Zebra Radient eV-CL™

Installation and Hardware Reference

Y11200-101-0700

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Chapter 1

Introduction

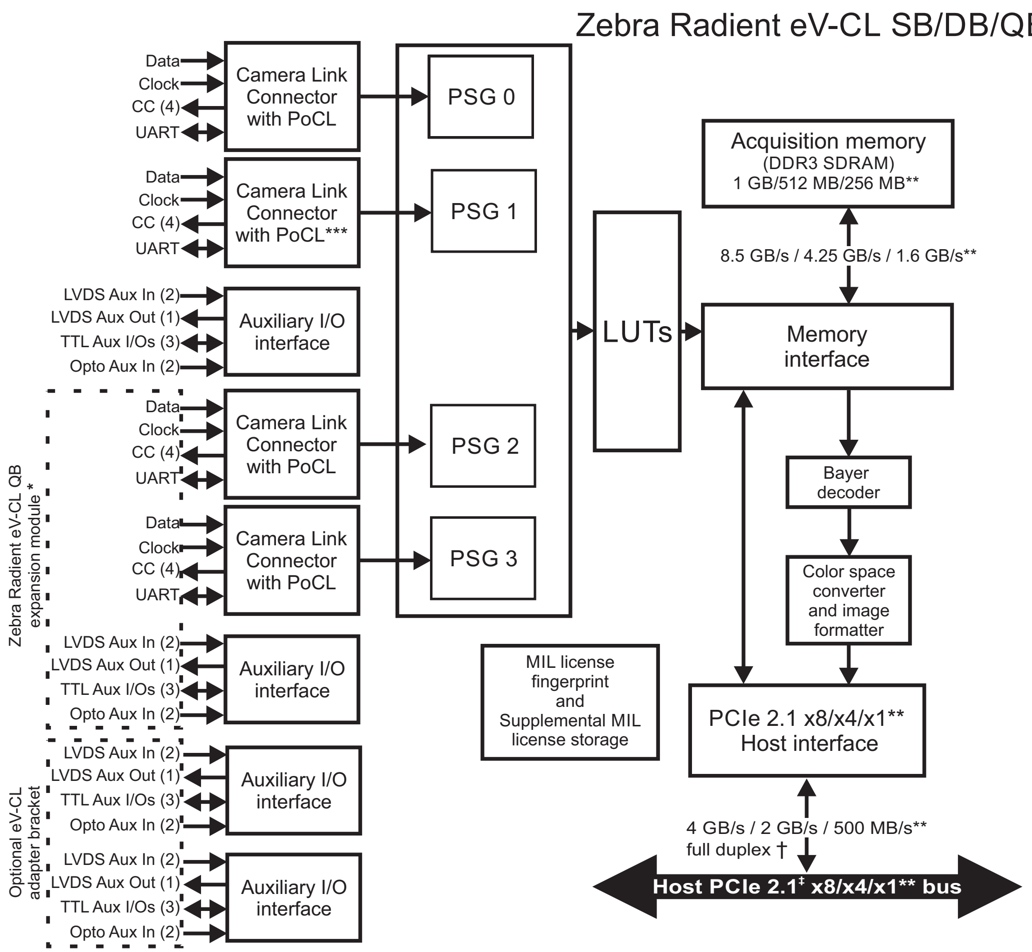
This chapter briefly describes the features of the Zebra Radient eV-CL boards, as well as the software that can be used with the boards.

Zebra Radient eV-CL boards

Zebra Radient eV-CL is a high-performance PCIe frame grabber that acquires images from Camera Link video sources. There are five models of Zebra Radient eV-CL: SB, DB, QB, SF, and DF. In addition, the eV-CL DB and eV-CL SF models have two versions: a PCIe x4 version and a PCIe x8 version. All Zebra Radient eV-CL models are regular profile PCIe boards, except for the eV-CL SB model which is a low profile PCIe board.

The eV-CL SB model supports acquisition from one Camera Link video source in Base configuration; eV-CL DB and eV-CL QB support simultaneous acquisition from up to two and up to four of these video sources, respectively. The eV-CL SF and eV-CL DF models support acquisition from Camera Link video sources in Medium, Full, or 80-bit configuration; eV-CL SF supports acquisition from one of these video sources, and eV-CL DF supports two simultaneously.

Zebra Radient eV-CL supports power-over Camera Link (PoCL) compliant video sources and Camera Link frequencies of 20 MHz to 85 MHz.



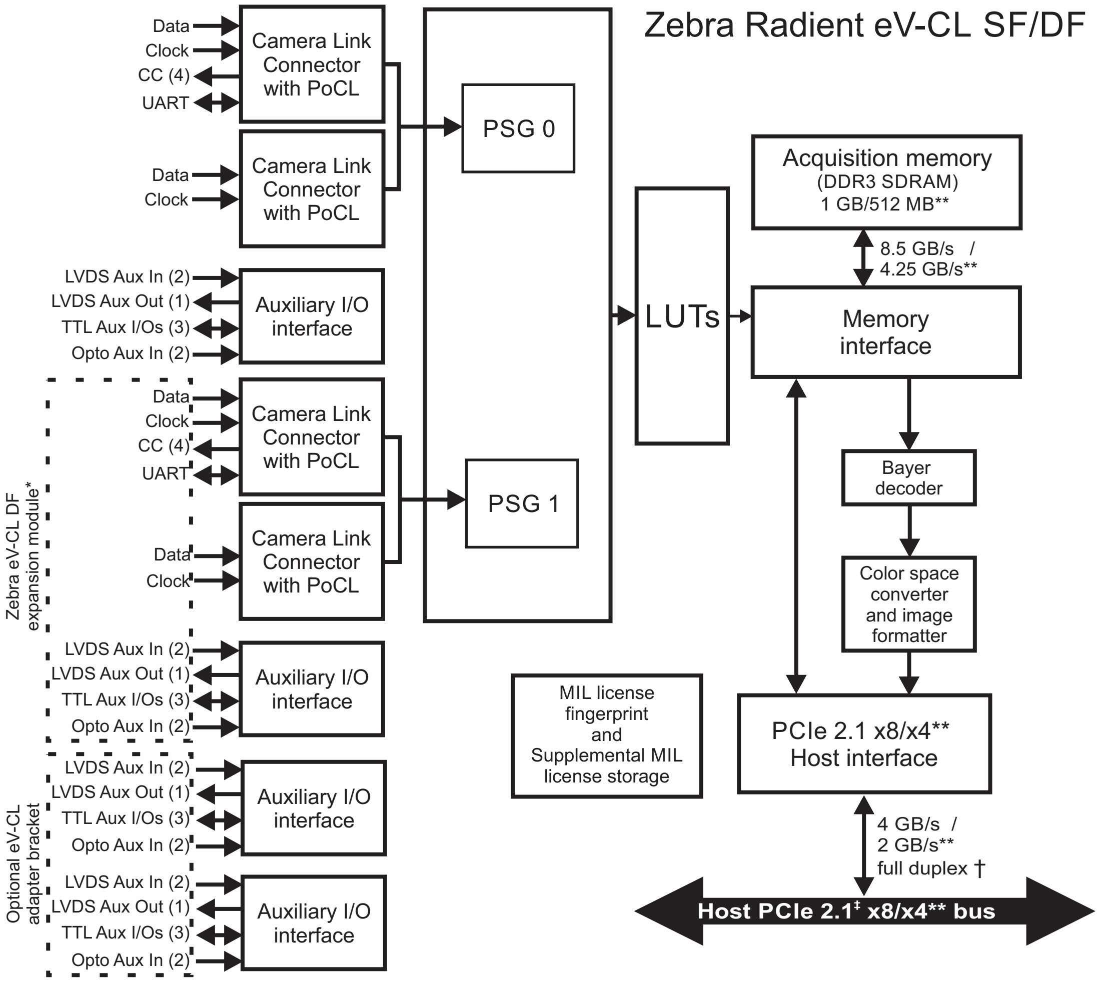
* Note that, without the expansion module, this is a flow diagram of Zebra Radient eV-CL SB or DB, depending on the number of camera link interfaces. With the expansion module, this is a flow diagram of Zebra Radient eV-CL QB. eV-CL SB and DB are not upgradable to eV-CL QB; the eV-CL SB and DB do not have the required connector for the eV-CL QB module.

** eV-CL x8 DB and eV-CL QB models/ eV-CL x4 DB model/ eV-CL SB model.

*** Note that this connector is not available on the eV-CL SB model.

† Note that these are the theoretical maximums. The practical maximums are 3 GB/s for the eV-CL x8 DB and eV-CL QB models, 1.8 GB/s for the eV-CL x4 DB model, and 425 MB/s for the eV-CL SB model.

‡ Note that you can install Zebra Radient eV-CL in a PCIe slot 2.1 and above, but the operating speed will only run at PCIe 2.1 speeds.



* Note that, without the expansion module, this is a flow diagram of Zebra Radient eV-CL SF. With the expansion module, this is a flow diagram of Zebra Radient eV-CL DF. eV-CL SF is not upgradable to eV-CL DF; the eV-CL SF does not have the required connector for the eV-CL DF module.

** eV-CL x8 SF and eV-CL DF models/ eV-CL x4 SF model.

† Note that these are the theoretical maximums. The practical maximums are 3 GB/s for the eV-CL x8 SF and eV-CL DF models and 1.8 GB/s for the eV-CL x4 SF model.

‡ Note that you can install Zebra Radient eV-CL in a PCIe slot 2.1 and above, but the operating speed will only run at PCIe 2.1 speeds.

General acquisition features

Zebra Radient eV supports area-scan and line-scan, monochrome and color video sources. The color video sources can be RGB video sources or video sources with a Bayer color filter. Zebra Radient eV can decode Bayer color-encoded images and perform color space conversions while transferring the image to the Host.

