Set, the Factory Set, and User Sets.

Work Set

The Work Set contains the current camera settings and thus determines the camera's present performance, that is, what your image currently 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 using binary programming commands.

Factory Set

When a camera is manufactured, a test set up is performed on the camera and an optimized configuration is determined. The Factory Set contains the camera's factory optimized configuration. The Factory Set is stored in non-volatile memory on the EEPROM and can not be altered.

User Sets

User Sets are also stored in the non-volatile EEPROM of the camera. The camera has 15 User Sets. Each User Set initially contains factory settings but User Sets can be modified. Modification is accomplished by making changes to the Work Set and then copying the Work set into one of the User Sets. The Camera Configuration Tool or binary commands can be used to copy the Work Set into one of the User Sets.

Startup Pointer

When power to the camera is switched off, the Work set in the RAM is lost. At the next power on, a configuration set is automatically copied into the Work Set. The Startup Pointer is used to specify which of the configuration sets stored in the EEPROM will be copied into the Work Set at power on. The Startup Pointer is initially set so that the Factory Set is loaded into the Work Set at power on. This can be changed using the Camera Configuration Tool or binary commands. The Startup Pointer can be set to the Factory Set or to any one of the User Sets. So, for example, if the Startup Pointer is set to User Set 13, then User Set 13 will be copied into the Work Set at power on.

You can work with configuration sets and the startup pointer using either the Camera Configuration Tool (see Section 4.1) or binary commands (see Section 4.2).

With the Camera Configuration Tool, you can use the Sets Tab to copy the Work Set to a User Set, to copy a User Set or the Factory Set to the Work Set, or to set the Startup Pointer.

With binary commands you use the Copy Work Set to User Set command, the Copy Factory Set or User Set to Work Set command, and the Select Startup Pointer command to manipulate configuration sets.

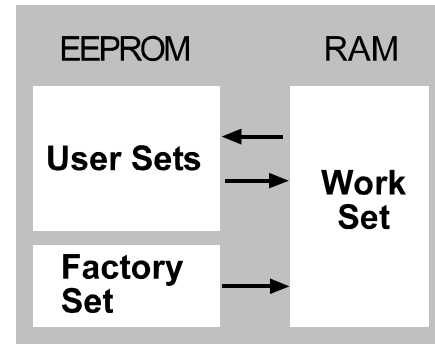


Figure 3-14: Config Sets

3.9 Camera Status

The **L301bc** monitors its 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) to check a list of several possible errors and an indication of whether those errors are present.
- with binary commands. You can use the Camera Status command (see Section 4.2.9) 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 6.1).

4 Configuring the Camera

The **L301bc** comes factory-set so that it 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 (for ExSync programmable mode or free-run programmable mode)

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

- Gain
- Offset
- Area of Interest
- Digital Shift

The **L301bc** is programmable via the serial port. Two methods can be used to change the camera's settings. The first and easier approach is to change the settings using the Camera Configuration Tool. See Section 4.1 and the configuration tool's on-line help file for instructions on using the configuration tool. You can also change the settings directly from your application using binary commands. 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 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 booklet that was shipped with the 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. To start the Camera Configuration Tool, click **Start**, click **Basler Vision Technologies**, and then click **Camera Config Tool** (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. Refer to the CCT installation booklet that was delivered with your camera for possible causes and solutions.

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 3.8). 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 Features Tab contains all of the parameters related to the Area of Interest feature and the Digital Shift feature.

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

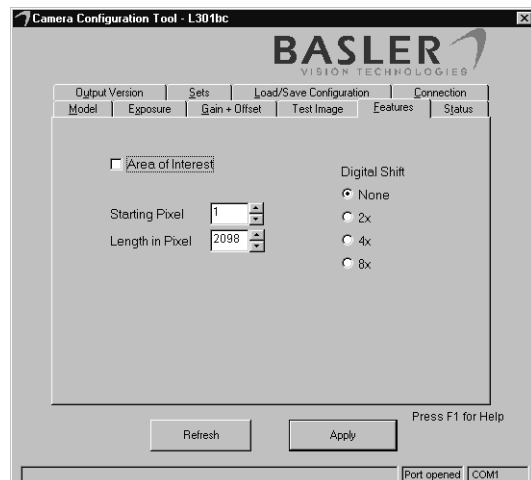


Figure 4-1: Features Tab

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 one of the camera's 15 User Sets. The User Sets are stored in non-volatile memory and will not be lost when the camera is switched off (see Section 3.8).

If you want your changes to be loaded into the Work Set at the next power on, go to the Sets Tab and set the Startup Pointer to the User Set where you saved your changes.

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 Binary Programming Commands

Commands can be issued to the **L301bc** via the RS-232 serial connection using a binary protocol. With this protocol, data is placed into a frame and sent to the camera. Once the data is received it is checked for validity. If valid, the data is extracted and the command is executed.

If the command issued to the camera was a read command, the camera will respond by placing the requested data into a frame and sending it to the host computer.

4.2.1 Command Frame and Response Format

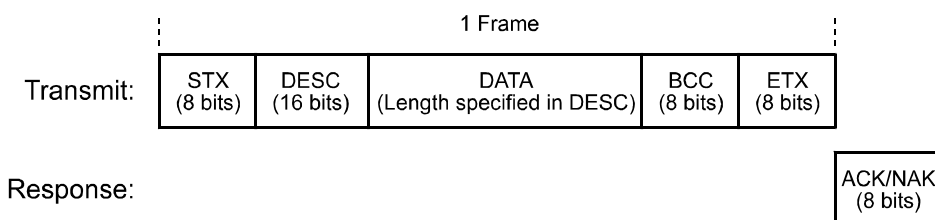


Figure 4-2: Representation of a Command Frame and Response

STX Identifies the start of the frame text
 Size = 1 Byte
 (The value of the STX byte is always 0x02)

DESC Descriptor
 Size = 2 Bytes
 The bits in the descriptor are assigned as follows:

8 bits	1 bit	7 bits
Command ID	Read/Write Flag (0 = write, 1 = read)	Data Length (in Bytes)

The MSB of the descriptor is on the left (highest bit of the command ID) and the LSB of the descriptor is on the right (lowest bit of the data length).

DATA Data field
 Size = Number of bytes indicated in the Data Length portion of the descriptor.

BCC Block check character

Size = 1 Byte

The block check character is the exclusive-or sum (XOR sum) of the bytes in the descriptor field and the data field.

ETX Identifies the end of the frame text

Size = 1 Byte

(The value of the ETX byte is always 0x03)

ACK/NAK Response Positive frame acknowledge/negative frame acknowledge

Size = 1 byte

(The value for a positive frame acknowledgement is 0x06 and for a negative frame acknowledgement is 0x15.)



All values are formatted as little endian (Intel format).

4.2.2 Error Checking

4.2.2.1 ACK/NAK

When the camera receives a frame, it checks the order of the bytes in the frame and checks to see if the XOR sum of the bytes in the descriptor and the data fields matches the block check character. The camera also checks to see if the number of bytes in the data field is equal to the number specified in the descriptor.

If all checks are correct, an ACK is sent to the host. If any check is incorrect, a NAK is sent.

4.2.2.2 Time-outs

Byte Time-out

The camera checks the time between the receipt of each byte in the frame. If the time between any two bytes exceeds 1 second, the camera enters a “garbage state” and discards any more incoming bytes. The camera remains in this state until it sees 1.5 seconds of silence. Once the camera sees 1.5 seconds of silence, it goes into an idle state (looking for an STX).

4.2.2.3 Read Command

In the normal case, when a read command is sent to the camera, the camera responds with an ACK and a frame. The frame will contain the data requested in the read command.

If the camera receives a read command with an unknown command ID in the descriptor, it will respond with an ACK but will not send a frame.

If the host sends a read command and gets no ACK/NAK, the host can assume that no camera is present.

If the host sends a read command and gets an ACK/NAK but does not receive a frame within 500 ms, the host can assume that there was a problem with the read command.

4.2.2.4 Write Command

In the normal case, when a write command is sent to the camera, the camera responds with an ACK.

If the camera receives a write command with an unknown command ID in the descriptor, it will respond with an ACK but will not perform the write.

After a write command has been issued by the host, the host can verify the write by issuing a corresponding read command and checking that the returned data is as expected. The host can also issue a camera status read command (see Section 4.2.9) and check the returned data to see if an error condition has been detected.



For many of the write commands listed in the Tables on pages 5-9 through 5-26, only data within a specified range or a specified group of values is valid. The camera **does not** perform a check to see if the data in the write command is within the allowed range or specified group of allowable values.

4.2.3 Example Commands

4.2.3.1 Read command

An example of the command message used to read the camera status is:

0x02, 0x43, 0x82, 0xC1, 0x03

0x02 - is the STX. The STX is always 0x02.

0x43 - is the first byte of the descriptor. The first byte of the descriptor is the command ID. Command IDs can be found in the tables on pages 5-9 through 5-26. If you check the table on page 5-25, you will find that the ID for the camera status read command is 0x43.

0x82 - is the second byte of the descriptor. The MSB in this byte represents the read/write flag and since this is a read command, the bit should be set to a 1. The other seven bits of this byte represent the data size (in bytes) that will be transferred using this command. If you check the table on page 5-25, the data size for the camera status command is 2 bytes. So the arrangement of the bits in the second byte of the descriptor should be 1000 0010 which translates to 0x82.

Note that for read commands, the data size specified in the descriptor represents the number of bytes of data that you expect to see in the response. No data bytes are actually included in the read command.

0xC1 - is the block check character (BCC). See page 5-8 for instructions on calculating a BCC.

0x03 - is the ETX. The ETX is always 0x03.

4.2.3.2 Write Command

An example of the command message used to copy the Work Set to User Set 2 is:

0x02, 0x46, 0x01, 0x02, 0x45, 0x03

0x02 - is the STX. The STX is always 0x02.

0x46 - is the first byte of the descriptor. If you check the table on page 5-23, you will find that the ID for the command to copy the Work Set to a User Set is 0x46.

0x01 - is the second byte of the descriptor. The MSB in this byte represents the read/write flag and since this is a write command, the bit should be set to a 0. The other seven bits of this byte represent the data size (in bytes) that will be transferred using this command. If you check the table on page 5-23, the data size for the copy Work Set to User Set command is 1 byte. So the arrangement of the bits in the second byte of the descriptor should be 0000 0001 which translates to 0x01.

0x02 - is the data byte. If you check the table on page 5-23, you will find that to copy the Work Set to User Set 2, the data byte must be set to 0x02.

0x45 - is the block check character (BCC). See page 5-8 for instructions on calculating a BCC.

0x03 - is the ETX. The ETX is always 0x03.

4.2.3.3 Calculating the Block Check Character

The block check character in any **L301bc** command is the exclusive-or sum (XOR sum) of the bytes in the descriptor and the data fields. For the write command example shown in Section 4.2.3.2, the block check character is 0x45. Let's consider how this block check character was calculated.

In this case, we must find the XOR sum of three bytes. This is done by finding the XOR sum of the first two bytes and then by taking the result and finding the XOR sum of the result plus the third byte.

Calculating XOR sums is most easily understood when numbers are shown in their binary form, so in the sample calculations shown below, the hexadecimal digits in our command have been converted to binary.

To find the XOR sum of two binary numbers, you must add the two digits in each column using the following rules:

If both digits are 0, the result is 0.

If both digits are 1, the result is 0.

If one of the digits is a 1 and the other is a 0, the result is 1.

With all of this in mind, here is how the BCC for the write command shown in Section 4.2.3.2 would be calculated:

```
0 1 0 0  0 1 1 0 = the binary representation of 0x46
0 0 0 0  0 0 0 1 = the binary representation of 0x01
-----
0 1 0 0  0 1 1 1 = the XOR sum of the first two bytes

0 1 0 0  0 1 1 1 = The XOR sum of the first two bytes
0 0 0 0  0 0 1 0 = the binary representation of 0x02
-----
0 1 0 0  0 1 0 1 = The XOR sum

0 1 0 0  0 1 0 1 = 0x45 = the block check character
```

4.2.4 Commands for Setting Camera Parameters

4.2.4.1 Video Data Output Mode

Purpose:	To set the video data output mode or to read the current video data output mode setting. See Section 2.4.6 for an explanation of the available video data output modes.													
Type:	This is a read or write command.													
Read Command:	Cmd-ID 0xC0	R/W-Flag 1	Data Length 1	Data -										
Response:	Cmd-ID 0xC0	R/W-Flag 0	Data Length 1	Data 1 Byte										
Write Command:	Cmd-ID 0xC0	R/W-Flag 0	Data Length 1	Data 1 Byte										
Response:	None													
Data Format:	Byte 1	An ID that specifies the data output mode (see the table below).												
	<table><tr><th>ID</th><th>Output Mode</th></tr><tr><td>0x00</td><td>60 Mhz Single 10 Bit mode</td></tr><tr><td>0x01</td><td>60 Mhz Single 8 Bit mode</td></tr><tr><td>0x02</td><td>20 MHz 8 Bit RGB mode</td></tr><tr><td>0x03</td><td>40 MHz Dual 8 Bit Mode</td></tr></table>	ID	Output Mode	0x00	60 Mhz Single 10 Bit mode	0x01	60 Mhz Single 8 Bit mode	0x02	20 MHz 8 Bit RGB mode	0x03	40 MHz Dual 8 Bit Mode			
ID	Output Mode													
0x00	60 Mhz Single 10 Bit mode													
0x01	60 Mhz Single 8 Bit mode													
0x02	20 MHz 8 Bit RGB mode													
0x03	40 MHz Dual 8 Bit Mode													

4.2.4.2 Exposure Time Control Mode

Purpose: To set the exposure time control mode or to read the current exposure time control mode setting. See Section 3.2 for an explanation of exposure time control modes.																
Type: This is a read or write command.																
Read Command:	Cmd-ID 0xA0	R/W-Flag 1	Data Length 1	Data -												
Response:	Cmd-ID 0xA0	R/W-Flag 0	Data Length 1	Data 1 Byte												
Write Command:	Cmd-ID 0xA0	R/W-Flag 0	Data Length 1	Data 1 Byte												
Response:	None															
Data Format:	Byte 1	An ID that specifies the exposure mode (see the table below).														
	<table><tr><th>ID</th><th>Exposure Time Control Mode</th></tr><tr><td>0x00</td><td>Free-run, Programmable</td></tr><tr><td>0x02</td><td>Free-run, Edge-controlled</td></tr><tr><td>0x04</td><td>ExSync, Level-controlled</td></tr><tr><td>0x05</td><td>ExSync, Programmable</td></tr><tr><td>0x06</td><td>ExSync, Edge-controlled</td></tr></table>	ID	Exposure Time Control Mode	0x00	Free-run, Programmable	0x02	Free-run, Edge-controlled	0x04	ExSync, Level-controlled	0x05	ExSync, Programmable	0x06	ExSync, Edge-controlled			
ID	Exposure Time Control Mode															
0x00	Free-run, Programmable															
0x02	Free-run, Edge-controlled															
0x04	ExSync, Level-controlled															
0x05	ExSync, Programmable															
0x06	ExSync, Edge-controlled															

4.2.4.3 Timer 1

Purpose:	To set Timer 1 or to read the current Timer 1 setting. Timer 1 is used when the camera is operating in ExSync programmable mode or in free-run mode. See Section 3.2 for details.			
Type:	This is a read or write command.			
Read Command:	Cmd-ID 0xA6	R/W-Flag 1	Data Length 3	Data -
Response:	Cmd-ID 0xA6	R/W-Flag 0	Data Length 3	Data 3 Bytes
Write Command:	Cmd-ID 0xA6	R/W-Flag 0	Data Length 2	Data 3 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of the Timer 1 setting		
	Byte 2	Mid byte of the Timer 1 setting		
	Byte 3	High byte of the Timer 1 setting		
Data Range:	The timer 1 setting can range from 0x000001 to 0xFFFFFFFF μ s.			