Acquisition memory

Zebra Radient eV-CL is equipped with DDR3 SDRAM acquisition memory, which is used to store acquired images. The memory interface has multiple input ports. Zebra Radient eV-CL has the following amount of memory and its memory interface has the following transfer rate:

Zebra Radient eV-CL board	DDR3 SDRAM	Memory interface data transfer rate
eV-CL SB	256 Mbytes	1.6 Gbytes/sec
eV-CL x4 DB	512 Mbytes	4.25 Gbytes/sec
eV-CL x8 DB	1 Gbytes	8.5 Gbytes/sec
eV-CL QB	1 Gbytes	8.5 Gbytes/sec
eV-CL x4 SF	512 Mbytes	4.25 Gbytes/sec
eV-CL x8 SF	1 Gbytes	8.5 Gbytes/sec
eV-CL DF	1 Gbytes	8.5 Gbytes/sec

Frame burst technology

All versions of Zebra Radient eV support frame burst technology. This technology allows you to grab a group of sequential frames into a multi-frame image buffer with one grab command; the defined number of frames are stored contiguously in the same buffer. The end-of-grab event only occurs once the entire group of frames has been grabbed, reducing the number of events that need to be handled. This is useful in cases where you have a high frame rate and need to ensure that no frames are missed.

Additional functionality

In addition to the core video capture capabilities, Zebra Radient eV-CL incorporates a variety of features to simplify overall system integration. These features include:

- **Color space converter and image formatter.** This can convert data as it is being transferred to the Host. It can convert 8- or 16-bit monochrome or 24- or 48-bit packed BGR data to monochrome, packed BGR, packed BGRa, planar RGB, or YUV (YUYV) format. In addition, it can flip or subsample data sent to the Host.

- **Bayer decoder.** This can convert Bayer-encoded data to RGB. The following Bayer patterns are supported: GRBG, GBRG, BGGR, and RGGB.

- **Auxiliary, multi-purpose signals.** These are non-video signals that can support one or more functionalities (for example, trigger input or timer output), depending on the auxiliary signal.

- **Integrated quadrature decoders.** These can decode quadrature input received from a rotary or linear encoder.

Data transfer

Your Zebra Radient eV-CL can send data to the Host at a maximum theoretical transfer rate of 500 Mbytes/sec, 2.0 Gbytes/sec, or 4.0 Gbytes/sec, depending on the model. Optimum conditions for high speed transfer include using the board in a PCIe 2.x slot with 8 active lanes, using a 256-byte payload. DMA write performance is chipset and computer dependent, and is slightly affected by the image size and alignment in Host memory (frame start address and line pitch).

To measure the effective available bandwidth of the PCIe slot in your computer with your Zebra Radient eV-CL board, Zebra provides the Radient eV-CL Bench tool. This tool is integrated in the MILConfig utility, which is shipped with software that supports Zebra Radient eV products (for example, MIL).

Documentation conventions

This manual refers to all Zebra Radient eV-CL boards as Zebra Radient eV-CL. When necessary, this manual distinguishes between the boards using their full names (for example, Zebra Radient eV-CL SF, Zebra Radient eV-CL DF, Zebra Radient eV-CL SB, Zebra Radient eV-CL DB, and Zebra Radient eV-CL QB), or their abbreviated forms (eV-CL SF, eV-CL DF, eV-CL SB, eV-CL DB, and eV-CL QB). If necessary to distinguish between the PCIe x8 and PCIe x4 versions of the eV-CL DB and SF models, the DB and SF are prefixed with either x8 or x4 (for example, eV-CL x4 DB).

Also note that, when the term Host is used in this manual, it refers to the host computer.

Software

To operate your Zebra Radient eV-CL, you can use one or more Matrox Imaging software products that supports the board. These are the Matrox Imaging Library (MIL) and its derivatives (for example, MIL-Lite and Matrox Intellicam). All Matrox software is supported under Windows; MIL is also supported under Linux when using Zebra Radient eV-CL. Consult your software manual for supported versions of these operating systems.

MIL

MIL is a high-level programming library with an extensive set of optimized functions for image capture, processing, analysis, transfer, compression, display, and archiving. Image processing operations include point-to-point, statistical, spatial filtering, morphological, geometric transformation, and FFT operations. Analysis operations support camera calibration, are performed with sub-pixel accuracy, and include pattern recognition (normalized grayscale correlation and Geometric Model Finder), blob analysis, edge extraction and analysis, measurement, image registration, metrology, character recognition (template-based and for both normal and dot-matrix text, feature based), code reading and verification (1D, 2D and composite code types), bead (continuous strips of material) inspection, 3D reconstruction, 3D processing, 3D analysis, classification, and color analysis.

MIL applications are easily ported to new Zebra hardware platforms and can be designed to take advantage of multi-processing and multi-threading environments.

MIL-Lite

MIL-Lite is a subset of MIL. It includes all the MIL functions for image acquisition, transfer, display control, and archiving. It also allows you to perform processing operations that are typically useful to preprocess grabbed images.

Matrox Intellicam

Matrox Intellicam is an interactive Windows program that allows for fast video source interfacing and provides interactive access to all the acquisition features of your Zebra board. Matrox Intellicam also has the ability to create custom digitizer configuration format (DCF) files, which MIL and its derivatives use to interface with specific non-standard video sources. Matrox Intellicam is included with all Matrox Imaging software products.

Essentials to get started

To begin using your Zebra Radient eV-CL, you must have a computer with the following:

- An available conventional PCIe 2.x x1, x4, x8, or x16 slot*, depending on your Zebra Radient eV-CL model. Note that a PCIe 2.x slot will ensure the fastest possible transfer of data to the Host.
- Processor with an Intel 64-bit architecture, or equivalent.
- A relatively up-to-date PCIe chipset. A chipset that supports the PCIe 2.x standard is preferable.
- MIL or one of its derivatives. This software should be installed after you install your board.

  Zebra does not guarantee compatibility with all computers that have the above specifications. Please consult with your local Zebra representative, local Zebra Imaging sales office, the Zebra web site, or the Zebra Customer Support Group at headquarters before using a specific computer.

  Consult your software package for other computer requirements (for example, operating system and memory requirements).

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*. Note that you can install Zebra Radient eV in any mechanical PCIe slot that fits your board (for example, connecting to open-ended connectors). The mechanical width of the connector does not always indicate the amount of electrically connected lanes it has. For example, you can install a x8 board in a PCIe x4 slot that has a mechanical x8 connector; however, the maximum transfer rate between Zebra Radient eV and the Host is reduced by 50%. Also, if you install it in a PCIe slot that is of an earlier version than the capabilities of the board, then the maximum bandwidth/transfer rate will also be affected.

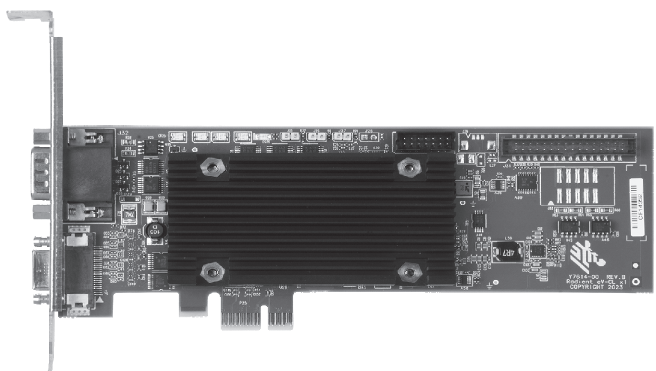
Inspecting the Zebra Radient eV-CL package

You should check the contents of your Zebra Radient eV-CL package when you first open it. If something is missing or damaged, contact your Zebra representative.

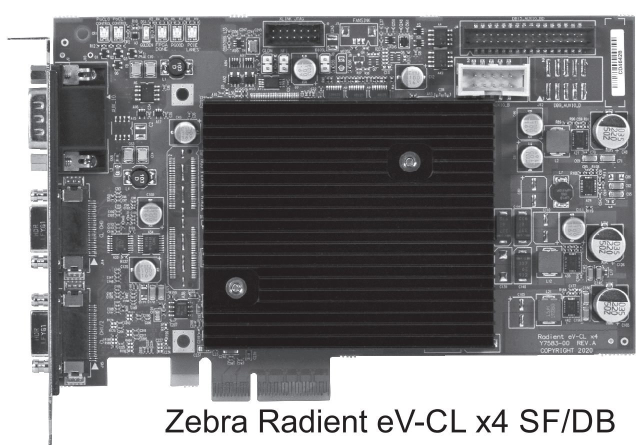
Standard items

You should receive the following items:

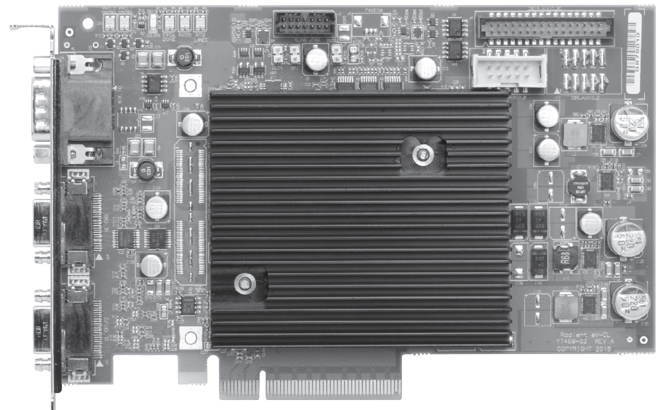
- The Zebra Radient eV-CL board.



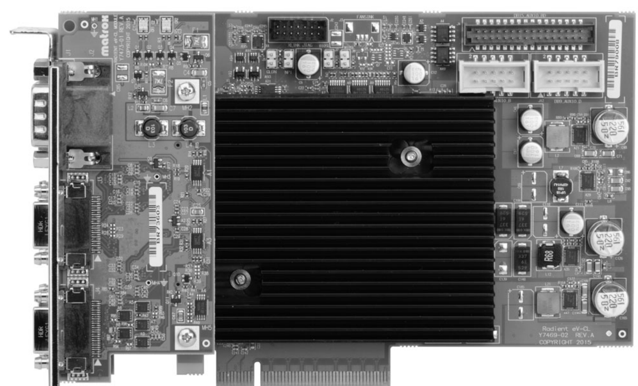
Zebra Radient eV-CL SB



Zebra Radient eV-CL x4 SF/DB



Zebra Radient eV-CL x8 SF/DB



Zebra Radient eV-CL DF/QB

❖ Note that older versions of Zebra Radient eV-CL included a fan. This has been replaced with a heat sink in newer versions.