4.2.4.4 Timer 2

Purpose: To set Timer 2 or read the current Timer 2 setting. Timer 2 is used when the camera is operating in free-run mode. See Section 3.2 for details.				
Type: This is a read or write command.				
Read Command:	Cmd-ID 0xA7	R/W-Flag 1	Data Length 3	Data -
Response:	Cmd-ID 0xA7	R/W-Flag 0	Data Length 3	Data 3 Bytes
Write Command:	Cmd-ID 0xA7	R/W-Flag 0	Data Length 3	Data 3 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of the Timer 2 setting		
	Byte 2	Mid byte of the Timer 2 setting		
	Byte 3	High byte of the Timer 2 setting		
Data Range:	The timer 2 setting can range from 0x000001 to 0xFFFFF μ s.			

4.2.4.5 Digital Shift

Purpose: To enable or disable digital shift. See Section 3.5 for an explanation of digital shift.														
Type: This is a read or write command.														
Read Command:	Cmd-ID 0xA5	R/W-Flag 1	Data Length 1	Data -										
Response:	Cmd-ID 0xA5	R/W-Flag 0	Data Length 1	Data 1 Byte										
Write Command:	Cmd-ID 0xA5	R/W-Flag 0	Data Length 1	Data 1 Byte										
Response:	None													
Data Format:	Byte 1	An ID that specifies the digital shift status (see the table below).												
<table><tr><th>ID</th><th>Digital Shift</th></tr><tr><td>0x00</td><td>No digital shift</td></tr><tr><td>0x01</td><td>Digital shift once (multiplies output 2X)</td></tr><tr><td>0x02</td><td>Digital shift twice (multiplies output 4X)</td></tr><tr><td>0x03</td><td>Digital shift by three (multiplies output 8X)</td></tr></table>					ID	Digital Shift	0x00	No digital shift	0x01	Digital shift once (multiplies output 2X)	0x02	Digital shift twice (multiplies output 4X)	0x03	Digital shift by three (multiplies output 8X)
ID	Digital Shift													
0x00	No digital shift													
0x01	Digital shift once (multiplies output 2X)													
0x02	Digital shift twice (multiplies output 4X)													
0x03	Digital shift by three (multiplies output 8X)													



See Section 3.5.3 for precautions that you must consider when using digital shift.

4.2.4.6 Area of Interest Starting Pixel

Purpose:	To set the starting pixel for the Area of Interest or to read the current starting pixel setting. See Section 3.6 for details.			
Type:	This is a read or write command.			
Read Command:	Cmd-ID 0xA9	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0xA9	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0xA9	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of the starting pixel setting		
	Byte 2	High byte of the starting pixel setting		
Data Range:	The starting pixel setting can range from 0x0000 to 0x0830. (When using binary commands, the starting pixel = n +1 where n is the setting made using this binary command. For example, if you wish to define pixel 100 as starting pixel, set 99 with the help of this command.)			

4.2.4.7 Area of Interest Length in Pixels

Purpose:	To set the length in pixels for the Area of Interest or to read the current length setting. See Section 3.6 for details.			
Type:	This is a read or write command.			
Read Command:	Cmd-ID 0xAB	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0xAB	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0xAB	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of the length in pixel setting		
	Byte 2	High byte of the length in pixel setting		
Data Range:	The length in pixel setting can range from 0x0001 to 0x0832			

4.2.4.8 Red Channel Gain

Purpose: To set the gain on the red channel or to read the current red channel gain setting.				
Type: This is a read or write command.				
Read Command:	Cmd-ID 0x80	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0x80	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0x80	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of red gain setting		
	Byte 2	High byte of red gain setting		
Data Range:	The red gain setting can range from 0x0000 to 0x013F			

4.2.4.9 Red Channel Offset

Purpose: To set the offset on the red channel or to read the current red channel offset setting.				
Type: This is a read or write command.				
Read Command:	Cmd-ID 0x84	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0x84	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0x84	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of red offset setting		
	Byte 2	High byte of red offset setting		
Data Range:	The red offset setting can range from 0x0000 to 0x03FF			

4.2.4.10 Green Channel Gain

Purpose: To set the gain on the green channel or to read the current green channel gain setting.				
Type: This is a read or write command.				
Read Command:	Cmd-ID 0x81	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0x81	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0x81	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of green gain setting		
	Byte 2	High byte of green gain setting		
Data Range:	The green gain setting can range from 0x0000 to 0x013F			

4.2.4.11 Green Channel Offset

Purpose: To set the offset on the green channel or to read the current green channel offset setting.				
Type: This is a read or write command.				
Read Command:	Cmd-ID 0x85	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0x85	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0x85	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of green offset setting		
	Byte 2	High byte of green offset setting		
Data Range:	The green offset setting can range from 0x0000 to 0x03FF			

4.2.4.12 Blue Channel Gain

Purpose: To set the gain on the blue channel or to read the current blue channel gain setting.				
Type: This is a read or write command.				
Read Command:	Cmd-ID 0x82	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0x82	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0x82	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of blue gain setting		
	Byte 2	High byte of blue gain setting		
Data Range:	The blue gain setting can range from 0x0000 to 0x013F			

4.2.4.13 Blue Channel Offset

Purpose: To set the offset on the blue channel or to read the current blue channel offset setting.				
Type: This is a read or write command.				
Read Command:	Cmd-ID 0x86	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0x86	R/W-Flag 0	Data Length 2	Data 2 Bytes
Write Command:	Cmd-ID 0x86	R/W-Flag 0	Data Length 2	Data 2 Bytes
Response:	None			
Data Format:	Byte 1	Low byte of blue offset setting		
	Byte 2	High byte of blue offset setting		
Data Range:	The blue offset setting can range from 0x0000 to 0x03FF			

4.2.5 Test Image Command

Purpose:	To enable or disable a test image. See Section 3.7 for an explanation of the available test images.															
Type:	This is a read or write command.															
Read Command:	Cmd-ID 0xA1	R/W-Flag 1	Data Length 1	Data -												
Response:	Cmd-ID 0xA1	R/W-Flag 0	Data Length 1	Data 1 Bytes												
Write Command:	Cmd-ID 0xA1	R/W-Flag 0	Data Length 1	Data 1 Byte												
Response:	None															
Data Format:	Byte 1	An ID that specifies the test image (see the table below).														
	<table><thead><tr><th>ID</th><th>Test Image</th></tr></thead><tbody><tr><td>0x00</td><td>No test image</td></tr><tr><td>0x01</td><td>Test Image 1 (gray gradient)</td></tr><tr><td>0x02</td><td>Test image 2 (red gradient)</td></tr><tr><td>0x03</td><td>Test Image 3 (green gradient)</td></tr><tr><td>0x04</td><td>Test Image 4 (blue gradient)</td></tr></tbody></table>	ID	Test Image	0x00	No test image	0x01	Test Image 1 (gray gradient)	0x02	Test image 2 (red gradient)	0x03	Test Image 3 (green gradient)	0x04	Test Image 4 (blue gradient)			
ID	Test Image															
0x00	No test image															
0x01	Test Image 1 (gray gradient)															
0x02	Test image 2 (red gradient)															
0x03	Test Image 3 (green gradient)															
0x04	Test Image 4 (blue gradient)															

4.2.6 Camera Reset Command

Purpose: Initiates a camera reset. The behavior is similar to a power up reset.				
Type: This is a write only command.				
Write Command:	Cmd-ID 0x42	R/W-Flag 0	Data Length 2	Data 0x07, 0xCF
Response:	None			
Data Format:	Byte 1	Low byte	0x07 is always used	
	Byte 2	High byte	0xCF is always used	

4.2.7 Query Commands

4.2.7.1 Read Microcontroller Firmware Version

Purpose: To read the microcontroller firmware version				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x40	R/W-Flag 1	Data Length 3	Data -
Response:	Cmd-ID 0x40	R/W-Flag 0	Data Length 3	Data 3 Bytes
Data Format:	Byte 1	Low byte of firmware version		BCD coded
	Byte 2	High byte of firmware version		BCD coded
	Byte 3	Protocol Version		

4.2.7.2 Read FPGA Firmware Version

Purpose: To read the FPGA firmware version				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x41	R/W-Flag 1	Data Length 3	Data -
Response:	Cmd-ID 0x41	R/W-Flag 0	Data Length 3	Data 3 Bytes
Data Format:	Byte 1	Low byte of firmware version		BCD coded
	Byte 2	High byte of firmware version		BCD coded
	Byte 3	undefined - 0x00 is always used		

4.2.7.3 Read Vendor Information

Purpose: To read the camera vendor's name.				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x01	R/W-Flag 1	Data Length 16	Data -
Response:	Cmd-ID 0x01	R/W-Flag 0	Data Length 16	Data 16 Bytes
Data Format:	Zero terminated string if less than 16 bytes are needed for the vendor information. Unterminated string if all 16 bytes are needed.			

4.2.7.4 Read Model Information

Purpose: To read the camera's model number.				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x02	R/W-Flag 1	Data Length 16	Data -
Response:	Cmd-ID 0x02	R/W-Flag 0	Data Length 16	Data 16 Bytes
Data Format: Zero terminated string if less than 16 bytes are needed for the model information. Unterminated string if all 16 bytes are needed.				

4.2.7.5 Read Product ID

Purpose: To read the camera's product ID number.				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x03	R/W-Flag 1	Data Length 16	Data -
Response:	Cmd-ID 0x03	R/W-Flag 0	Data Length 16	Data 16 Bytes
Data Format: Zero terminated string if less than 16 bytes are needed for the product ID information. Unterminated string if all 16 bytes are needed.				

4.2.7.6 Read Serial Number

Purpose: To read the camera's serial number.				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x04	R/W-Flag 1	Data Length 16	Data -
Response:	Cmd-ID 0x04	R/W-Flag 0	Data Length 16	Data 16 Bytes
Data Format: Zero terminated string if less than 16 bytes are needed for the serial number information. Unterminated string if all 16 bytes are needed.				

4.2.7.7 Read Gain and Offset Default Values

Purpose: To read the gain and offset values that are used as defaults.				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x08	R/W-Flag 1	Data Length 16	Data -
Response:	Cmd-ID 0x08	R/W-Flag 0	Data Length 16	Data 16 Bytes
Data Format:	Byte 1	undefined - 0x00 is always used		
	Byte 2	undefined - 0x00 is always used		
	Byte 3	Low byte of the red gain default value		
	Byte 4	High byte of the red gain default value		
	Byte 5	undefined - 0x00 is always used		
	Byte 6	undefined - 0x00 is always used		
	Byte 7	Low byte of the red offset default value		
	Byte 8	High byte of the red offset default value		
	Byte 9	undefined - 0x00 is always used		
	Byte 10	undefined - 0x00 is always used		
	Byte 11	Low byte of the green gain default value		
	Byte 12	High byte of the green gain default value		
	Byte 13	undefined - 0x00 is always used		
	Byte 14	undefined - 0x00 is always used		
	Byte 15	Low byte of the green offset default value		
	Byte 16	High byte of the green offset default value		
	Byte 17	undefined - 0x00 is always used		
	Byte 18	undefined - 0x00 is always used		
	Byte 19	Low byte of the blue gain default value		
	Byte 20	High byte of the blue gain default value		
	Byte 21	undefined - 0x00 is always used		
	Byte 22	undefined - 0x00 is always used		
	Byte 23	Low byte of the blue offset default value		
	Byte 24	High byte of the blue offset default value		

4.2.8 Commands for Manipulating Configuration Sets

4.2.8.1 Copy the Factory Set or the User Set into the Work Set

Purpose: To copy the Factory Set or one of the 15 User Sets into the Work Set. See Section 3.8 for an explanation of configuration sets. The write command will cause the selected set to be copied into the Work Set and the set will become active immediately. The read command returns the ID of the set that was last copied into the Work Set. (If nothing has been copied to the Work Set since the last power up or reset, the read command will return the ID for “no active set.” This condition indicates that no valid Factory Set or User Sets were found. It will also cause the yellow LED on the back of the camera to show six pulses.)																																								
Type: This is a read or write command.																																								
Read Command:	Cmd-ID 0x45	R/W-Flag 1	Data Length 1	Data -																																				
Response:	Cmd-ID 0x45	R/W-Flag 0	Data Length 1	Data 1 Byte																																				
Write Command:	Cmd-ID 0x45	R/W-Flag 0	Data Length 1	Data 1 Byte																																				
Response:	None																																							
Data Format:	Byte 1	An ID that specifies the set. (see the table below).																																						
	<table><thead><tr><th>Set ID</th><th>Set</th></tr></thead><tbody><tr><td>0x00</td><td>Factory Set</td></tr><tr><td>0x01</td><td>User Set 1</td></tr><tr><td>0x02</td><td>User Set 2</td></tr><tr><td>0x03</td><td>User Set 3</td></tr><tr><td>0x04</td><td>User Set 4</td></tr><tr><td>0x05</td><td>User Set 5</td></tr><tr><td>0x06</td><td>User Set 6</td></tr><tr><td>0x07</td><td>User Set 7</td></tr><tr><td>0x08</td><td>User Set 8</td></tr><tr><td>0x09</td><td>User Set 9</td></tr><tr><td>0x0A</td><td>User Set 10</td></tr><tr><td>0x0B</td><td>User Set 11</td></tr><tr><td>0x0C</td><td>User Set 12</td></tr><tr><td>0x0D</td><td>User Set 13</td></tr><tr><td>0x0E</td><td>User Set 14</td></tr><tr><td>0x0F</td><td>User Set 15</td></tr><tr><td>0xFF</td><td>No active set</td></tr></tbody></table>	Set ID	Set	0x00	Factory Set	0x01	User Set 1	0x02	User Set 2	0x03	User Set 3	0x04	User Set 4	0x05	User Set 5	0x06	User Set 6	0x07	User Set 7	0x08	User Set 8	0x09	User Set 9	0x0A	User Set 10	0x0B	User Set 11	0x0C	User Set 12	0x0D	User Set 13	0x0E	User Set 14	0x0F	User Set 15	0xFF	No active set			
Set ID	Set																																							
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0x0E	User Set 14																																							
0x0F	User Set 15																																							
0xFF	No active set																																							

4.2.8.2 Copy Work Set into User Set

Purpose: To copy the Work Set into one of the 15 User Sets. See Section 3.8 for an explanation of configuration sets.																																				
Type: This is a write only command.																																				
Write Command:	Cmd-ID 0x46	R/W-Flag 0	Data Length 1	Data 1 Byte																																
Response:	None																																			
Data Format:	Byte 1	An ID that specifies the user set. (see the table below).																																		
	<table><tr><th>Set ID</th><th>Set</th></tr><tr><td>0x01</td><td>User Set 1</td></tr><tr><td>0x02</td><td>User Set 2</td></tr><tr><td>0x03</td><td>User Set 3</td></tr><tr><td>0x04</td><td>User Set 4</td></tr><tr><td>0x05</td><td>User Set 5</td></tr><tr><td>0x06</td><td>User Set 6</td></tr><tr><td>0x07</td><td>User Set 7</td></tr><tr><td>0x08</td><td>User Set 8</td></tr><tr><td>0x09</td><td>User Set 9</td></tr><tr><td>0x0A</td><td>User Set 10</td></tr><tr><td>0x0B</td><td>User Set 11</td></tr><tr><td>0x0C</td><td>User Set 12</td></tr><tr><td>0x0D</td><td>User Set 13</td></tr><tr><td>0x0E</td><td>User Set 14</td></tr><tr><td>0x0F</td><td>User Set 15</td></tr></table>	Set ID	Set	0x01	User Set 1	0x02	User Set 2	0x03	User Set 3	0x04	User Set 4	0x05	User Set 5	0x06	User Set 6	0x07	User Set 7	0x08	User Set 8	0x09	User Set 9	0x0A	User Set 10	0x0B	User Set 11	0x0C	User Set 12	0x0D	User Set 13	0x0E	User Set 14	0x0F	User Set 15			
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0x0D	User Set 13																																			
0x0E	User Set 14																																			
0x0F	User Set 15																																			