Available separately

You might have also ordered one or more of the following:

- A HD-15 cable adapter bracket, equipped with two HD-15 auxiliary I/O connectors.

- MIL or MIL-Lite. Matrox Intellicam is included with both of these software packages.

Handling components

The electronic circuits in your computer and the circuits on your Zebra Radient eV-CL are sensitive to static electricity and surges. Improper handling can seriously damage the circuits. Be sure to drain static electricity from your body by touching a metal fixture (or ground) before you touch any electronic component. In addition, do not let your clothing come in contact with the circuit boards or components.

Warning

Before you add or remove devices from your computer, always **turn off** the power to your computer and all peripherals.

Installation

The installation procedure consists of the following steps:

1. Complete the hardware installation procedure described in *Chapter 2: Hardware installation*.

2. Complete the software installation procedure described in the documentation accompanying your software package.

More information

For information on using multiple Zebra Radient eV boards, refer to *Chapter 3: Using multiple Zebra Radient eV-CL boards*.

For in-depth hardware information, refer to *Chapter 4: Zebra Radient eV-CL hardware reference*; whereas for a summary of this information, as well as environmental and electrical specifications, and connector pinout descriptions, see *Appendix B: Technical information*.

This manual occasionally makes reference to a MIL-Lite function. However, anything that can be accomplished with MIL-Lite can also be accomplished with MIL.

Need help?

If you experience problems during installation or while using this product, you can refer to the support page on the Zebra web site: zebra.com/mv-support. This support page provides information on how to contact technical support.

To request support, you should first complete and submit the online Technical Support Request Form, accessible from the above-mentioned web page. Once you have submitted the information, a Zebra support agent will contact you shortly thereafter by email or phone, depending on the problem.

Vision Academy

The Vision Academy online training resource is also available to help customers visualize the steps involved in using various products. For access to these videos, visit the Zebra website.

Chapter

2

Hardware installation

This chapter explains how to install your Zebra Radient eV-CL board in your computer.

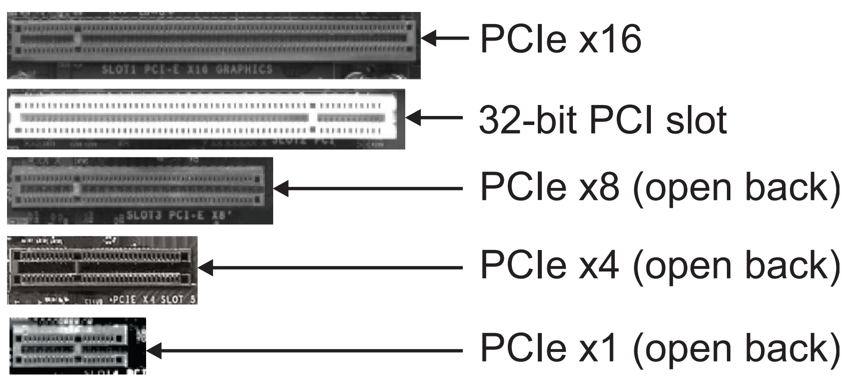
Installing your Zebra Radient eV-CL board

Before you install your Zebra Radient eV-CL board, some precautionary measures must be taken. Turn off the power to your computer and its peripherals, and drain static electricity from your body (by touching a metal part of the computer chassis).

Proceed with the following steps to install your board:

1. Remove the cover from your computer; refer to your computer's documentation for instructions.

2. Check that you have an empty PCIe 2.x[*] slot in which to install your Zebra Radient eV-CL. A PCIe 2.x x8 or x16 slot will ensure the fastest possible transfer of data to the Host, depending on your model. If you use a PCIe 1.x slot, the transfer rate will be half of that of a PCIe 2.x slot.

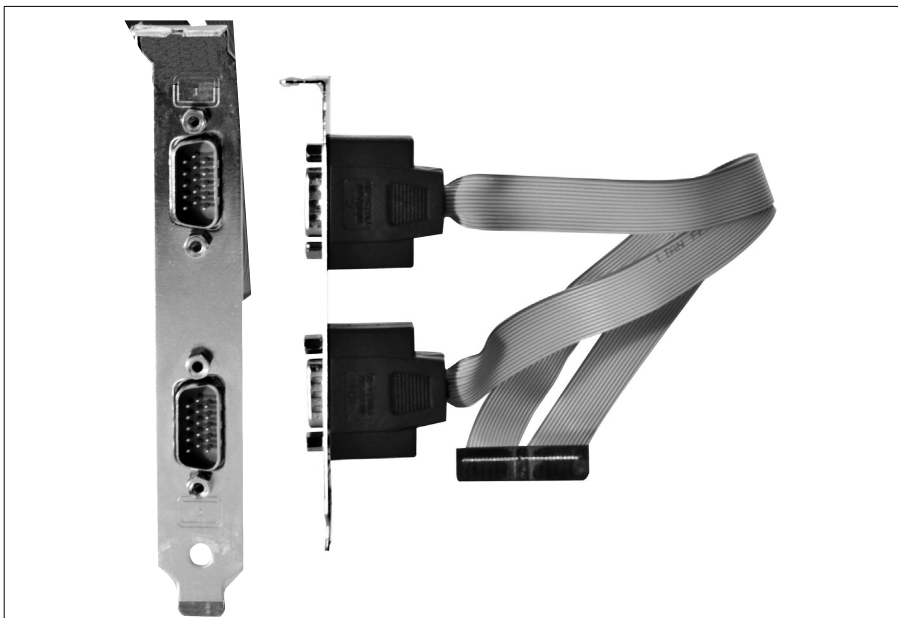


*. Note that you can install Zebra Radient eV-CL in any mechanical PCIe slot that fits your board (for example, connecting to open-ended connectors). The mechanical width of the connector does not always indicate the amount of electrically connected lanes it has. For example, you can install a x8 board in a PCIe x4 slot that has a mechanical x8 connector; however, the maximum transfer rate between Zebra Radient eV-CL and the Host is reduced by 50%. Also, if you install it in a PCIe slot that is of an earlier version than the capabilities of the board, then the maximum bandwidth/transfer rate will also be affected.

Zebra Radient eV-CL might drop frames if the PCIe slot does not have the appropriate number of active lanes (for example, if a x8 board is connected to a PCIe x8 slot that has only four active lanes*). Verify with your motherboard manufacturer to find out the number of active lanes of each slot on the motherboard.

If you need to install the HD-15 cable adapter bracket, you will need an additional slot for the cable adapter bracket. The slot need not be adjacent to the Zebra Radient eV-CL board. In addition, the cable adapter bracket does not plug into a slot's connector; it attaches only to the back of the computer's chassis.

❖ Note that the external auxiliary I/O connectors on the cable adapter bracket are panel mount connectors. If you don't want to occupy an entire slot for the bracket, you can punch out two holes in the computer chassis, and then screw the connectors in the holes.



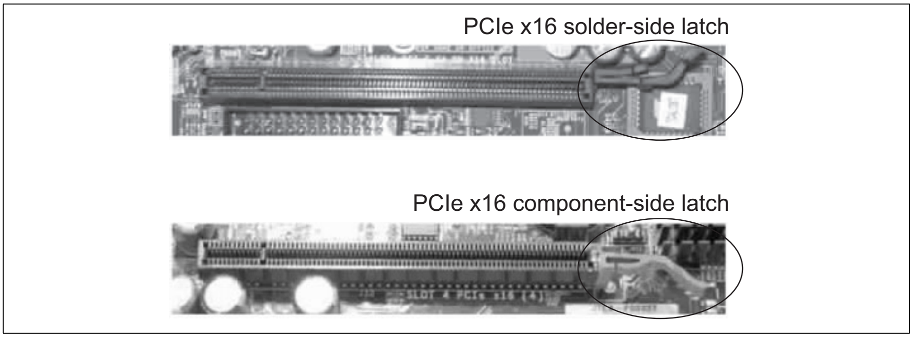
*. After installing the board, you can verify in software the number of PCIe lanes that are currently active, using the MIL-Lite function MsysInquire() with M_PCIE_NUMER_OF_LANES.

3. If there is a metal plate at the back of the selected slots, remove it. Keep the screw from the top of the plate to anchor your board and cable adapter bracket once they are installed.

4. Position your Zebra Radient eV-CL board in the selected PCIe slot. Align the connectors of your board with the opening at the back of the slot, and move the board until the connectors pass through the opening.

Important

When installing your Zebra Radient eV-CL board in a PCIe x16 slot, special care must be taken to avoid damaging the board. Some PCIe x16 slots have a connector with a retainer. You should avoid touching the latch of this retainer with the board. Alternatively, you can remove the latch from the retainer.



5. Once the input connectors are in the opening of the chassis, press the board firmly but carefully straight down into the connector of the slot.

6. Anchor the board using the screw that you removed in step 3.

7. If required, install the cable adapter brackets, as described in the section *Installing the cable adapter bracket*, later in this chapter.

8. Attach your video sources, as described in the section *Connecting video sources to Zebra Radient eV-CL*, later in this chapter.

9. Turn on your computer.

    - When you boot your computer under Windows, Windows' Plug-and-Play system will detect a new Multimedia Video Device and you will be asked to assign it a driver. At this point, you should click on **Cancel**.

- Under Windows and Linux, the driver will be installed during the installation of Zebra Radient eV software.

10. Disable active state power management (ASPM) for PCIe devices, to maximize the performance of Zebra Radient eV-CL. In the BIOS, disable all ASPM (or equivalent) settings (typically accessible from the **Power management** sub-menu of the **Advanced Configurations** menu). In addition, if the operating system has an **ASPM for PCIe devices** option, disable this option as well. For example, under Microsoft Windows 10, open the **Power Options** dialog box from the Windows Control Panel. For the currently selected power plan, click on **Change Plan Settings** and then click on **Change Advanced Power Settings**. In the presented dialog, expand **PCI Express**, and then expand **Link State Power Management** and set it to **Off**.

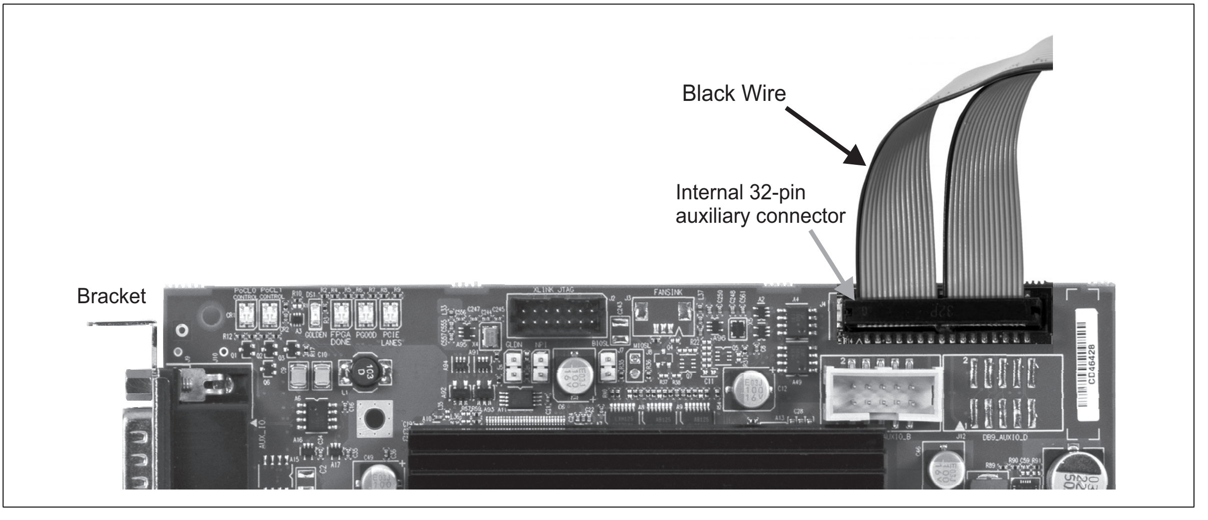
11. Under Microsoft Windows, set the power plan option to high performance to maximize the performance of Zebra Radient eV-CL and minimize the possibility of dropped frames. For example, under Microsoft Windows 10, open the **Power Options** dialog box from the Windows Control Panel and set the power plan option to **High Performance**.

Installing the cable adapter bracket

To install the cable adapter bracket, proceed with the following steps:

1. Make sure that your Zebra Radient eV-CL board is fastened to the computer chassis.

2. Attach the cable adapter bracket to the internal auxiliary I/O connector on the Zebra Radient eV board. When attaching the flat ribbon cable of the adapter bracket, position the cable so that the black wire is on the same side as the bracket of the Zebra Radient eV-CL board. Zebra Radient eV-CL has one internal 32-pin auxiliary I/O connector and one internal 10-pin auxiliary I/O connector.



3. Slide the bracket of the cable adapter bracket into the opening at the back of the selected slot.

4. Anchor the bracket to the chassis using the screw that you removed in the previous section.

❖ Note that the external auxiliary I/O connectors on the cable adapter bracket are panel mount connectors. If you don't want to occupy an entire slot for the bracket, you can punch out two holes in the computer chassis, and then screw the connectors in the holes.

Connecting video sources to Zebra Radient eV-CL

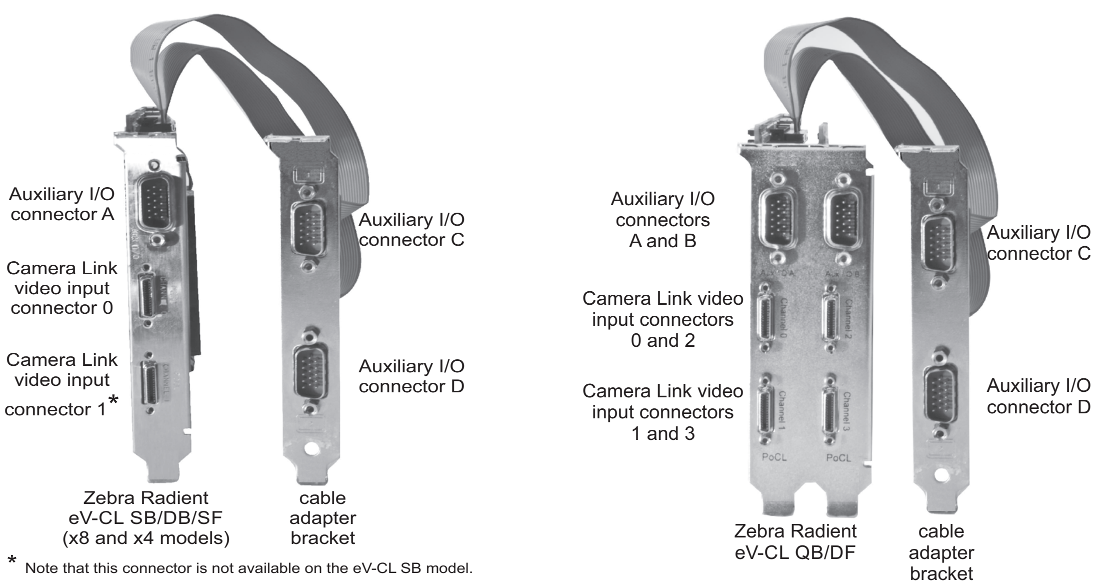
The Zebra Radient eV-CL board has the following connectors on its bracket(s):

- **One, two, or four Camera Link-compliant video input connectors.** Used to receive video input, timing, and synchronization signals, from the video source. These are also used to transmit/receive communication signals between the video source and the frame grabber through a UART port.

- **External auxiliary I/O connector A or external auxiliary I/O connectors A and B** (HD-15). Each used to transmit/receive auxiliary signals.

To access the signals of the internal auxiliary I/O connectors, you might have installed a cable adapter bracket. It can have the following connectors:

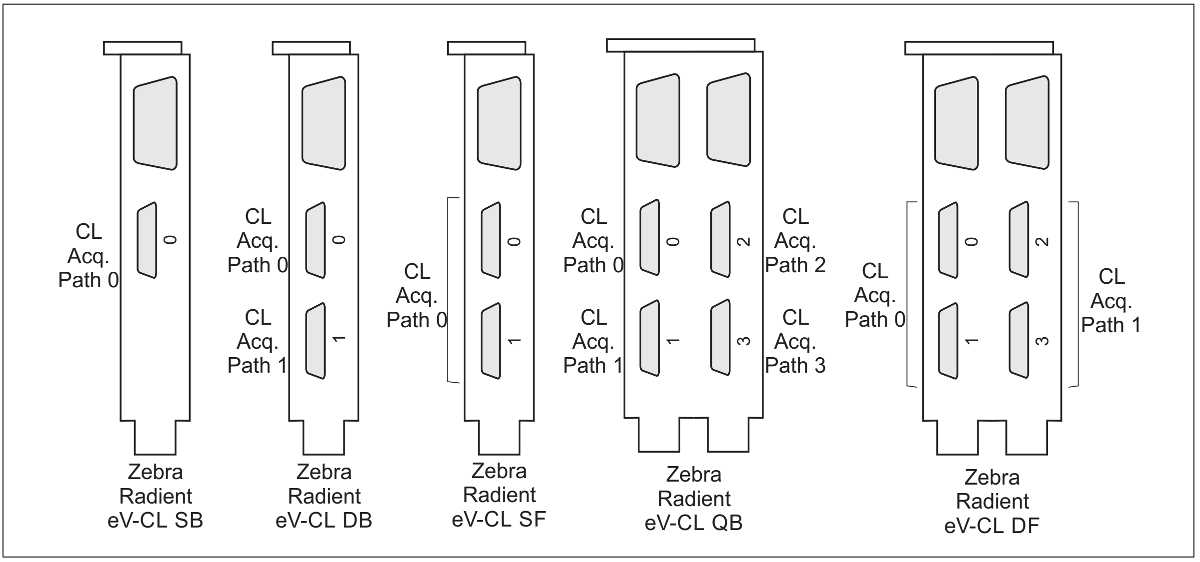
- **External auxiliary I/O connectors C and D (panel mount HD-15 or DB-9).** Each used to transmit/receive auxiliary signals.



* Note that this connector is not available on the eV-CL SB model.

Attach video sources to Zebra Radient eV-CL as follows:

Zebra Radient eV-CL board	Camera Link connector 0	Camera Link connector 1	Camera Link connector 2	Camera Link connector 3
SB	Video source 0 in Base configuration	--	--	--
DB	Video source 0 in Base configuration	Video source 1 in Base configuration	--	--
QB	Video source 0 in Base configuration	Video source 1 in Base configuration	Video source 2 in Base configuration	Video source 3 in Base configuration
SF	Video source 0 in Medium, Full, or 80-bit configuration		--	--
DF	Video source 0 in Medium, Full, or 80-bit configuration		Video source 1 in Medium, Full, or 80-bit configuration	



Warning

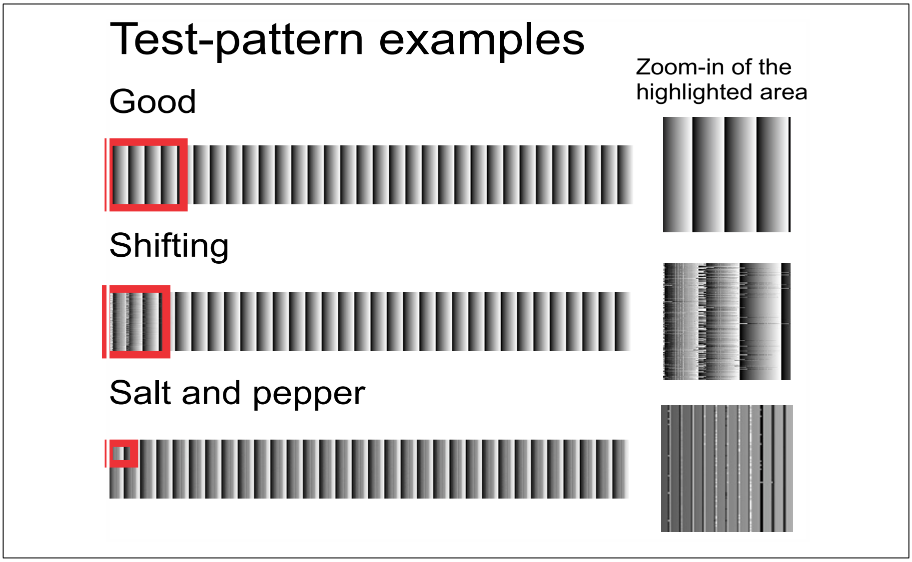
❖ When connecting a video source in Full or 80-bit configuration, ensure that you are connecting its cables to the appropriate connector. Accidentally connecting the cables to the wrong connector can damage the board or your video source. The Camera Link connector's pins 2-5 and pins 15-18 are output pins on the top connector (0 and 2), while they are input pins on the bottom connector (1 and 3). For a pinout of the Camera Link connector, see *Camera Link video input connectors* in *Appendix B: Technical information*.