4.2.8.3 Select the Startup Pointer

Purpose: The Startup Pointer is used to tag the configuration set that will be copied into the Work Set at power on (see Section 3.8). The write command is used to set the Startup Pointer to the Factory Set or to one of the User Sets. The read command returns the Set ID for the current setting.																																						
Type: This is a read or write command.																																						
Read Command:	Cmd-ID 0x47	R/W-Flag 1	Data Length 1	Data -																																		
Response:	Cmd-ID 0x47	R/W-Flag 0	Data Length 1	Data 1 Byte																																		
Write Command:	Cmd-ID 0x47	R/W-Flag 0	Data Length 1	Data 1 Byte																																		
Response:	None																																					
Data Format:	Byte 1	An ID that specifies the set. (see the table below).																																				
<table><tr><th>Set ID</th><th>Set</th></tr><tr><td>0x00</td><td>Factory Set</td></tr><tr><td>0x01</td><td>User Set 1</td></tr><tr><td>0x02</td><td>User Set 2</td></tr><tr><td>0x03</td><td>User Set 3</td></tr><tr><td>0x04</td><td>User Set 4</td></tr><tr><td>0x05</td><td>User Set 5</td></tr><tr><td>0x06</td><td>User Set 6</td></tr><tr><td>0x07</td><td>User Set 7</td></tr><tr><td>0x08</td><td>User Set 8</td></tr><tr><td>0x09</td><td>User Set 9</td></tr><tr><td>0x0A</td><td>User Set 10</td></tr><tr><td>0x0B</td><td>User Set 11</td></tr><tr><td>0x0C</td><td>User Set 12</td></tr><tr><td>0x0D</td><td>User Set 13</td></tr><tr><td>0x0E</td><td>User Set 14</td></tr><tr><td>0x0F</td><td>User Set 15</td></tr></table>					Set ID	Set	0x00	Factory Set	0x01	User Set 1	0x02	User Set 2	0x03	User Set 3	0x04	User Set 4	0x05	User Set 5	0x06	User Set 6	0x07	User Set 7	0x08	User Set 8	0x09	User Set 9	0x0A	User Set 10	0x0B	User Set 11	0x0C	User Set 12	0x0D	User Set 13	0x0E	User Set 14	0x0F	User Set 15
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0x0F	User Set 15																																					

4.2.9 Camera Status Command

Purpose: The camera has been programmed to detect several error conditions. When an error condition is detected, a flag is set. The status command allows you to read the error flags.				
Type: This is a read only command.				
Read Command:	Cmd-ID 0x43	R/W-Flag 1	Data Length 2	Data -
Response:	Cmd-ID 0x43	R/W-Flag 0	Data Length 2	Data 2 Bytes
Data Format:	Byte 1	Each bit specifies an error condition (see table below). If a bit is set to 1, the error condition assigned to that bit is present. If the bit is set to 0, the error is not present.		
	Byte 2	Each bit specifies an error condition (see table below). If a bit is set to 1, the error condition assigned to that bit is present. If the bit is set to 0, the error is not present.		
	Byte 1			
	Bit 0	No ExSync signal in the last 5 seconds		
	Bit 1	A reset has occurred.		
	Bit 2	The camera is unlocked		
	Bit 3	Reserved		
	Bit 4	Unknown command ID specified in a read or write command		
	Bit 5	A read or write command could not be executed; access denied		
	Bit 6	The length member of the last command does not match the defined length		
	Bit 7	Parameter error (currently has no meaning - reserved for future use)		
	Byte 2			
	Bit 0	FPGA; general error		
	Bit 1	FPGA; no FPGA firmware available		
	Bit 2	No FPGA/ADC command list available		
	Bit 3	Error in FPGA/ADC command list item		
	Bit 4	User set is erroneous		
	Bit 5	Factory set is erroneous		
	Bit 6	EEPROM checksum error (this is a checksum used to determine if the contents of the EEPROM are valid)		
	Bit 7	No EEPROM command list available		

4.2.10 Bitrate Command

Purpose:	To set the bitrate of the serial communications link. The bitrate is changed immediately after the successful receipt of this command. (The default bitrate is 9600.)			
Type:	This is a write only command.			
Write Command:	Cmd-ID	R/W-Flag	Data Length	Data
	0x44	0	4	4 Bytes
Response:	None			
Data Format:	Byte 1	An ID that specifies the bitrate (see table below).		
	Byte 2	undefined - always write 0x00		
	Byte 3	undefined - always write 0x00		
	Byte 4	undefined - always write 0x00		
	ID	Bitrate		
	0x12	4800		
	0x13	9600		
	0x14	14400		
	0x15	19200		
	0x17	38400		
	0x19	57600		
	0x1A	76800		
	0x1B	115200		



When changing the bitrate for serial communication, use the following procedure:

1. Issue the write command with the new bitrate.
2. Wait one second.
3. Change the bitrate on the serial port that the camera is connected to.
4. Restart the PC and the camera.
5. Resume communication.

5 Mechanical Considerations

5.1 Camera Dimensions and Mounting Facilities

The **L301bc** camera housing is manufactured with high precision. Planar, parallel, and angular sides guarantee precise mounting with high repeatability.

The **L301bc** camera is equipped with four M4 mounting holes on the front and two M4 mounting holes on each side as indicated in Figure 5-1.

**Caution!**

To avoid collecting dust on the sensor, mount a lens on the camera immediately after unpacking it.

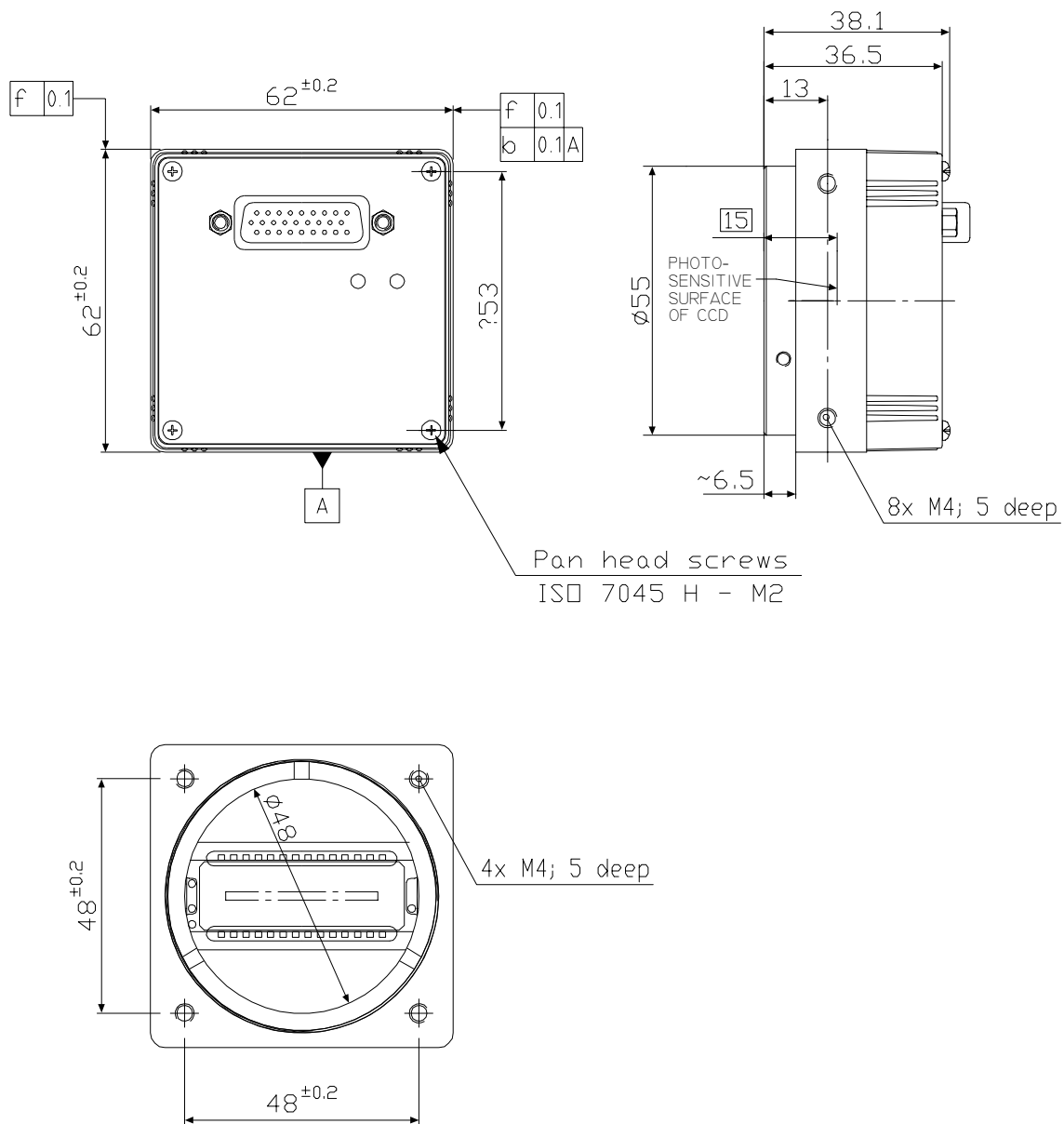


Figure 5-1: L301bc Mechanical Dimensions (in mm)

5.2 F-Mount Adapter Dimensions

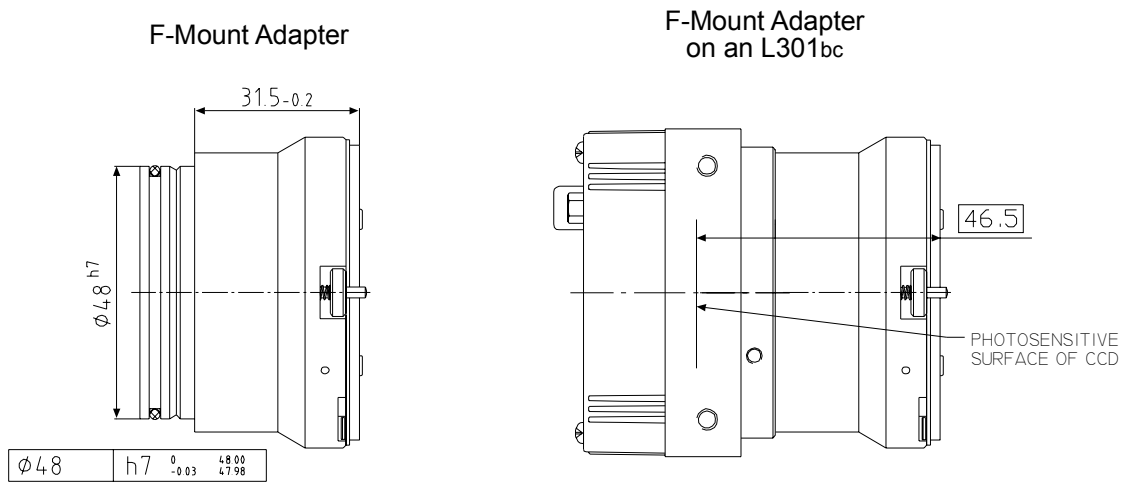


Figure 5-2: F-Mount Adapter Dimensions (in mm)

5.3 Positioning Accuracy of the Sensor Chip

Positioning accuracy of the sensor chip in the horizontal and vertical direction is ± 0.2 mm. Rotational positioning accuracy is as shown in Figure 5-3.

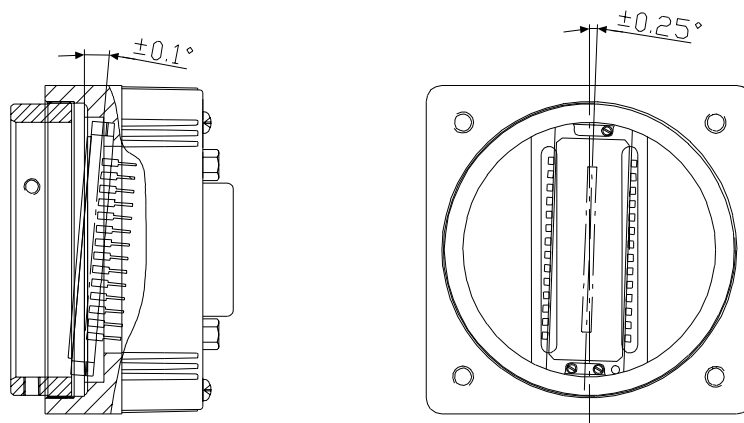


Figure 5-3: Rotational Positioning Accuracy

6 Troubleshooting

6.1 Fault Finding Using Camera LEDs

6.1.1 Yellow LED

The L301bc regularly performs self tests. Detected errors are signaled by blinking of the yellow LED on the back of the camera. The number of pulses indicate the detected error. If several error states are present, the LED outputs the error codes in succession.

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

LED	Description
On Continuous	The camera is OK.
3 pulses	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	The Work Set could not be stored into a User set. Please contact Basler support.
6 pulses	A User Set or the Factory Set could not be loaded into the Work Set. Please contact Basler support.
7 pulses	A valid list of commands was not available. Please contact Basler support.
8 pulses	The FPGA could not be configured. Please contact Basler support

Table 6-1: Camera Status Indicators

6.1.2 Green LED

When the green LED on the back of the camera is not lit, it means that no power is present. When the green LED is lit, it means that power is present.

Keep in mind that the circuit used to light the green LED does not perform a range check. If power is present but it is out of range, the LED may be lit but the camera will not operate properly.