To connect video sources to the Camera Link connectors on Zebra Radient eV-CL, use standard Camera Link cables with a 26-pin high-density male mini Camera Link connector (HDR). When connecting to PoCL-compliant video sources, you should use PoCL-compliant Camera Link cables (HDR). Camera Link cables are not available from Zebra; for possible sources, see the *Connectors on Zebra Radient eV-CL boards* section in *Appendix B: Technical information*.

❖ If using both Camera Link connectors to connect to the same video source (Medium configuration or Full configuration), the cables you choose should be of the same type and length. Note, however, if they are not, Zebra Radient eV-CL will adapt to any delay caused by reasonable differences in length.

Camera Link cables longer than 7 meters

When using Camera Link cables that are longer than 7 meters with Zebra Radient eV-CL and using a pixel clock of 85 MHz, the resulting images from your camera might have either salt and pepper noise or unsynchronized lines (that is, a row is shifted either left or right, and clipped to fit the frame). These errors might be caused by signal degradation due to long cables.



To fix this problem, you must adjust your DCF. To do so:

1. Set your camera to generate images that contain as many different pixel values as possible for every tap (for example, a test pattern containing a horizontal ramp). Refer to your camera's documentation for more information. If your camera does not have a test-pattern mode, select an image similar to a horizontal ramp.

2. Once the test pattern (or sample image) is available, use the **Deseralizer** tool. This tool is accessible from the **Radient eV-CL** page of the MILConfig utility. This tool will adjust values within your DCF to compensate for signal degradation due to the long cables. Follow all on-screen instructions.

When the process is complete, your camera's DCF is updated. Any MIL application that uses this DCF in the same physical environment should now be able to receive better images (using your camera as a video source).

❖ Note that, if your MILConfig utility does not have the **Deserializer** tool, contact Zebra Technical Support for assistance.

Chapter

3

Using multiple Zebra Radient eV-CL boards

This chapter explains how to use multiple Zebra Radient eV-CL boards.

Installation of multiple boards

You can install and use multiple Zebra Radient eV-CL boards in one computer.

Install each additional Zebra Radient eV board as you installed the first board (refer to *Chapter 2: Hardware installation*). The number of Zebra Radient eV-CL boards that you can install is primarily dependent on the number of physical slots in your computer, and your BIOS; your BIOS establishes how many PCIe devices can be mapped to the PCIe memory space of your computer.

Using MIL-Lite, you have to allocate a MIL system for each board and allocate the resources of each MIL system. For more information, see **MsysAlloc**() with **M_SYSTEM_RADIENTEVCL** in the MIL Reference.

Simultaneous image capture from different boards

In addition to capturing images from multiple video sources with a single Zebra Radient eV-CL board, you can also simultaneously capture images from video sources attached to multiple Zebra Radient eV-CL boards. Note that the number of video sources from which you can simultaneously capture images is limited by the PCIe chipset on your computer.

The use of a high performance PCIe chipset is necessary to sustain PCIe transfers to Host memory. Ideally, a PCIe 2.x chipset should be used. A PCIe 2.x Host bus will optimize the speed of data transmission, and will minimize data loss.

To measure the effective available bandwidth of the PCIe slot in your computer with the Zebra Radient eV-CL board, you can use the Radient eV-CL Bench tool integrated in the MILConfig utility. As a reference point, capturing from a 2K x 2K, 8-bit, 60 frames/sec video source will require a minimum bandwidth of 240 Mbytes/sec, plus an additional bandwidth margin of approximately 20%, for a bandwidth of 288 Mbytes/sec.

Chapter

4

Zebra Radient eV-CL hardware reference

This chapter explains the architecture, features, and modes of the Zebra Radient eV-CL hardware.

Zebra Radient eV-CL hardware reference

This chapter provides information on the Zebra Radient eV-CL hardware. It covers the architecture, features, and modes of the board's acquisition section. In addition, the chapter covers the Zebra Radient eV-CL hardware related to the formatting and transfer of data. A summary of the features of Zebra Radient eV-CL, as well as pin assignments for the various connectors, can be found in *Appendix B: Technical information*.

Acquisition path

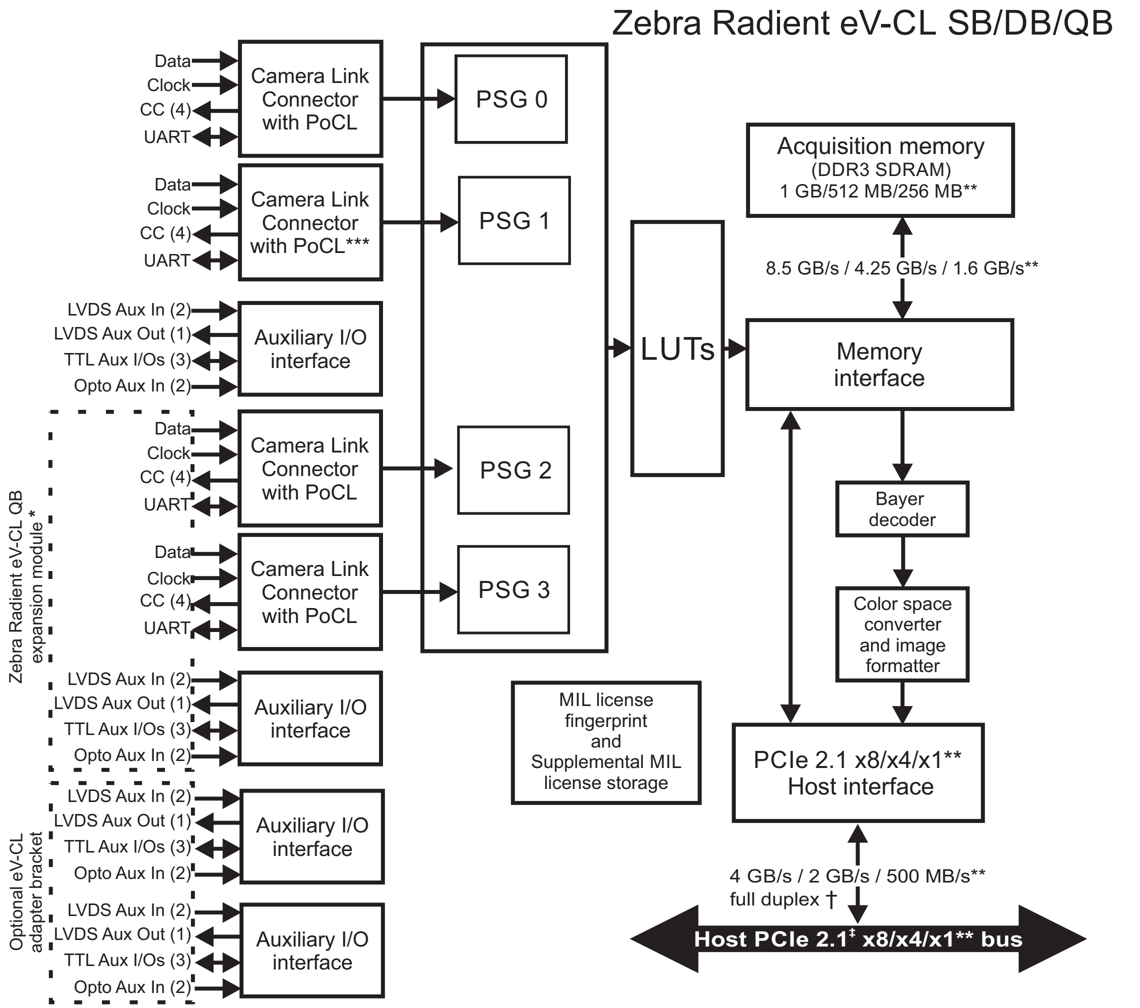
This manual uses the term acquisition path to refer to a path that has the capability to, for example, capture a component or stream of the video input signal. The term *independent acquisition path* is used to refer to an acquisition path that can, if required, acquire data from a video source independently from another such path on the same frame grabber.

Digitizer

MIL-Lite uses the concept of a MIL digitizer to represent the acquisition path(s) with which to grab from one input source of the specified type. When several MIL digitizers are allocated, their device number along with their DCF identify if they represent the same path(s) (but perhaps for a different input format) or independent path(s) for simultaneous acquisition.

Digitizer configuration format

To program the acquisition section, allocate a MIL digitizer using **MdigAlloc**() with an appropriate DCF (supplied or created) and digitizer device number. If you find a DCF file that is suitable for your video source, but you need to adjust some of the more common settings, you can do so directly, without adjusting the file, using the appropriate MIL-Lite function. For more specialized adjustments, use the Matrox Intellicam program to adjust the DCF file.