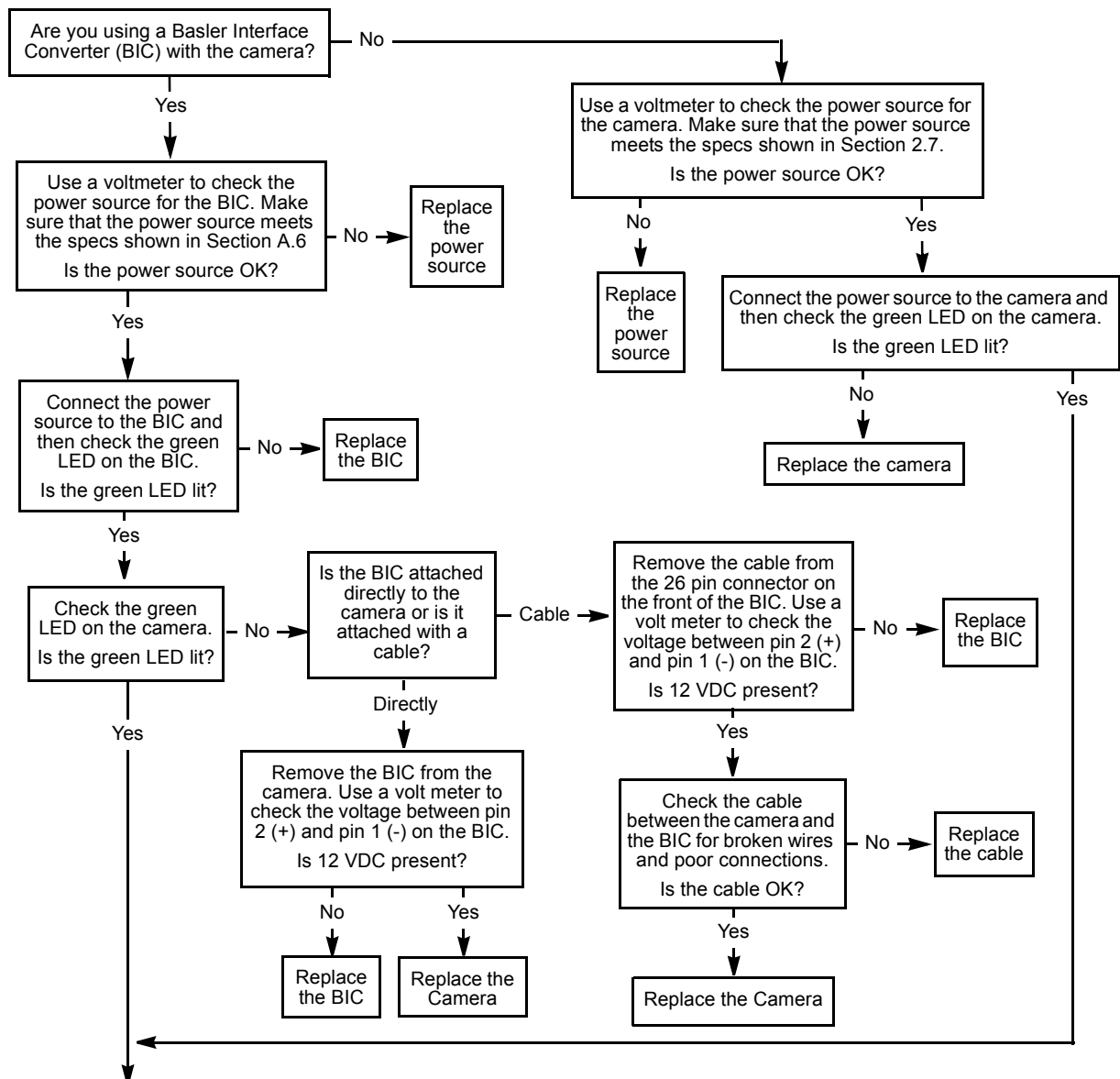
6.2 Troubleshooting Charts

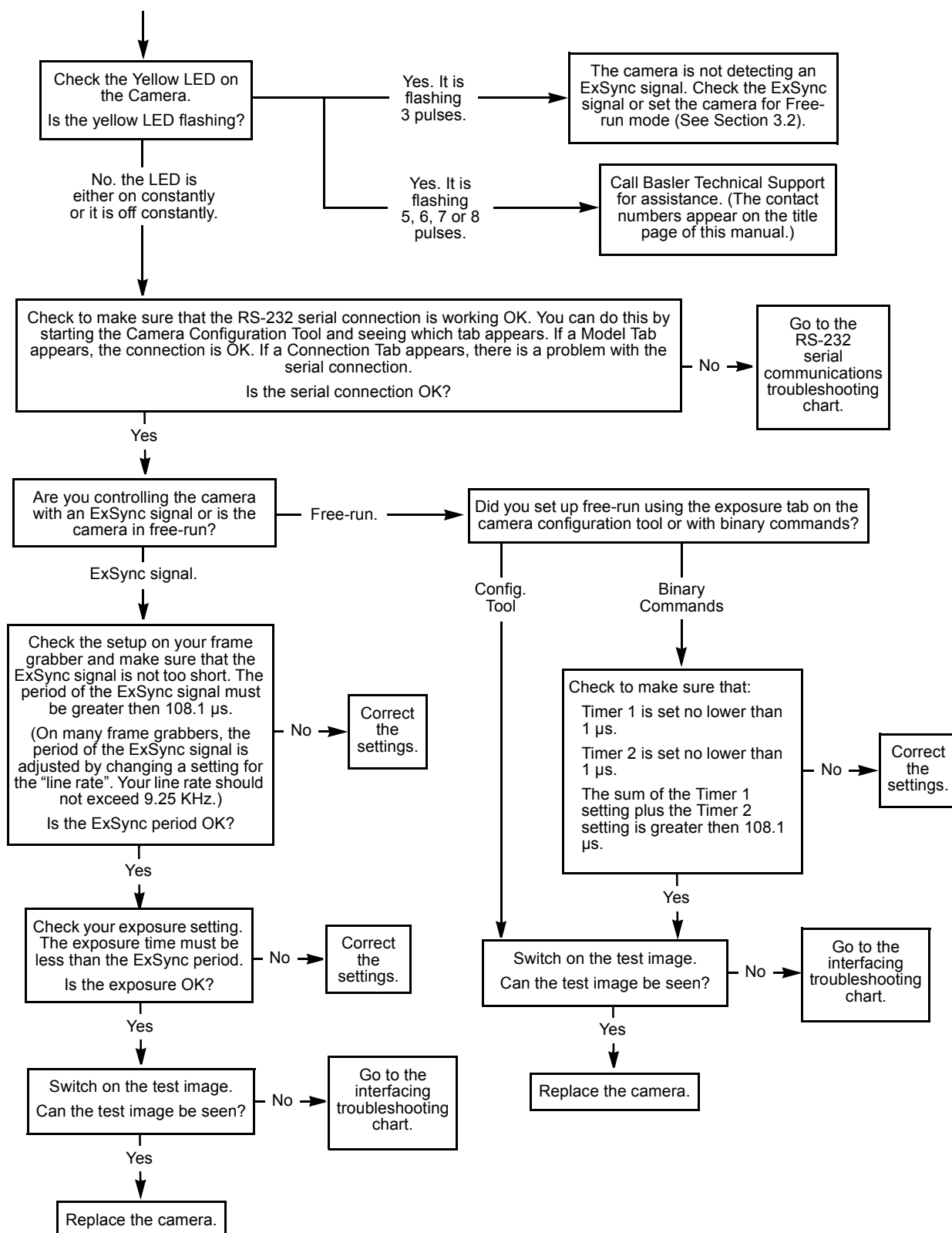
The following pages contain several troubleshooting charts which can help you find the cause of problems that users sometimes encounter. The charts assume that you are familiar with the camera's features and settings and with the settings for your frame grabber. If you are not, we suggest that you review the manuals for your camera and frame grabber before you troubleshoot a problem.

6.2.1 No Image

Use this chart if you see no image at all when you attempt to capture an image with your frame grabber (in this situation, you will usually get a message from the frame grabber such as "time-out"). If you see a poor quality image, a completely black image, or a completely white image, use the chart in Section 6.2.2.

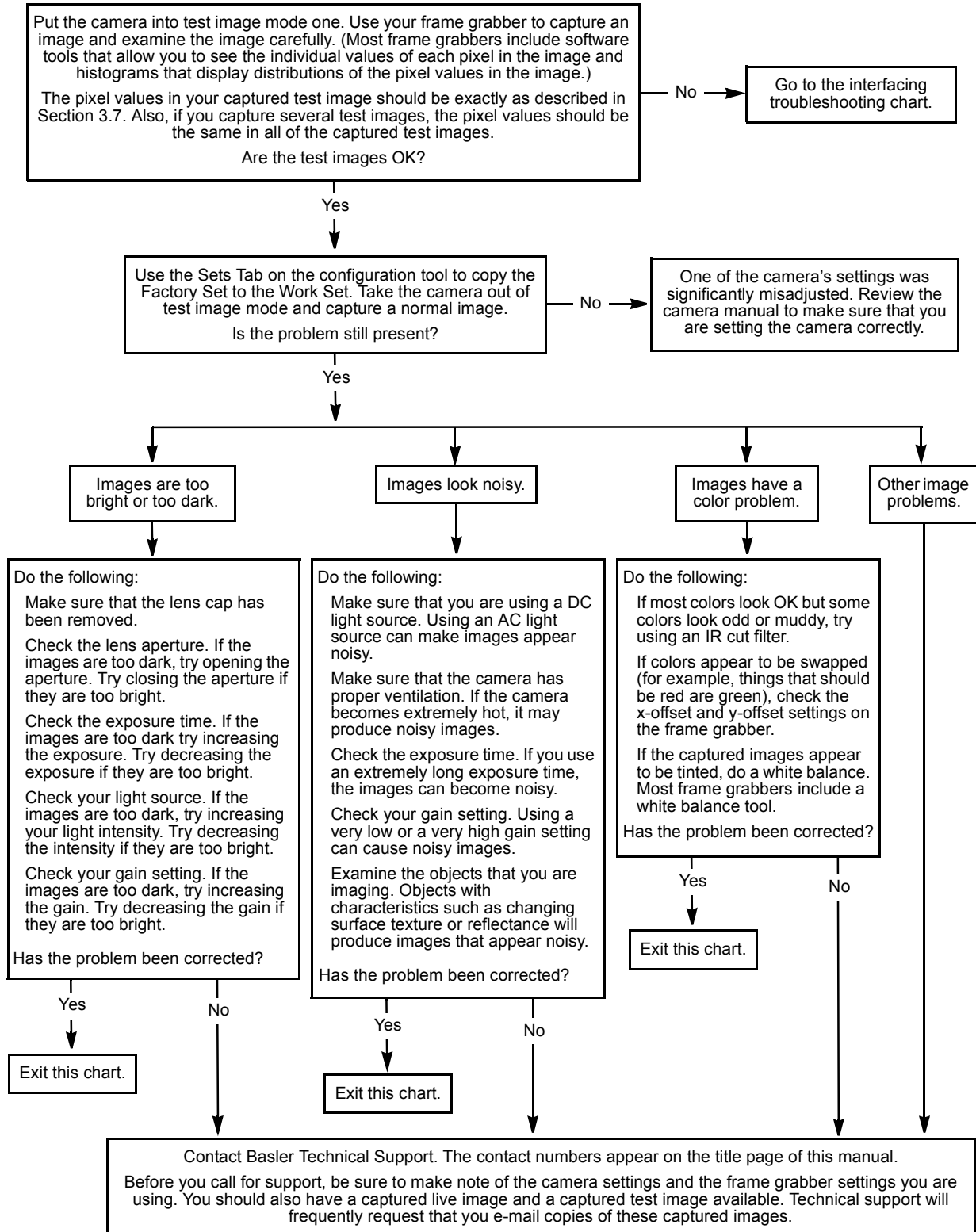
Always switch off power to the system before making or breaking any connection.





6.2.2 Poor Quality Image

Use this chart if the image is poor quality, is completely white, or is completely black. If you get no image at all when you attempt to capture an image with the frame grabber, use the chart that appears in Section 6.2.1.

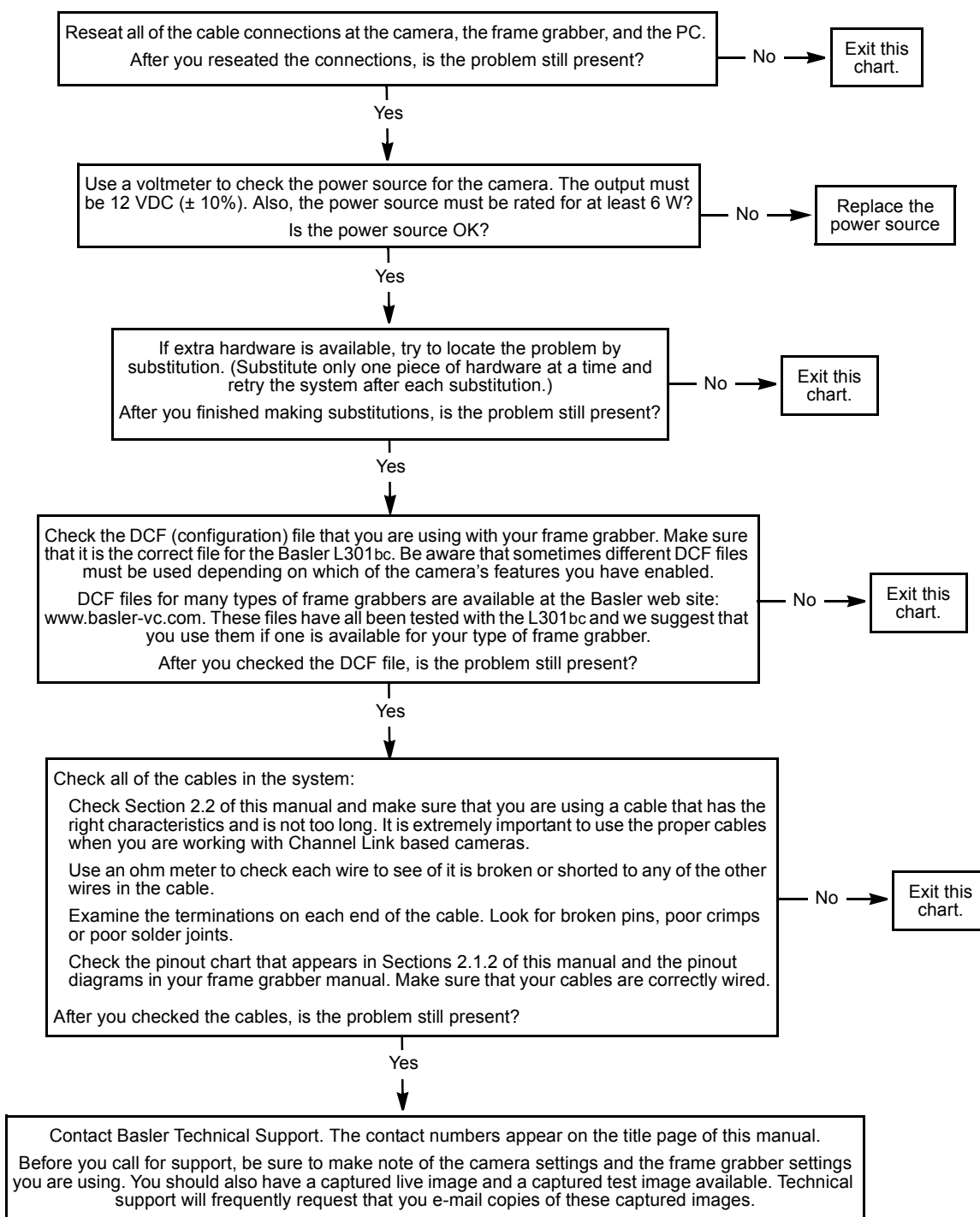


6.2.3 Interfacing

Use the interfacing troubleshooting charts if you think that there is a problem with the cables between your devices or if you have been directed here from another chart. Go to Chart A if you are using the camera without a Basler Interface Converter (BIC) and use Chart B if you are using the camera with a BIC.

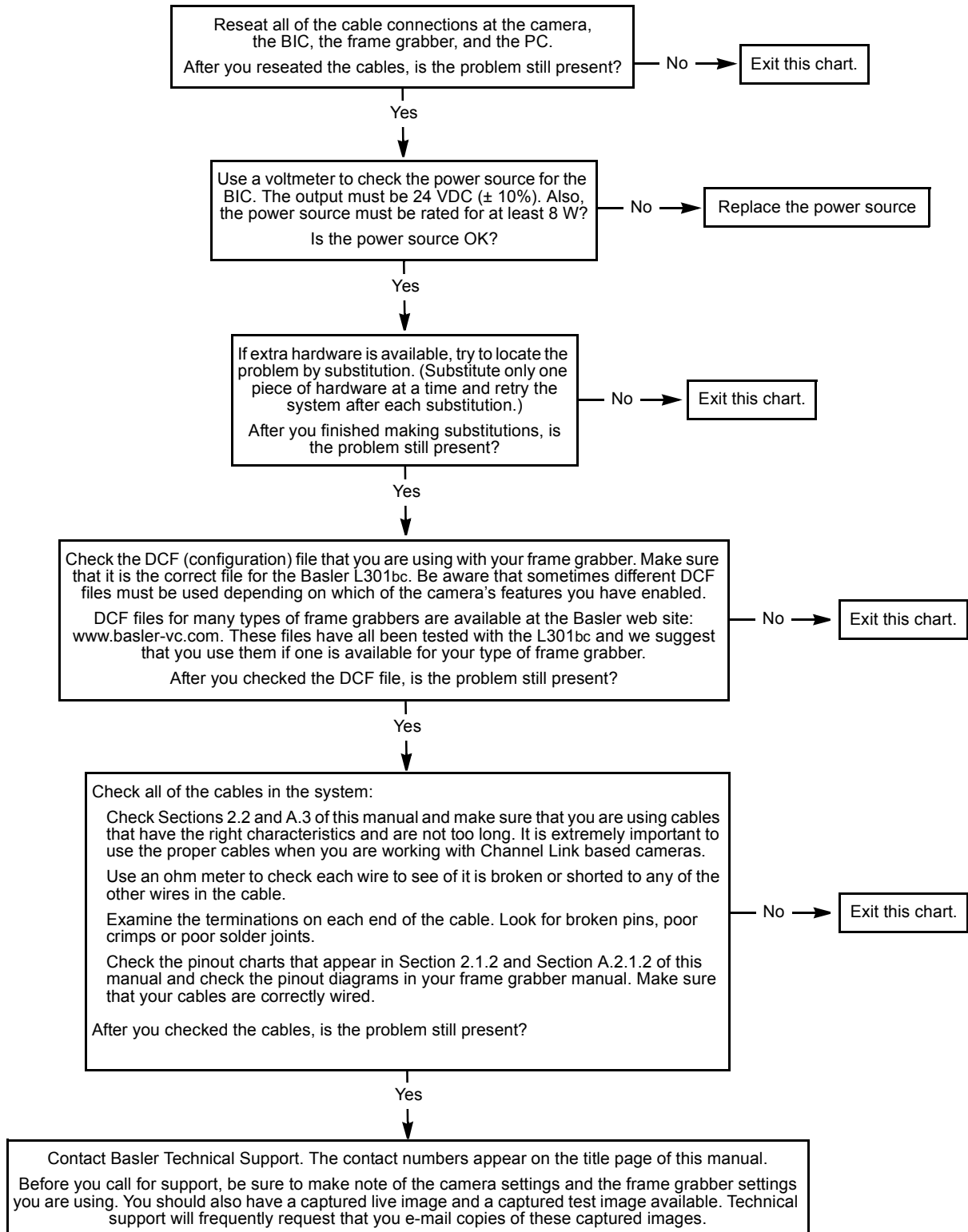
Interfacing Chart A (without a BIC)

Always switch off power to the system before making or breaking any connection.



Interfacing Chart B (with a BIC)

Always switch off power to the system before making or breaking any connection.

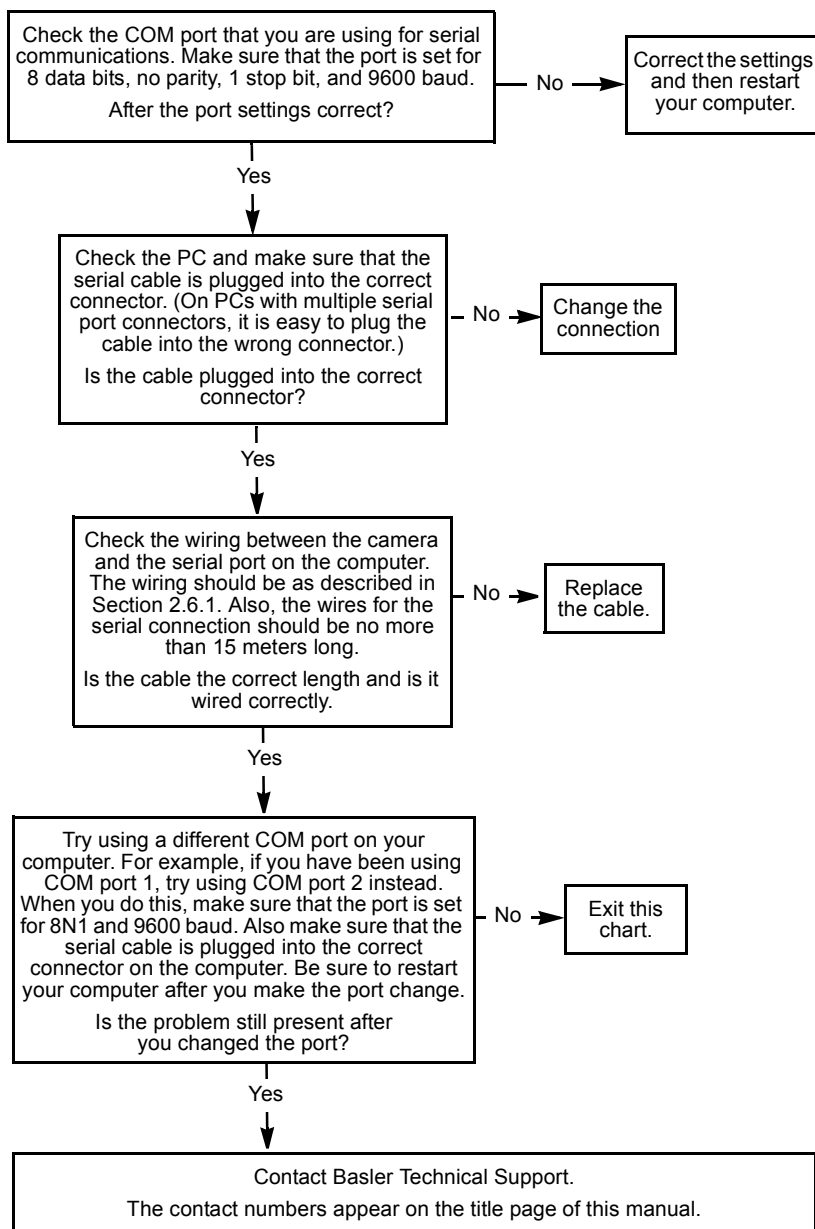


6.2.4 RS-232 Serial Communication

Use the serial communication troubleshooting charts if you think that there is a problem with RS-232 serial communication or if you have been directed here from another chart. Go to Chart A if you are using the camera without a Basler Interface Converter (BIC) and go to Chart B if you are using the camera with a BIC.

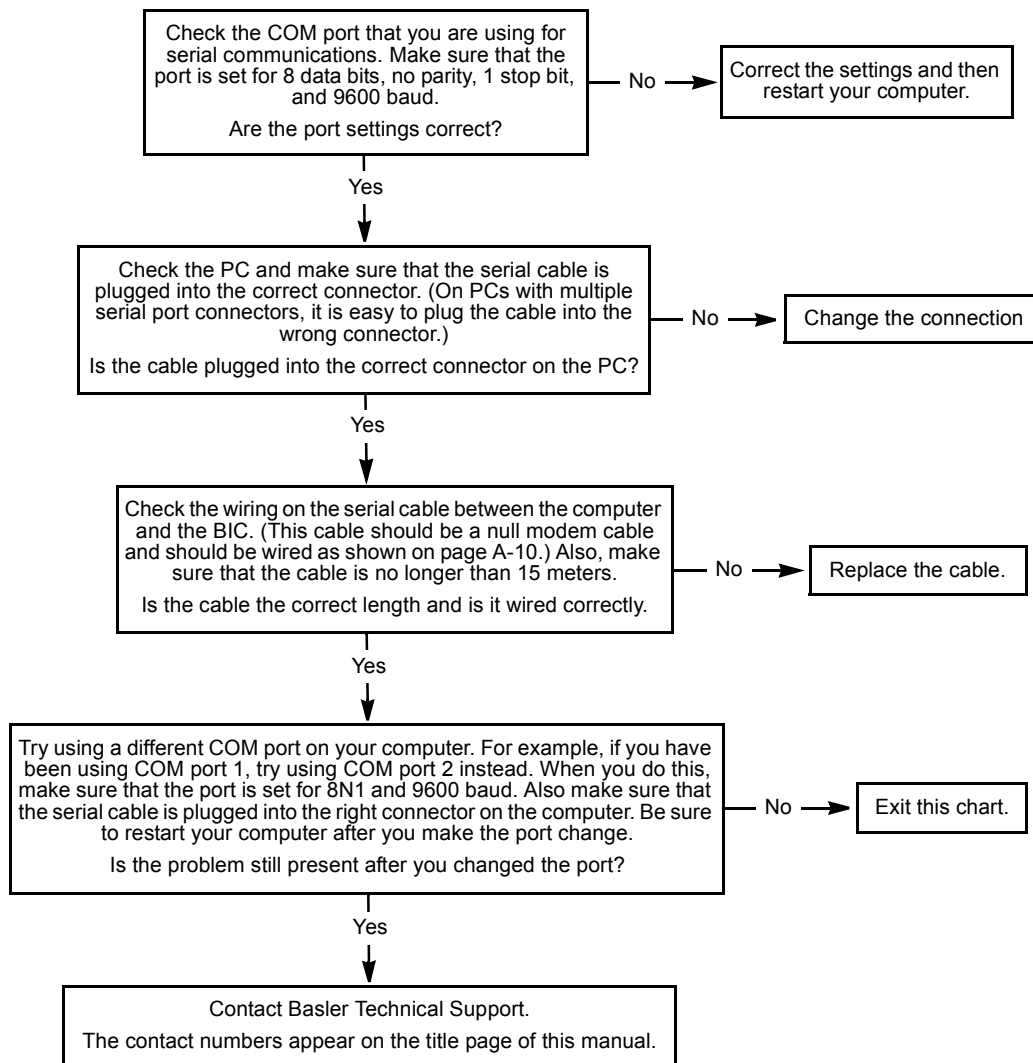
Serial Communication Chart A (without a BIC)

Always switch off power to the system before making or breaking any connection.



Serial Communication Chart B (with a BIC)

Always switch off power to the system before making or breaking any connection.



Appendix A

Using the Camera with a BIC

A.1 Introduction

As mentioned in Section 2.4, video data is output from the **L301bc** in a Channel Link LVDS format. The video output from the camera can be converted to LVDS as specified for RS-644 by using a Basler Interface Converter (BIC). The BIC is a small device that attaches to the **L301bc**.

A.1.1 BIC Functional Description

As shown in the block diagram in Figure A-1, a channel link receiver in the BIC receives the output data from the camera in Channel Link LVDS format. The receiver converts the Channel Link signals to TTL level signals and passes the TTL signals to a group of RS-644 LVDS transmitters. The LVDS transmitters convert the TTL level signals to standard LVDS signals as specified for RS-644 and transmit the signals out of the BIC.

The **L301bc** can accept an ExSync input signal in RS-644 LVDS format. The ExSync signal from the frame grabber is passed through the BIC to the camera using a straight through connection with no active circuitry.

Configuration commands and responses are transmitted between the camera and the host computer via an RS-232 serial connection. RS-232 commands and responses are passed through the BIC using a straight through connection with no active circuitry.

The BIC requires a 24 VDC power input. The **L301bc**, however, requires 12 VDC power. The BIC converts incoming 24 VDC to 12 VDC and supplies 12 VDC to the camera.

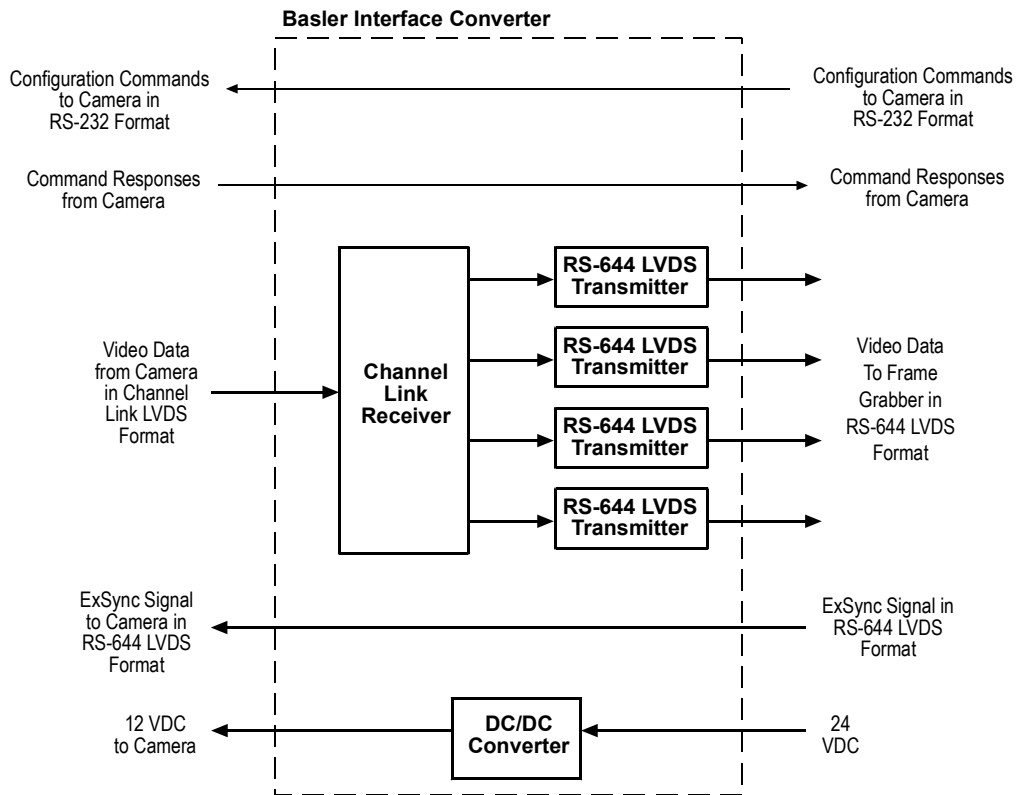


Figure A-1: BIC Block Diagram

A.1.2 BIC Specifications

Category	Specification
Video Input	Channel Link LVDS
Video Output	RS-644 LVDS
Power Requirements	24 VDC ($\pm 10\%$), max. 8 W (when attached to an L301bc)
Pixel Clock Speed	Depends on the output mode of the attached camera (see Sections A.4.2.4 and A.4.2.5)
Size	35.5 x 59.5 x 59.5 mm (L x W x H)
Weight	~ 110 g

Table A-1: BIC Specifications

A.1.3 BIC Environmental Requirements

A.1.3.1 Temperature and Humidity

Housing temperature during operation: 0° C ... + 50° C (+ 32° F ... + 122° F)

Humidity during operation: 20% ... 80%, relative, non-condensing

A.1.3.2 Ventilation

Allow sufficient air circulation around the BIC to prevent internal heat build-up in your system and to keep the BIC housing temperature during operation below 50° C. Provide additional cooling such as fans or heat sinks if necessary.



Warning!

Without sufficient cooling the BIC can get hot enough during operation to cause burning when touched.

A.1.4 BIC Precautions

Power



Caution!

Be sure that all power to your system is switched off before you make or break connections to the camera or the BIC. Making or breaking connections when power is on can result in damage to the camera or the BIC.

Keep foreign matter outside of the BIC

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

Be careful not to spill water or other liquids on the BIC. Do not allow flammable or metallic material inside of the housing. If used with any foreign matter inside, the BIC may fail or cause a fire.

Electromagnetic Fields

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

Transporting

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

Cleaning

To clean the surface of the BIC 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 may damage the surface finish.

A.2 BIC Interface Description

A.2.1 Connections

A.2.1.1 General Description

The BIC is interfaced to external circuitry via one connector on its front and three connectors on its back. Figure A-2 shows the connector types used on the BIC and shows the location of the power indicator LED. Figure A-3 provides a general description of the function of each connector on the BIC. Figure A-4 shows how the pins in the BIC's connectors are numbered.