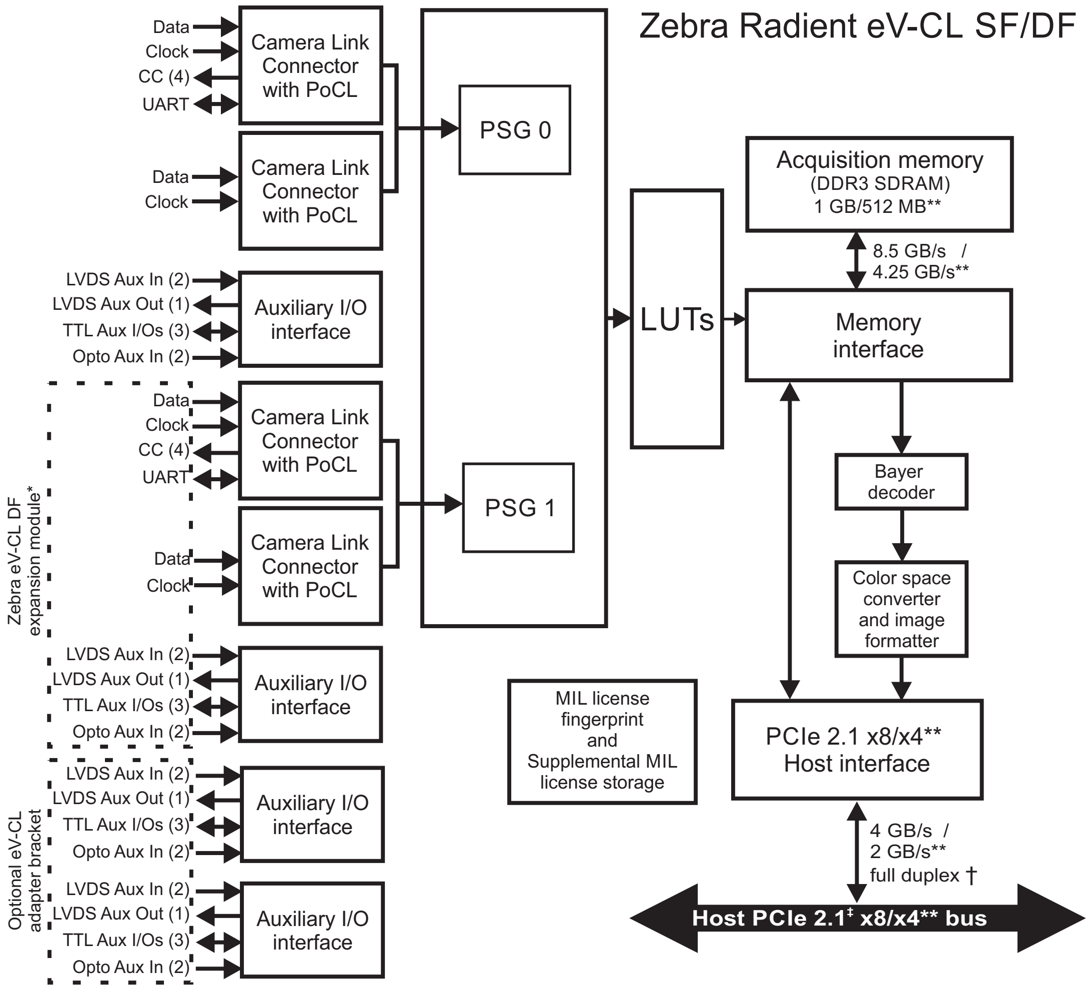
* Note that, without the expansion module, this is a flow diagram of Zebra Radient eV-CL SB or DB, depending on the number of camera link interfaces. With the expansion module, this is a flow diagram of Zebra Radient eV-CL QB. eV-CL SB and DB are not upgradable to eV-CL QB; the eV-CL SB and DB do not have the required connector for the eV-CL QB module.

** eV-CL x8 DB and eV-CL QB models/ eV-CL x4 DB model/ eV-CL SB model.

*** Note that this connector is not available on the eV-CL SB model.

† Note that these are the theoretical maximums. The practical maximums are 3 GB/s for the eV-CL x8 DB and eV-CL QB models, 1.8 GB/s for the eV-CL x4 DB model, and 425 MB/s for the eV-CL SB model.

‡ Note that you can install Zebra Radient eV-CL in a PCIe slot 2.1 and above, but the operating speed will only run at PCIe 2.1 speeds.



* Note that, without the expansion module, this is a flow diagram of Zebra Radient eV-CL SF. With the expansion module, this is a flow diagram of Zebra Radient eV-CL DF. eV-CL SF is not upgradable to eV-CL DF; the eV-CL SF does not have the required connector for the eV-CL DF module.

** eV-CL x8 SF and eV-CL DF models/ eV-CL x4 SF model.

† Note that these are the theoretical maximums. The practical maximums are 3 GB/s for the eV-CL x8 SF and eV-CL DF models and 1.8 GB/s for the eV-CL x4 SF model.

‡ Note that you can install Zebra Radient eV-CL in a PCIe slot 2.1 and above, but the operating speed will only run at PCIe 2.1 speeds.

Zebra Radient eV-CL acquisition

Zebra Radient eV-CL can capture video from digital video sources compliant with the Camera Link 2.1 specification (or earlier). Zebra Radient eV-CL can provide power over Camera Link to attached video sources.

Zebra Radient eV-CL supports area-scan and line-scan monochrome and color video sources. The color video sources can be RGB video sources or video sources with a Bayer color filter. Zebra Radient eV-CL can decode Bayer color-encoded images and perform color space conversions while transferring the image to the Host. Besides standard Camera Link video sources, Zebra Radient eV-CL also supports additional types of video sources, including some time-multiplexed video sources.

Zebra Radient eV-CL SB has one independent acquisition path, Zebra Radient eV-CL DB has two independent acquisition paths, and Zebra Radient eV-CL QB has four independent acquisition paths; the acquisition paths of these models operate in Base configuration. Zebra Radient eV-CL SF has one acquisition path and Zebra Radient eV-CL DF has two independent acquisition paths; the acquisition paths of these models operate in Medium, Full, or 80-bit configuration.

Each acquisition path can grab at Camera Link frequencies of 20 MHz to 85 MHz. Each acquisition path has its own programmable synchronization generator (PSG) and can operate at different acquisition rates.

The acquisition section of Zebra Radient eV-CL supports a comprehensive set of general purpose I/O and serial ports to control cameras and other devices.

Performance

The video timing of each acquisition path is as follows:

	Maximum
Number of pixels / line (including sync and blanking)	64 K
Number of lines / frame (including sync and blanking)	64 K
Pixel clock	85 Mhz

The maximum pixel clock frequency is dependent on the length of the cable used. Refer to the *Technical features of Zebra Radient eV-CL boards* subsection of the *Board summary* section in *Appendix B: Technical information*.

Acquisition

A Base-type acquisition path supports up to 24 bits of video data when acquiring from Camera Link-compliant video sources or up to 48 bits when acquiring from non-standard time-multiplexed video sources. Similarly, a Medium-type acquisition path can grab up to 48 bits of video data when acquiring from Camera Link-compliant sources or up to 64 bits when acquiring from non- standard time-multiplexed sources. A Full-type acquisition path supports up to 64 bits of video data when acquiring from Camera Link-compliant video sources. An 80-bit-type acquisition path supports up to 80 bits of video data when acquiring from Camera Link-compliant video sources.

The video sources can be area-scan or line-scan video sources. Note that the acquisition paths in dual-Base mode are completely independent; therefore, the video sources do not need to be identical when running in these modes.

Supported video sources

Zebra Radient eV-CL boards support all video sources that are Camera Link 2.1 compatible.

The following are some video sources that are supported when running in Base configuration:

	Video sources supported per acquisition path
Camera Link Standard	• One tap 8/10/12/14/16-bit. • Two tap 8/10/12-bit. • One tap 3 x 8-bit (RGB).

In addition to the above video sources, the following are some video sources that are supported when running in Medium configuration:

	Video sources supported
Camera Link Standard	• Two tap 14/16-bit. • Three tap 12/14-bit. • Three tap 16-bit*. • Four tap 8/10/12-bit. • Five*/six tap 8-bit.

*. Due to lack of demand, these modes are not natively supported with the current driver and/or firmware; however, support could be possible with an appropriate DCF. Contact Zebra customer support to have an appropriate DCF implemented.

In addition to the above video sources, the following are some video sources that are supported when running in Full configuration:

	Video sources supported
Camera Link Standard	• Four tap 14/16-bit. • Five*/six tap 10/12-bit. • Seven*/eight/nine tap 8-bit.

*. Due to lack of demand, these modes are not natively supported with the current driver and/or firmware; however, support could be possible with an appropriate DCF. Contact Zebra customer support to have an appropriate DCF implemented.

In addition to the above video sources, the following are some video sources that are supported when running in 72-bit configuration:

	Video sources supported
Camera Link Standard	• Five tap 14-bit*.

*. Due to lack of demand, these modes are not natively supported with the current driver and/or firmware; however, support could be possible with an appropriate DCF. Contact Zebra customer support to have an appropriate DCF implemented.

In addition to the above video sources, the following are some video sources that are supported when running in 80-bit configuration:

	Video sources supported
Camera Link Standard	• Five tap 16-bit*. • Seven*/eight tap 10-bit. • 10 tap 8-bit.

*. Due to lack of demand, these modes are not natively supported with the current driver and/or firmware; however, support could be possible with an appropriate DCF. Contact Zebra customer support to have an appropriate DCF implemented.

Zebra Radient eV-CL supports power-over-Camera Link (PoCL) video sources and video sources that use an external power supply. For compatibility with video sources that use an external power supply, Zebra Radient eV-CL features SafePower mode to supply power only after determining whether the connected video source is PoCL compliant. The PoCL protection on-board fuse can sustain a current of 0.75 A.

Demultiplexers to support time-multiplexed video sources

The acquisition paths of the board feature a demultiplexer. Each can deserialize input from time-multiplexed video sources on a clock cycle basis.

Time-multiplexed video sources can output larger pixel depths and more taps than are possible with non-time-multiplexed video sources in the same configuration, but with a decrease in overall performance. When enabled, the demultiplexer assumes that two video streams share the same data path and that the streams are interleaved based on the clock cycle. The demultiplexer assumes that on one clock cycle, the data is from one stream and that on the next clock cycle, the data is from another stream. The demultiplexer can only deserialize video inputs that, when combined and, if necessary, expanded, total a maximum depth of 64 bits per acquisition path.