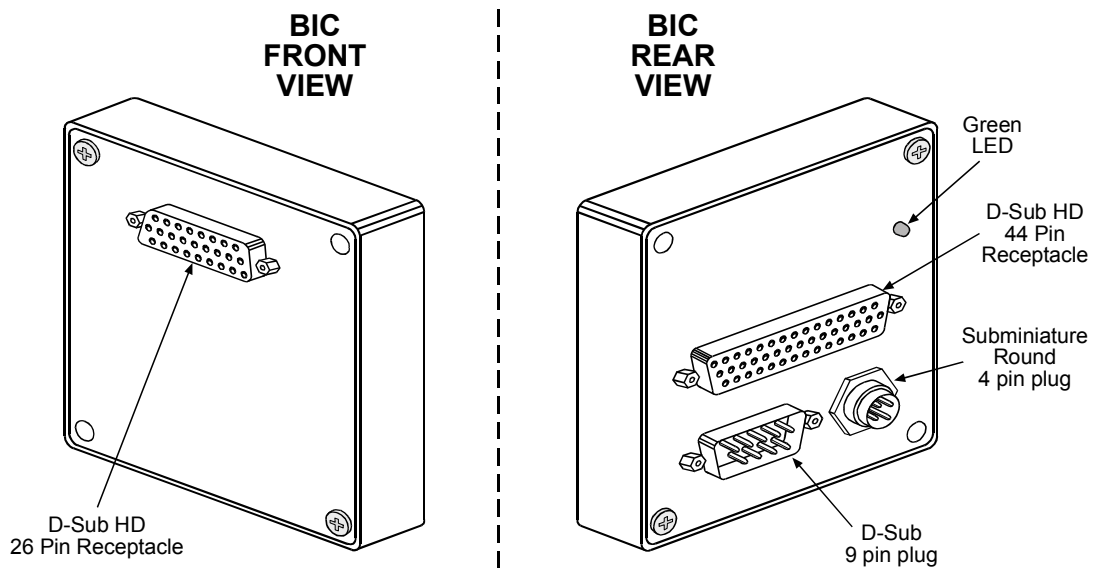


Figure A-2: BIC Connector Types

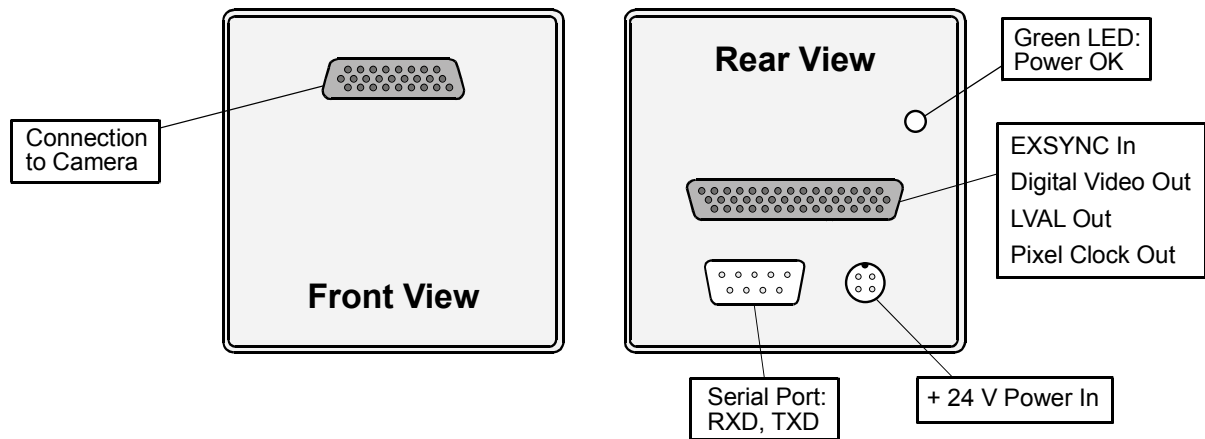


Figure A-3: BIC Connectors and Signals

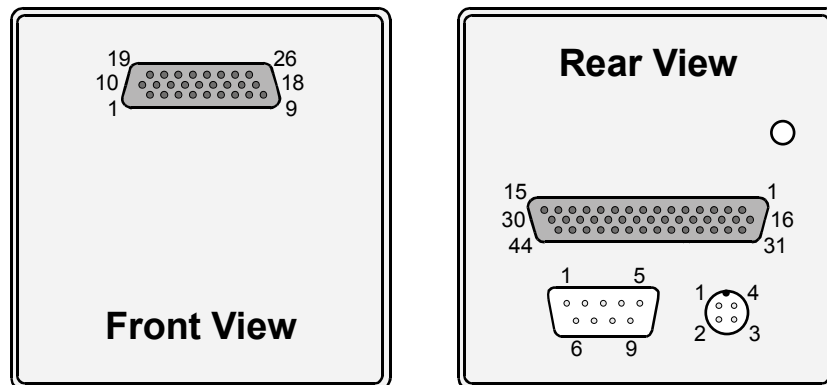


Figure A-4: BIC Pin Numbering

A.2.1.2 Pin Assignments

The D-Sub HD 26-pin receptacle on the front of the BIC is used to interface video data and control signals with the camera. The pin assignments for the receptacle are shown in Table A-2.

Pin Number	Signal Name	Direction	Level	Function
1, 9, 18, 19, 25, 26 ¹	DC Gnd	Output	Ground	DC Ground
2, 20 ²	+12 VDC	Output	12 VDC \pm 10%	DC Power Output to the Camera
22	TxD	Output	RS-232	RS-232 Serial Communication
24	RxD	Input	RS-232	RS-232 Serial Communication
21, 23 ¹	Signal Gnd	Output	Ground	Signal Ground
11	ExSync+	Output	RS-644 LVDS	External Trigger
10	ExSync-			
13	Reserved+	Output	RS-644 LVDS	Reserved LVDS Output
12	Reserved-			
17	RxCiIn+	Input	Channel Link LVDS	Receive Clock to Channel Link Receiver
16	RxCiIn-			
8	RxDatIn3+	Input	Channel Link LVDS	Data to Channel Link Receiver
7	RxDatIn3-			
6	RxDatIn2+	Input	Channel Link LVDS	Data to Channel Link Receiver
5	RxDatIn2-			
15	RxDatIn1+	Input	Channel Link LVDS	Data to Channel Link Receiver
14	RxDatIn1-			
4	RxDatIn0+	Input	Channel Link LVDS	Data to Channel Link Receiver
3	RxDatIn0-			

¹ Pins 1, 9, 18, 19, 25, 26, 21 and 23 are all tied together inside of the BIC.

² Pins 2 and 20 are tied together inside of the BIC.

Table A-2: Pin Assignments for the D-sub HD 26-pin Receptacle



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

The D-Sub 9-pin plug on the rear of the BIC is used for RS-232 communication between the host computer and the camera. The pin assignments for the plug are shown in Table A-3.

Pin Number	Signal Name	Direction	Level	Function
1				Not Connected
2	RxD	Input	RS-232	RS-232 Serial Communication
3	TxD	Output	RS-232	RS-232 Serial Communication
4				Tied to pin 6 internally
5	Signal Gnd	Input	Ground	Signal Ground
6				Tied to pin 4 internally
7				Tied to pin 8 internally
8				Tied to pin 7 internally
9				Not Connected

Table A-3: Pin Assignments for the 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 A-4.

Pin Number	Signal Name	Direction	Level	Function
1	DC Gnd	Input	Ground	DC Ground
2				Tied to pin 1 internally
3	+24 VDC	Input	24 VDC \pm 10%	DC Power input for the BIC
4				Tied to pin 3 internally

Table A-4: Pin Assignments for the Subminiature, Round 4-pin Plug

The D-Sub HD 44-pin receptacle on the front of the BIC is used to interface video data and control signals with the frame grabber. The pin assignments for the receptacle are shown in Table A-5. As shown in the table, the assignment of pixel data varies depending on the output mode setting of the attached camera.

Pin Number	Signal Name	Direction	Level	60 MHz Single 10 Bit Output Mode	60 MHz Single 8 Bit Output Mode	40 MHz Dual 8 Bit Output Mode
1	DOUT 0	Output	RS-644 LVDS	Pixel Bit 0	Pixel Bit 0	Pixel A Bit 0
2	DOUT 1	Output	RS-644 LVDS	Pixel Bit 1	Pixel Bit 1	Pixel A Bit 1
3	DOUT 2	Output	RS-644 LVDS	Pixel Bit 2	Pixel Bit 2	Pixel A Bit 2
4	DOUT 3	Output	RS-644 LVDS	Pixel Bit 3	Pixel Bit 3	Pixel A Bit 3
5	DOUT 4	Output	RS-644 LVDS	Pixel Bit 4	Pixel Bit 4	Pixel A Bit 4
6	DOUT 5	Output	RS-644 LVDS	Pixel Bit 5	Pixel Bit 5	Pixel A Bit 5
7	DOUT 6	Output	RS-644 LVDS	Pixel Bit 6	Pixel Bit 6	Pixel A Bit 6
8	DOUT 7	Output	RS-644 LVDS	Pixel Bit 7	Pixel Bit 7 (MSB)	Pixel A Bit 7 (Pixel A MSB)
9	DOUT 8	Output	RS-644 LVDS	Pixel Bit 8	Not Used	Pixel B Bit 0
10	DOUT 9	Output	RS-644 LVDS	Pixel Bit 9 (MSB)	Not Used	Pixel B Bit 1
11	DOUT 10	Output	RS-644 LVDS	Not used	Not used	Pixel B Bit 2
12	DOUT 11	Output	RS-644 LVDS	Not used	Not used	Pixel B Bit 3
13	DOUT 12	Output	RS-644 LVDS	Not used	Not used	Pixel B Bit 4
14	DOUT 13	Output	RS-644 LVDS	Not used	Not used	Pixel B Bit 5
15	DOUT 14	Output	RS-644 LVDS	Not used	Not used	Pixel B Bit 6
16	/DOUT 0	Output	RS-644 LVDS	/Pixel Bit 0	/Pixel Bit 0	/Pixel A Bit 0
17	/DOUT 1	Output	RS-644 LVDS	/Pixel Bit 1	/Pixel Bit 1	/Pixel A Bit 1
18	/DOUT 2	Output	RS-644 LVDS	/Pixel Bit 2	/Pixel Bit 2	/Pixel A Bit 2
19	/DOUT 3	Output	RS-644 LVDS	/Pixel Bit 3	/Pixel Bit 3	/Pixel A Bit 3
20	/DOUT 4	Output	RS-644 LVDS	/Pixel Bit 4	/Pixel Bit 4	/Pixel A Bit 4
21	/DOUT 5	Output	RS-644 LVDS	/Pixel Bit 5	/Pixel Bit 5	/Pixel A Bit 5
22	/DOUT 6	Output	RS-644 LVDS	/Pixel Bit 6	/Pixel Bit 6	/Pixel A Bit 6
23	/DOUT 7	Output	RS-644 LVDS	/Pixel Bit 7	/Pixel Bit 7	/Pixel A Bit 7
24	/DOUT 8	Output	RS-644 LVDS	/Pixel Bit 8	Not Used	/Pixel B Bit 0
25	/DOUT 9	Output	RS-644 LVDS	/Pixel Bit 9	Not Used	/Pixel B Bit 1
26	/DOUT 10	Output	RS-644 LVDS	Not used	Not used	/Pixel B Bit 2
27	/DOUT 11	Output	RS-644 LVDS	Not used	Not used	/Pixel B Bit 3
28	/DOUT 12	Output	RS-644 LVDS	Not used	Not used	/Pixel B Bit 4
29	/DOUT 13	Output	RS-644 LVDS	Not used	Not used	/Pixel B Bit 5

Table A-5: Pin Assignments for the D-sub HD 26-pin Receptacle

Pin Number	Signal Name	Direction	Level	60 MHz Single 10 Bit Output Mode	60 MHz Single 8 Bit Output Mode	40 MHz Dual 8 Bit Output Mode
30	/DOUT 14	Output	RS-644 LVDS	Not used	Not used	/Pixel B Bit 6
31	DOUT 15	Output	RS-644 LVDS	Not used	Not used	Pixel B Bit 7 (Pixel B MSB)
32	/DOUT 15	Output	RS-644 LVDS	Not used	Not used	/Pixel B Bit 7
33	LVAL	Output	RS-644 LVDS	Line Valid	Line Valid	Line Valid
34	/LVAL	Output	RS-644 LVDS	/Line Valid	/Line Valid	/Line Valid
35	PClk	Output	RS-644 LVDS	Pixel Clock	Pixel Clock	Pixel Clock
36	/PClk	Output	RS-644 LVDS	/Pixel Clock	/Pixel Clock	/Pixel Clock
37	SyncIn	Input	RS-644 LVDS	External Trigger	External Trigger	External Trigger
38	/SyncIn	Input	RS-644 LVDS	/External Trigger	/External Trigger	/External Trigger
39	Not used					
40	Not used					
41	Not Connected					
42	Not Connected					
43	Signal Gnd	Output	Ground	Signal Ground	Signal Ground	Signal Ground
44	Tied to pin 43 internally					

/ means an inverted signal with the low signal being active

Table A-5: Pin Assignments for the D-sub HD 26-pin Receptacle

A.3 Cable Information

A.3.1 Channel Link Cable between the Camera and the BIC

The BIC can be attached directly to a Channel Link based camera or a cable can be used between the camera and the BIC. In cases where a cable is used between the camera and the BIC, the cable must meet the specifications shown in Section 2.2.

A.3.2 Video Data Cable Between the BIC and the Frame Grabber

The video data cable between the BIC and the frame grabber must be made with 28 gauge AWG twisted pair wire and have a characteristic impedance of 100 ohms.

The maximum allowed length of the cable depends on the video data output mode that the camera is using. If the camera attached to the BIC is set for 60 MHz Single 10 bit or 8 bit output, the maximum allowed cable length is 5 meters. If the camera attached to the BIC is set for 40 MHz dual output, the maximum allowed cable length is 11 meters.

A.3.3 RS-232 Cable Details

The RS-232 cable between the nine pin plug on the BIC and the serial port connector on the PC can be a null modem cable or a simple three wire connection as illustrated in Figure A-5.

The maximum allowed length of the RS-232 cable is 15 meters.

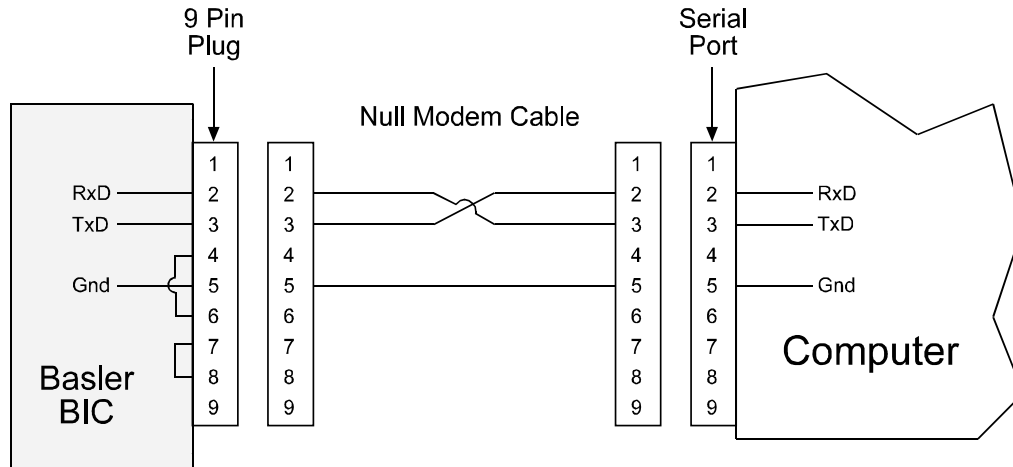


Figure A-5: BIC to PC RS-232 Interface Cable



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

A.4 Video Data and Control Signals Between the BIC and the Frame Grabber

All video data and control signals transmitted between the BIC and the frame grabber use LVDS technology as specified for RS-644. Detailed information on RS-644 appears in Section A.4.3.

A.4.1 Signals Input to the BIC by the Frame Grabber

A.4.1.1 ExSync: Controls Line Readout and Exposure Time

The camera attached to the BIC can be programmed to function in several exposure time control modes. In some of these modes, an ExSync signal is used to control exposure time and line read out. For more detailed information on exposure control modes and the use of the ExSync signal, see Section 3.2.

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

The BIC accepts the ExSync signal from the frame grabber and passes it through to the camera using a straight through connection with no active circuitry.

A.4.2 Signals Output from the BIC to the Frame Grabber

A.4.2.1 LVAL: Indicates a Valid Line

Line valid (LVAL) indicates a valid line of data as illustrated in Figures A-6 through A-9. Video data is valid when LVAL is high.