Expansion refers to the automatic addition of padding zeros on the most significant bits (MSB) of 10-, 12-, and 14-bit data to create byte aligned 16-bit data.

Communication

For each acquisition path, two LVDS pairs are used to transmit and receive asynchronous serial communication between the video source and the board. These signals are handled by the Universal Asynchronous Receiver/Transmitters (UARTs).

For each acquisition path, four camera control output signals are also available. These are general-purpose signals that are sent to the video source.

UARTs

Zebra Radient eV-CL offers an LVDS-compatible Zebra serial interface. Each interface is mapped as a COM port so that it can be accessed through the Microsoft Windows API. Each interface is comprised of both a transmit port and a receive port, permitting the interface to work in full-duplex (bidirectional) mode. The interfaces are located on the Camera Link connectors.

Each interface is controlled by a Universal Asynchronous Receiver-Transmitter (UART)[*]. Each UART features independently programmable baud rates, supporting all standard baud rates from 300 baud up to 115200[†] baud.

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*. The UART implementation was derived from a design by Daniel Wallner. Please see *Appendix C: Acknowledgments* for copyright information.

†. In addition, the maximum baud rate is highly dependent on the amount of computer resources available.

Acquisition Controller

The acquisition controller is responsible for reconstructing and storing image data in main on-board memory. When writing data to memory, the acquisition controller can perform line and frame reversal; it can flip the image horizontally and/or vertically. On all Zebra Radient eV-CL boards, the acquisition controller supports adjacent and non adjacent taps in any of the configurations (Base, Medium, Full, 72-bit, or 80-bit) supported by Camera Link 2.1.

On Zebra Radient eV-CL SB/DB/QB, the acquisition controller can write up to three non-sequential memory regions (zones) per acquisition path.

On Zebra Radient eV-CL SF/DF, the acquisition controller can write to a maximum of the following number of non-sequential memory regions: 6 for Medium, 8 for Full, 9 for 72-bit, and 10 for 80-bit[*].

Note that the width of each region must be a multiple of the number of adjacent taps in that region.

To establish the number of non-sequential memory regions to which your video source must write, refer to the documentation accompanying your video source.

PSGs

For each acquisition path, the acquisition controller provides a programmable synchronization generator (PSG). Each PSG allows for independent acquisition from one video source, since each PSG is responsible for managing all video timing and synchronization signals.

The PSGs are also responsible for managing the camera control and auxiliary signals supported by the board. These signals are configurable signals that can support one or several functions, one of which is user-defined for Zebra Radient eV-CL; the table in the next subsection identifies the functions to which the camera control and auxiliary signals can be defined. The PSGs are also responsible for implementing the functionality to which these can be defined.

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*. The 10 non-sequential memory regions in 80-bit configuration are only available with 8-bit taps.

Auxiliary signals

The following subsections describe the auxiliary signals for Zebra Radient eV-CL.

Camera control and auxiliary signals for Zebra Radient eV-CL SB/DB/QB

The following tables summarize the auxiliary functionality that the PSGs support, and the corresponding signals that the PSGs can receive/generate, for Zebra Radient eV-CL SB/DB/QB. The table also documents the MIL constants to use.

		LVDS cam. ctrl				LVDS cam. ctrl				LVDS cam. ctrl				LVDS cam. ctrl			
		Camera Link Connector 0				Camera Link Connector 1*				Camera Link Connector 2†				Camera Link Connector 3†			
M_CC_IO*n*	**n**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
for M_DEV*m*‡	**m**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
Functionality that can be routed	**Acquisition path**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**
Timer (M_TIMER*n*†)	0	1/2	1/2	1/2	1/2												
	1					1/2	1/2	1/2	1/2								
	2									1/2	1/2	1/2	1/2				
	3													1/2	1/2	1/2	1/2
User output (bit of Camera Link static-user-output register M_USER_BIT_CC_IO*n*†)	0	0/1	0/1	0/1	0/1												
	1					0/1	0/1	0/1	0/1								
	2									0/1	0/1	0/1	0/1				
	3													0/1	0/1	0/1	0/1

*. Available on Zebra Radient eV-CL DB and Zebra Radient eV-CL QB.

†. Only available on Zebra Radient eV-CL QB

‡. MIL constant, where *n* and *m* correspond to the number in the row. M_DEV*m* is the required device number of the digitizer (**MdigAlloc()**) that you must use to access this signal.

		TTL Aux I/O Aux I/O Connector											
		A			C			B*			D		
M_AUX_IO*n* for M_DEV*m*†	n	8	9	2	8	9	3	8	9	2	8	9	3
	m	0	0	0/1	1	1	0/1	2	2	2/3	3	3	2/3
Functionality that can be routed or received	Acquisition path‡	TTL_AUX_IO_4	TTL_AUX_IO_5	TTL_AUX_IO_6	TTL_AUX_IO_12	TTL_AUX_IO_13	TTL_AUX_IO_14	TTL_AUX_IO_20	TTL_AUX_IO_21	TTL_AUX_IO_22	TTL_AUX_IO_28	TTL_AUX_IO_29	TTL_AUX_IO_30
Timer (M_TIMER*n*†)	0		1	2									
	1					1	2						
	2								1	2			
	3											1	2
Trigger controller affected by input signal§	0	T0	T1	T2			T3						
	1			T2	T0	T1	T3						
	2							T0	T1	T2			T3
	3									T2	T0	T1	T3
Timer-clock input	0												
	1												
	2												
	3												
Bit of quadrature input**	0												
	1												
	2												
	3												
User output (bit of main static-user-output register M_USER_BIT*n*†)	0	2	3	4			5						
	1			4	2	3	5						
	2							2	3	4			5
	3									4	2	3	5

		OPTO Aux In Aux I/O Connector							
		A		C		B*		D	
M_AUX_IO*n* for M_DEV*m*†	n	6	7	0	1	6	7	0	1
	m	0	0	0/1	0/1	2	2	2/3	2/3
Functionality that can be routed or received	Acquisition path‡	OPTO_AUX_IN0	OPTO_AUX_IN1	OPTO_AUX_IN8	OPTO_AUX_IN9	OPTO_AUX_IN16	OPTO_AUX_IN17	OPTO_AUX_IN24	OPTO_AUX_IN25
Timer (M_TIMER*n*†)	0								
	1								
	2								
	3								
Trigger controller affected by input signal§	0	T0	T1	T2	T3				
	1			T0/ T2	T1/ T3				
	2					T0	T1	T2	T3
	3							T0/ T2	T1/ T3
Timer-clock input	0								
	1								
	2								
	3								
Bit of quadrature input**	0								
	1								
	2								
	3								
User output (bit of main static-user-output register M_USER_BIT*n*†)	0								
	1								
	2								
	3								

		LVDS Aux In Aux I/O Connector							
		A		C		B*		D	
M_AUX_IO*n* for M_DEV*m*†	n	10	11	4	5	10	11	4	5
	m	0	0	0/1	0/1	2	2	2/3	2/3
Functionality that can be routed or received	Acquisition path‡	LVDS_AUX_IN2	LVDS_AUX_IN3	LVDS_AUX_IN10	LVDS_AUX_IN11	LVDS_AUX_IN18	LVDS_AUX_IN19	LVDS_AUX_IN26	LVDS_AUX_IN27
Timer (M_TIMER*n*†)	0								
	1								
	2								
	3								
Trigger controller affected by input signal§	0	T0	T1	T2	T3				
	1			T0/ T2	T1/ T3				
	2					T0	T1	T2	T3
	3							T0/ T2	T1/ T3
Timer-clock input	0		0						
	1				0				
	2						0		
	3								0
Bit of quadrature input**	0	0	1						
	1			0	1				
	2					0	1		
	3							0	1
User output (bit of main static-user-output register M_USER_BIT*n*†)	0								
	1								
	2								
	3								

		LVDS Aux Out Aux I/O Connector			
		A	C	B*	D
M_AUX_IO*n* for M_DEV*m*†	n	12	12	13	13
	m	0	1	2	3
Functionality that can be routed or received	Acquisition path‡	LVDS_AUX_OUT7	LVDS_AUX_OUT15	LVDS_AUX_OUT23	LVDS_AUX_OUT31
Timer (M_TIMER*n*†)	0	1/2			
	1		1/2		
	2			1/2	
	3				1/2
Trigger controller affected by input signal§	0				
	1				
	2				
	3				
Timer-clock input	0				
	1				
	2				
	3				
Bit of quadrature input**	0				
	1				
	2				
	3				
User output (bit of main static-user-output register M_USER_BIT*n*†)	0	0			
	1		0		
	2			0	
	3				0

*. Zebra Radient eV-CL SB and Zebra Radient eV-CL DB do not have this connector.

†. MIL constant, where *n* and *m* correspond to the number in the row. M_DEV*m* is the required device number of the digitizer (**MdigAlloc()**) that you must use to access this signal.

‡. Only Zebra Radient eV-CL QB has four acquisition paths. For Zebra Radient eV-CL SB, only information for acquisition path 0 is applicable. For Zebra Radient eV-CL DB, only information for acquisition path 0 and 1 is applicable.

§. Note that there are only 4 trigger controllers per acquisition path.

**. A rotary encoder with quadrature output transmits a two-bit code. The table entries 0 and 1, therefore, denote bit position.

Type of signal	Acquisition path	LVDS cam. ctrl															
		CL connect. 0				CL connect. 1				CL connect. 2				CL connect. 3			
		CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4
VSYNC output	0	1	1	1	1												
	1					1	1	1	1								
	2									1	1	1	1				
	3													1	1	1	1
HSYNC output	0	1	1	1	1												
	1					1	1	1	1								
	2									1	1	1	1				
	3													1	1	1	1
Clock output	0	1	1	1	1												
	1					1	1	1	1								
	2									1	1	1	1				
	3													1	1	1	1

The following table lists the auxiliary input signals (or auxiliary I/O signals set to input) that can be rerouted onto output signals and the output signals onto which they can be rerouted.