A.4.2.2 Pixel Clock: Indicates a Valid Pixel

Pixel clock (PClk) indicates a valid pixel of data as illustrated in Figures A-6 through A-9. The LVAL and PClk signals are used to clock the digital video output data into external circuitry. Digital data is valid on the rising edge of pixel clock with LVAL high.

The frequency of the pixel clock output from the BIC varies depending on the output mode setting of the attached camera. See sections A.4.2.4 and A.4.2.5 for more information.

A.4.2.3 Video Data

The assignment of pixel data bits to the output pins on the BIC and the output sequence of the pixel data varies depending on the output mode of the attached camera. Table A-5 shows how the pixel data bits are assigned for each camera output mode. Sections A.4.2.4 and A.4.2.5 describe the data output sequence for each camera output mode.



The **L301bc** attached to the BIC **must** be set for 60 MHz Single 10 Bit mode, 60 MHz Single 8 Bit mode, or 40 MHz Dual 8 Bit mode. The BIC can not accept 20 MHz 8 Bit RGB output from the camera.

A.4.2.4 BIC Operation with the Attached Camera in 60 MHz Single 10 Bit or 60 MHz Single 8 Bit Output Mode

When the camera attached to the BIC is operating in 60 MHz Single 10 Bit output mode, the pixel clock output from the BIC will be 60 MHz. On each clock cycle, the BIC will transmit 10 bits of pixel data. The assignment of the bits is shown in Table A-5.

When the camera attached to the BIC is operating in 60 MHz Single 8 Bit output mode, the pixel clock output from the BIC will be 60 MHz. On each clock cycle, the BIC will transmit 8 bits of pixel data. (The two least significant bits output from each ADC are dropped.)

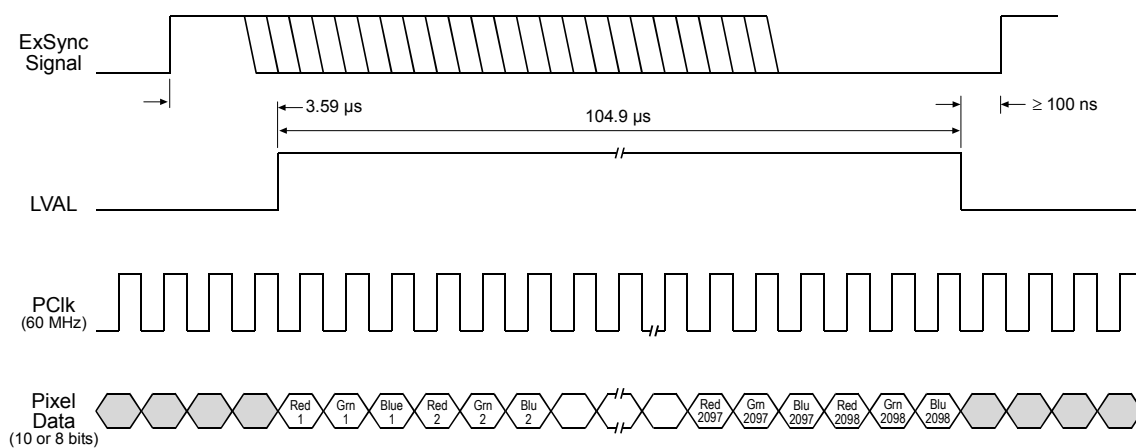
Video Data Sequence¹

When the camera is not transmitting valid data, the line valid signal on each cycle of the pixel clock will be low. Once the camera has completed line acquisition, it will begin to send valid data:

- On the pixel clock cycle where line data transmission begins, LVAL will become high. On this clock cycle, 10 bits of data for pixel number one in the red line will be transmitted from the BIC.
- On the second cycle of the pixel clock, LVAL will be high. On this clock cycle, 10 bits of data for pixel number one in the green line will be transmitted.
- On the third cycle of the pixel clock, LVAL will be high. On this clock cycle, 10 bits of data for pixel number one in the blue line will be transmitted.
- On the fourth cycle of the pixel clock, LVAL will be high. On this clock cycle, 10 bits of data for pixel number two in the red line will be transmitted.
- This pattern will continue for 6294 cycles of the pixel clock. (The camera must transmit data for 2098 pixels in each line and there are three lines; $3 \times 2098 = 6294$.)
- After all 6294 pixels have been transmitted, LVAL will become low indicating that valid line data is no longer being transmitted.

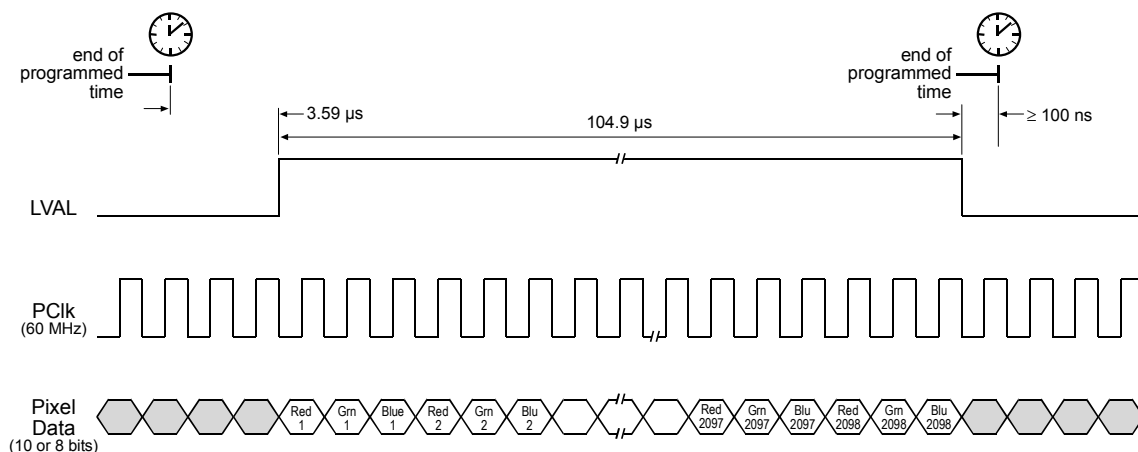
Figure A-6 shows the data sequence when the camera is operating in edge-controlled or level controlled exposure mode and Figure A-7 shows the data sequence when the camera is operating in programmable exposure mode.

¹ The data sequence assumes that the camera attached to the BIC is operating in 10 bit mode. If the attached camera is operating in 8 bit mode, only 8 bits of data per pixel will be transmitted.



This diagram assumes that the area of interest feature is not being used. With the area of interest feature enabled, the number of pixels transferred could be smaller.

Figure A-6: 60 MHz Single 10 Bit or Single 8 Bit Mode with Edge or Level Controlled Exposure



This diagram assumes that the area of interest feature is not being used. With the area of interest feature enabled, the number of pixels transferred could be smaller.

Figure A-7: 60 MHz Single 10 Bit or Single 8 Bit Mode with Programmable Exposure

A.4.2.5 BIC Operation with the Attached Camera in 40 MHz Dual 8 Bit Output Mode

When the camera attached to the BIC is operating in 40 MHz Dual 8 Bit output mode, the pixel clock output from the BIC will be 40 MHz. On each clock cycle, the BIC will transmit 8 bits of data for two pixels. The assignment of the bits is shown in Table A-5.

Video Data Sequence

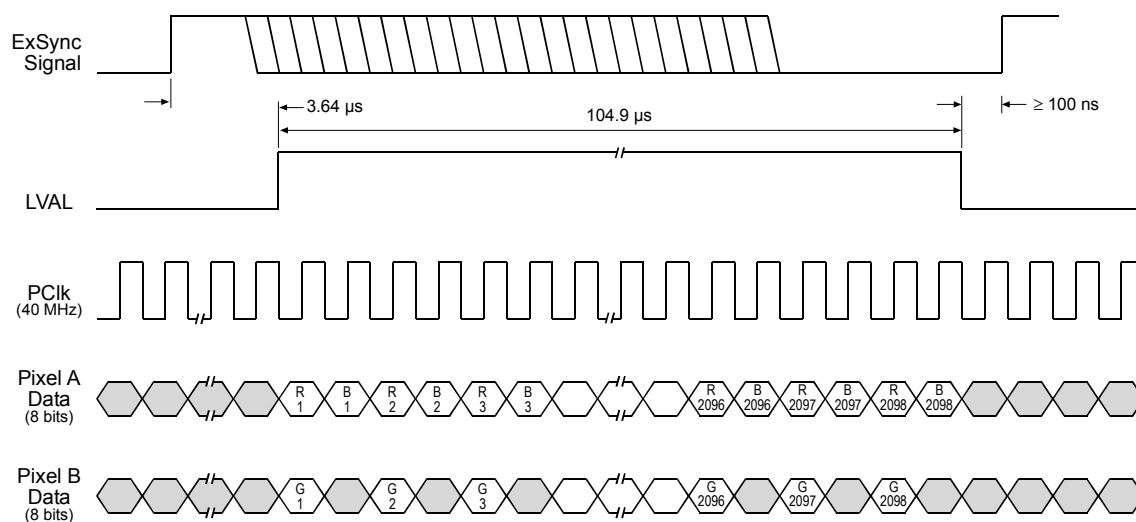
When the camera is not transmitting valid pixel data, the line valid signal on each cycle of the pixel clock will be low. Once the camera has completed line acquisition, it will begin to send valid data:

- On the pixel clock cycle where valid line data transmission begins, LVAL will become high. The eight "Pixel A" bits transmitted from the BIC during this clock cycle will contain the data for pixel number one in the red line and the eight "Pixel B" bits will contain the data for pixel number one in the green line.
- On the second cycle of the pixel clock, LVAL will be high. The eight "Pixel A" bits transmitted during this clock cycle will contain the data for pixel number one in the blue line and the eight "Pixel B" bits will contain dummy data that should be ignored.
- On the third cycle of the pixel clock, LVAL will be high. The eight "Pixel A" bits transmitted on this cycle will contain the data for pixel number two in the red line and the eight "Pixel B" bits will contain the data for pixel number two in the green line.
- On the fourth cycle of the pixel clock, LVAL will be high. The eight "Pixel A" bits transmitted during this clock cycle will contain the data for pixel number two in the blue line and the eight "Pixel B" bits will contain dummy data that should be ignored.

This pattern will continue for 4196 cycles of the pixel clock as the data for the 2098 pixels in the lines is transmitted.

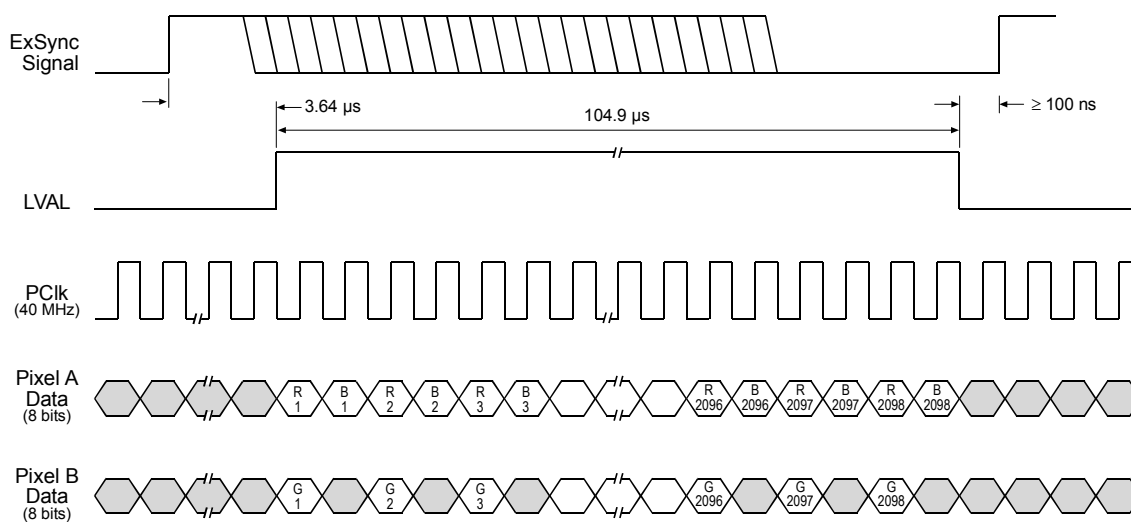
- After the data for all 2098 pixels has been transmitted, LVAL will become low indicating that valid line data is no longer being transmitted.

Figure A-8 shows the data sequence when the camera is operating in edge-controlled or level controlled exposure mode and Figure A-9 shows the data sequence when the camera is operating in programmable exposure mode.



This diagram assumes that the area of interest feature is not being used. With the area of interest feature enabled, the number of pixels transferred could be smaller.

Figure A-8: 40 MHz Dual 8 Bit Mode with Edge or Level Controlled Exposure



This diagram assumes that the area of interest feature is not being used. With the area of interest feature enabled, the number of pixels transferred could be smaller.

Figure A-9: 40 MHz Dual 8 Bit Mode with Programmable Exposure

A.4.3 RS-644 LVDS Information

All video data and control signals output from the BIC and the ExSync control signal input to the BIC use LVDS technology as specified for RS-644.

As shown in Figure A-10, the BIC uses National Semiconductor DS90LV047A differential line drivers to generate the LVDS output signals DOut0 through DOut15, FValOut, LValOut, and PClkOut.

The ExSync control signal input to the BIC passes straight through the BIC and into the camera. The camera uses a National Semiconductor DS90LV048A differential line receiver to receive the ExSync input signal.

Detailed spec sheets for these devices are available at the National Semiconductor web site (www.national.com).

A.4.3.1 RS-644/RS-422 Compatibility

Outputs From the BIC

The output voltage level for the RS-644 differential line drivers used in the BIC can range from a low of 0.90 V to a high of 1.6 V. The typical voltage swing for these devices is ± 0.31 V.

The receive threshold for typical RS-422 receivers is well within the ± 0.31 V swing generated by the RS-644 line drivers. Also, the input voltage tolerance for typical RS-422 receivers is well above the output voltage generated by the RS-644 devices. For these reasons, typical RS-422 receivers are compatible with the RS-644 signals output from the BIC.

Inputs To the BIC

As shown in Figure A-10, the ExSync signal input to the BIC passes directly through the BIC and on to the camera. The input voltage tolerance for the RS-644 receiver used in the camera is 0.0 V to 3.9 V.

On typical RS-422 transmitters, the output voltage can range as high as 4.0 V. As you see, the output voltage of a typical RS-422 transmitter can exceed the input voltage tolerance of the RS-644 receiver used in the camera. Therefore, RS-422 signals should not be input directly into the BIC.

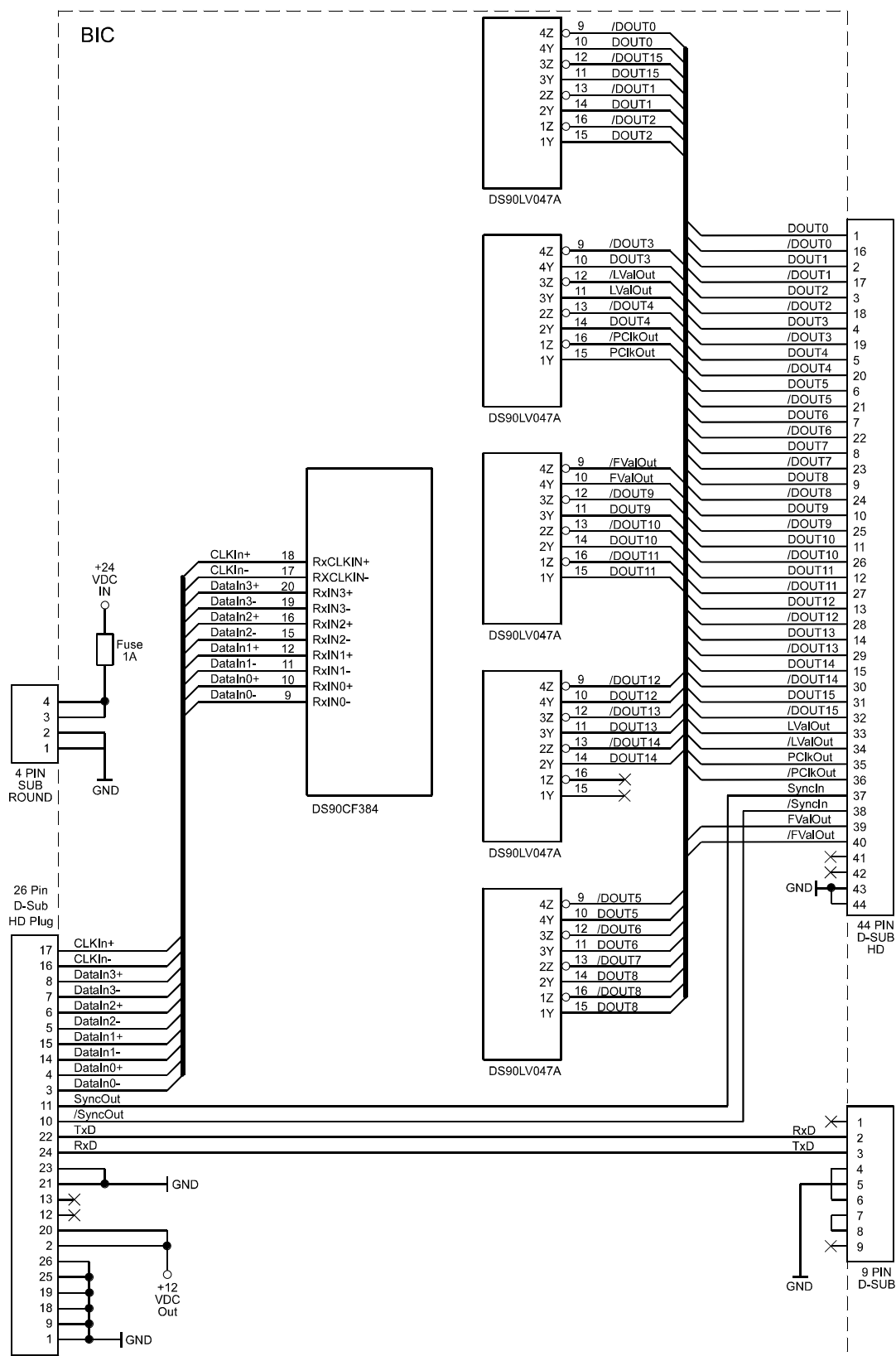


Figure A-10: BIC Power, RS-232, and Video Data Connections

A.5 RS-232 Serial Connection

As mentioned in Section A.1.1, configuration commands and responses are transmitted between the camera and the host computer via an RS-232 serial connection. RS-232 commands and responses are passed through the BIC using a straight through connection with no active circuitry.

A.6 Power Supply

The BIC requires a 24 VDC ($\pm 10\%$) power supply. The maximum wattage required for a BIC attached to an **L301bc** is approximately 8 W.



The BIC operates on 24 VDC, but the **L301bc** operates on 12 VDC. The BIC will convert its 24 VDC input to 12 VDC and will supply 12 VDC to the camera.

DO NOT apply 24 VDC to the camera.

A.7 Status LED

Green LED

When the green LED on the BIC is lit, it indicates that power is being supplied to the BIC.

A.8 Installing the Camera and the BIC

The camera and BIC can be installed in two ways: the BIC can be attached directly to the camera or the BIC can be attached to the camera with a cable. If you are installing a system with the BIC directly attached to the camera, start your installation with Section A.8.1. If you are installing a system with the BIC and camera connected with a cable, start your installation with Section A.8.2.

A.8.1 Making Connections (BIC Directly Attached to Camera)



Caution!

Be sure that all power to your system is switched off before you make or break connections to the camera or the BIC. Making or breaking connections when power is on can result in damage to the camera or the BIC.

1. Remove the six-sided standoffs on each side of the 26-pin plug on the back of the camera and on each side of the 26-pin receptacle on the front of the BIC (see Figure A-11). Replace the standoffs with pan head screws from the BIC installation kit.
2. Remove two screws from the back of the camera as shown in Figure A-11. Replace the screws with six-sided standoffs from the BIC installation kit

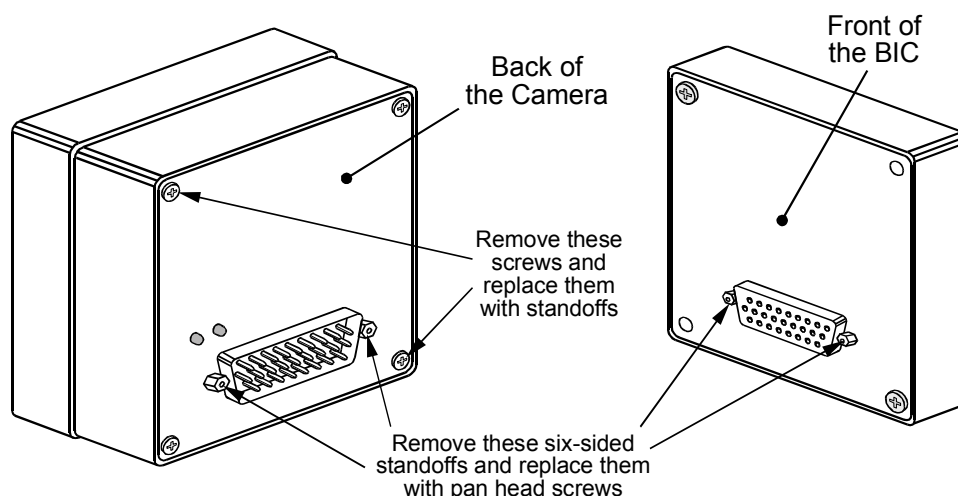


Figure A-11: Changing the Screws

3. Hold the camera and the BIC so that the 26 pin plug on the back of the camera is aligned with the 26 pin receptacle on the front of the BIC.
4. Press the camera and the BIC together.
5. Get two 20 mm long screws from the BIC installation kit. Insert the screws through the BIC (see Figure A-12) and screw them into the back of the camera. This will lock the BIC and the camera together.

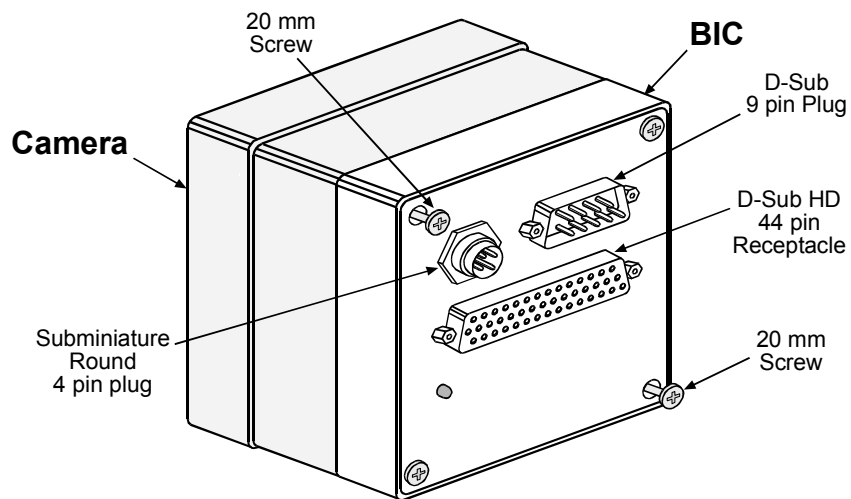


Figure A-12: BIC Mated Directly to Camera

6. Attach one end of your video data/control signal cable to the 44 pin receptacle on the BIC and the other end to your frame grabber.
7. Attach one end of a null modem cable to the nine pin plug on the BIC and the other end to a serial port on your computer.
8. Make sure that the power source you will be using to supply the BIC meets the requirements shown in Section A.6.
9. Attach the output connector from your power source to the four pin plug on the BIC.
10. Switch on the power to your system.
11. Go on to Section A.8.3 to continue the installation.



The BIC operates on 24 VDC, but the **L301bc** operates on 12 VDC. The BIC will convert its 24 VDC input to 12 VDC and will supply 12 VDC to the camera.

A.8.2 Making Connections (BIC and Camera Mated with a Cable)



Caution!

Be sure that all power to your system is switched off before you make or break connections to the camera or the BIC. Making or breaking connections when power is on can result in damage to the camera or the BIC.

1. Connect a straight-through Channel Link Cable from the 26 pin plug on the back of the camera to the 26 pin receptacle on the front of the BIC (see Figure A-13).

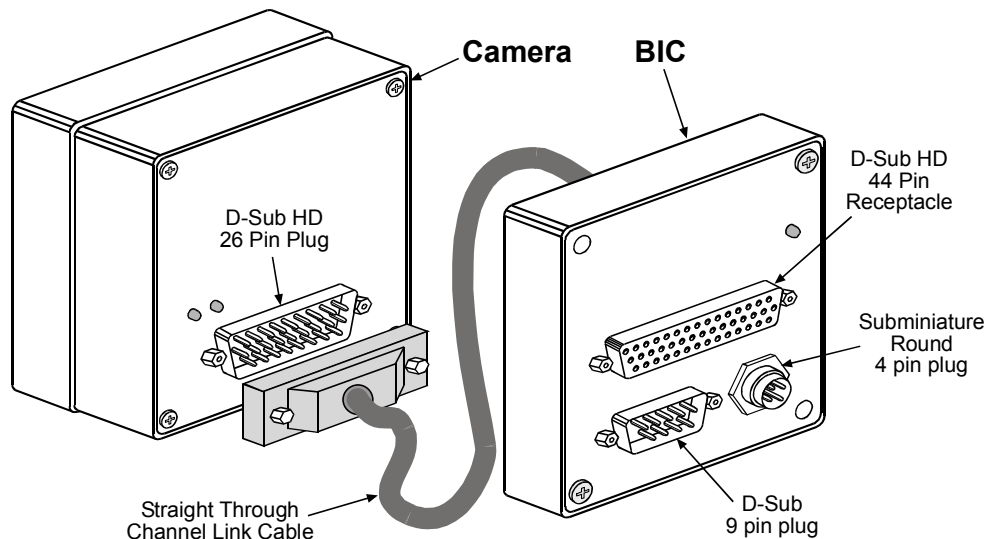


Figure A-13: Attaching a Cable to the Camera and the BIC

2. Attach one end of your video data/control signal cable to the 44 pin receptacle on the back of the BIC and the other end to your frame grabber.
3. Attach one end of a null modem cable to the nine pin plug on the back of the BIC and the other end to a serial port on your computer.
4. Make sure that the power source you will be using to supply the BIC meets the requirements shown in Section A.6.
5. Attach the output connector from your power source to the four pin plug on the BIC.
6. Switch on the power to your system.
7. Go on to Section A.8.3 to continue the installation.



The BIC operates on 24 VDC, but the **L301bc** operates on 12 VDC. The BIC will convert its 24 VDC input to 12 VDC and will supply 12 VDC to the camera.

A.8.3 Setting Up the Serial Port

The RS-232 serial connection between your computer and the camera is used to issue commands to the camera for changing camera modes and parameters. In order for your camera to receive commands, it must be connected to a serial port and the serial port must be set up correctly.

Make sure that the serial port your camera is connected to has the following settings:

- 8 data bits
- no parity
- 1 stop bit
- baud rate = 9600 bps

You must use the computer's "control panel" to set up the serial port. If you are not familiar with setting up a serial port on your computer, refer to the manual or help files for your computer's operating system.

Once you have set up the serial port, go on to Section A.8.4.

A.8.4 Installing 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 with the camera via the serial connection.

For instructions on installing the tool, see the CCT installation booklet that was shipped with the camera.

A.8.5 Next Steps

- Look at each of the Tabs in the Camera Configuration Tool and look through the on-line help included with the tool. This is a good way to familiarize yourself with the camera's features and settings.
- Read the manual for your Basler camera. You will get the most from your camera if you understand how the camera's features work and what happens when you change camera settings.
- Read the supporting material included with your frame grabber and make sure that the frame grabber is properly configured to work with your Basler camera. **In order to capture images, your frame grabber must be properly configured to work with your Basler camera.**



In addition to configuring the camera and the frame grabber, you must also set up other system components such as light sources, optics and the host computer. Only a complete, careful setup will guarantee optimum performance.

A.9 BIC Dimensions

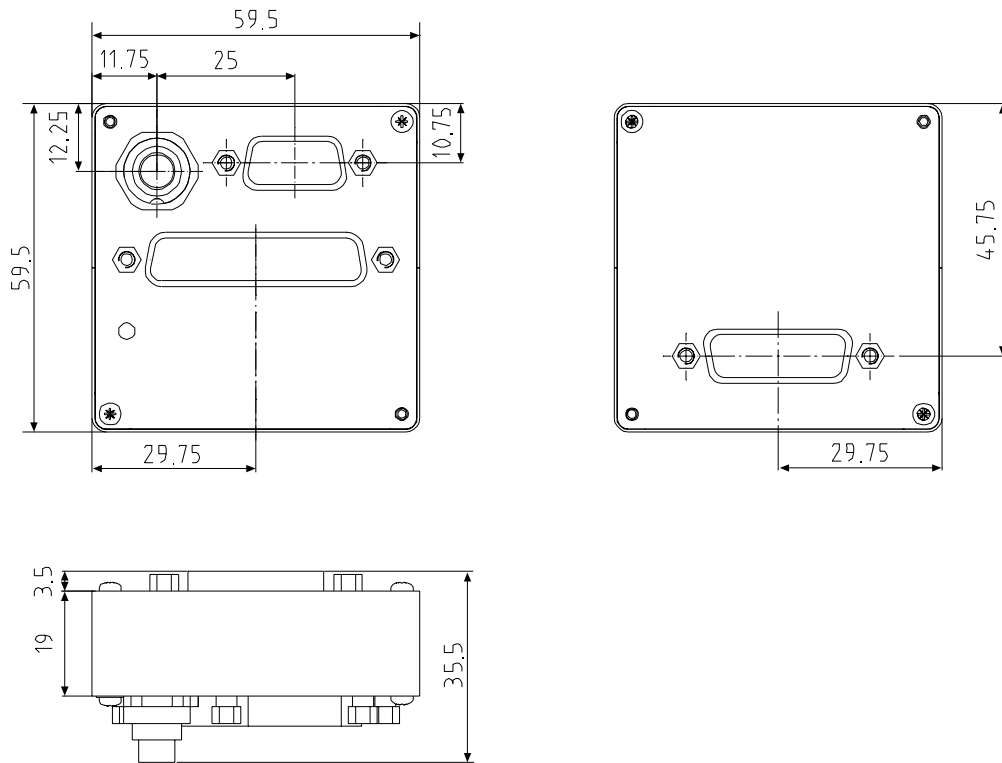


Figure A-14: BIC Dimensions (in mm)

Revision History

Doc. ID Number	Date	Changes
DA 033501	Dec. 21, 2000	Initial release.
DA 033502	July 13, 2001	<p>Made numerous small changes to grammar and phrasing.</p> <p>Removed the "Camera Installation" section. Camera installation is described in the camera's Installation Guide only.</p> <p>Removed information on camera configuration tool installation. Installation is described in the tool's Installation Guide only.</p> <p>Added ripple specification to Table 1-1 and Sections 2.7, A.1.2 and A.6.</p> <p>Added note on reverse power and overvoltage protection to Sections 2.1.2 and 2.7.</p> <p>Added maximum cable length specification to Section 2.2.</p> <p>Added information on absolute maximum voltage to Section 2.7.</p> <p>Added a more detailed specification of the green LED to Section 2.8 and Section 6.1.2.</p>

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