			LVDS cam. ctrl																TTL Aux I/O Aux I/O Connector												LVDS Aux Out Aux I/O Connector			
			Camera Link Connector 0				Camera Link Connector 1				Camera Link Connector 2				Camera Link Connector 3				A			C			B*			D			A	C	B*	D
M_AUX_IO*x* or M_CC_IO*y* for M_DEV*z*†		**x**																	8	9	2	8	9	3	8	9	2	8	9	3	12	12	13	13
		y	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4																
		z	0	0	0	0	1	1	1	1	2	2	2	2	3	3	3	3	0	0	0/1	1	1	0/1	2	2	2/3	3	3	2/3	0	1	2	3
Auxiliary input signal (or auxiliary I/O signal set to input)	**M_AUX_IO*x***	**Acquisition path**	CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4	CC1	CC2	CC3	CC4	TTL_AUX_IO_4	TTL_AUX_IO_5	TTL_AUX_IO_6	TTL_AUX_IO_12	TTL_AUX_IO_13	TTL_AUX_IO_14	TTL_AUX_IO_20	TTL_AUX_IO_21	TTL_AUX_IO_22	TTL_AUX_IO_28	TTL_AUX_IO_29	TTL_AUX_IO_30	LVDS_AUX_OUT7	LVDS_AUX_OUT15	LVDS_AUX_OUT23	LVDS_AUX_OUT31
TTL_AUX_IO_4	8	0	•	•	•	•																												
TTL_AUX_IO_5	9	0																																
TTL_AUX_IO_6	2	0/1	•	•	•	•	•	•	•	•																								
TTL_AUX_IO_12	8	1					•	•	•	•																								
TTL_AUX_IO_13	9	1																																
TTL_AUX_IO_14	3	0/1																																
TTL_AUX_IO_20*	8	2									•	•	•	•																				
TTL_AUX_IO_21*	9	2																																
TTL_AUX_IO_22*	2	2/3									•	•	•	•	•	•	•	•																
TTL_AUX_IO_28	8	3													•	•	•	•																
TTL_AUX_IO_29	9	3																																
TTL_AUX_IO_30	3	2/3																																

			LVDS cam. ctrl																TTL Aux I/O Aux I/O Connector												LVDS Aux Out Aux I/O Connector			
			Camera Link Connector 0				Camera Link Connector 1				Camera Link Connector 2				Camera Link Connector 3				A			C			B*			D			A	C	B*	D
M_AUX_IO*x* or M_CC_IO*y* for M_DEV*z*†		x																	8	9	2	8	9	3	8	9	2	8	9	3	12	12	13	13
		y	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4																
		z	0	0	0	0	1	1	1	1	2	2	2	2	3	3	3	3	0	0	0/1	1	1	0/1	2	2	2/3	3	3	2/3	0	1	2	3
Auxiliary input signal (or auxiliary I/O signal set to input)	**M_AUX_IO*x***	**Acquisition path**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**	TTL_AUX_IO_4	TTL_AUX_IO_5	TTL_AUX_IO_6	TTL_AUX_IO_12	TTL_AUX_IO_13	TTL_AUX_IO_14	TTL_AUX_IO_20	TTL_AUX_IO_21	TTL_AUX_IO_22	TTL_AUX_IO_28	TTL_AUX_IO_29	TTL_AUX_IO_30	LVDS_AUX_OUT7	LVDS_AUX_OUT15	LVDS_AUX_OUT23	LVDS_AUX_OUT31
OPTO_AUX_IN0	6	0																																
OPTO_AUX_IN1	7	0	•	•	•	•																												
OPTO_AUX_IN8	0	0/1					•	•	•	•																								
OPTO_AUX_IN9	1	0/1	•	•	•	•	•	•	•	•																								
OPTO_AUX_IN16	6	2																																
OPTO_AUX_IN17	7	2									•	•	•	•																				
OPTO_AUX_IN24	0	2/3													•	•	•	•																
OPTO_AUX_IN25	1	2/3									•	•	•	•	•	•	•	•																
LVDS_AUX_IN2	10	0	•	•	•	•																												
LVDS_AUX_IN3	11	0																																
LVDS_AUX_IN10	4	0/1					•	•	•	•																								
LVDS_AUX_IN11	5	0/1	•	•	•	•	•	•	•	•																								
LVDS_AUX_IN18‡	10	2									•	•	•	•																				
LVDS_AUX_IN19‡	11	2																																
LVDS_AUX_IN26	4	2/3													•	•	•	•																
LVDS_AUX_IN27	5	2/3									•	•	•	•	•	•	•	•																

*. Zebra Radient eV-CL SB and Zebra Radient eV-CL DB do not have this connector or signal.

†. MIL constant, where *x*, *y*, and *z* correspond to the numbers in the row. M_DEV*z* is the required device number of the digitizer (**MdigAlloc()**) that you must use to access this signal.

‡. Zebra Radient eV-CL SB and Zebra Radient eV-CL DB does not have this signal.

Camera control and auxiliary signals for Zebra Radient eV-CL SF/DF

The following tables summarize the auxiliary functionality that the PSGs support, and the corresponding signals that the PSGs can receive/generate, for Zebra Radient eV-CL SF/DF. The table also documents the MIL constants to use.

		LVDS cam. ctrl Camera Link Connector 0				LVDS cam. ctrl Camera Link Connector 2*			
M_CC_IO*n*	**n**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
for M_DEV*m*†	**m**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
Functionality that can be routed	**Acquisition path**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**
Timer (M_TIMER*n*†)	0	1/2	1/2	1/2	1/2				
	1					1/2	1/2	1/2	1/2
User output (bit of Camera Link static-user-output register M_USER_BIT_CC_IO*n*†)	0	0/1	0/1	0/1	0/1				
	1					0/1	0/1	0/1	0/1

*. Only available on Zebra Radient eV-CL DF.

†. MIL constant, where *n* and *m* correspond to the number in the row. M_DEV*m* is the required device number of the digitizer (**MdigAlloc()**) that you must use to access this signal.

		TTL Aux I/O Aux I/O Connector								OPTO Aux In Aux I/O Connector								LVDS Aux In Aux I/O Connector								LVDS Aux Out Aux I/O Connector	
		A			C	B*			D	A		C		B*		D		A		C		B*		D		A	B*
M_AUX_IO*n* for M_DEV*m*†	**n**	8	9	2	3	8	9	2	3	6	7	0	1	6	7	0	1	10	11	4	5	10	11	4	5	12	13
	m	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	1
Functionality that can be routed or received	**Acquisition path‡**	TTL_AUX_IO_4	TTL_AUX_IO_5	TTL_AUX_IO_6	TTL_AUX_IO_14	TTL_AUX_IO_20	TTL_AUX_IO_21	TTL_AUX_IO_22	TTL_AUX_IO_30	OPTO_AUX_IN0	OPTO_AUX_IN1	OPTO_AUX_IN8	OPTO_AUX_IN9	OPTO_AUX_IN16	OPTO_AUX_IN17	OPTO_AUX_IN24	OPTO_AUX_IN25	LVDS_AUX_IN2	LVDS_AUX_IN3	LVDS_AUX_IN10	LVDS_AUX_IN11	LVDS_AUX_IN18	LVDS_AUX_IN19	LVDS_AUX_IN26	LVDS_AUX_IN27	LVDS_AUX_OUT7	LVDS_AUX_OUT23
Timer (M_TIMER*n*†)	0		1	2																						1/2	
	1						1	2																			1/2
Trigger controller affected by input signal§	0	T0	T1	T2	T3					T0	T1	T2	T3					T0	T1	T2	T3						
	1					T0	T1	T2	T3					T0	T1	T2	T3					T0	T1	T2	T3		
Timer-clock input	0																		0								
	1																						0				
Bit of quadrature input**	0																	0	1								
	1																					0	1				
User output (bit of main static-user-output register M_USER_BIT*n*†)	0	2	3	4	5																					0	
	1					2	3	4	5																		0

*. Zebra Radient eV-CL SF does not have this connector.

†. MIL constant, where *n* and *m* correspond to the number in the row. M_DEV*m* is the required device number of the digitizer (**MdigAlloc()**) that you must use to access this signal.

‡. Only Zebra Radient eV-CL DF has two acquisition paths. For Zebra Radient eV-CL SF, only information for acquisition path 0 is applicable.

§. Note that there are only 4 trigger controllers per acquisition path.

**. A rotary encoder with quadrature output transmits a two-bit code. The table entries 0 and 1, therefore, denote bit position.

Type of signal	Acquisition path	LVDS cam. ctrl CL connect. 0 CC1	CC2	CC3	CC4	CL connect. 2 CC1	CC2	CC3	CC4
VSYNC output	0	1	1	1	1				
	1					1	1	1	1
HSYNC output	0	1	1	1	1				
	1					1	1	1	1
Clock output	0	1	1	1	1				
	1					1	1	1	1

The following table lists the auxiliary input signals (or auxiliary I/O signals set to input) that can be rerouted onto output signals and the output signals onto which they can be rerouted.

			LVDS cam. ctrl								TTL Aux I/O Aux I/O Connector								LVDS Aux Out Aux I/O Connector	
			Camera Link Connector 0				Camera Link Connector 2				A			C	B*			D	A	B*
M_AUX_IO*x* or M_CC_IO*y* for M_DEV*z*†		**x**									8	9	2	3	8	9	2	3	12	13
		y	1	2	3	4	1	2	3	4										
		z	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	1
Auxiliary input signal (or auxiliary I/O signal set to input)	**M_AUX_IO*x***	**Acquisition path**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**	TTL_AUX_IO_4	TTL_AUX_IO_5	TTL_AUX_IO_6	TTL_AUX_IO_14	TTL_AUX_IO_20	TTL_AUX_IO_21	TTL_AUX_IO_22	TTL_AUX_IO_30	LVDS_AUX_OUT7	LVDS_AUX_OUT23
TTL_AUX_IO_4	8	0	•	•	•	•														
TTL_AUX_IO_5	9	0																		
TTL_AUX_IO_6	2	0	•	•	•	•														
TTL_AUX_IO_14	3	0																		
TTL_AUX_IO_20*	8	1					•	•	•	•										
TTL_AUX_IO_21*	9	1																		
TTL_AUX_IO_22*	2	1					•	•	•	•										
TTL_AUX_IO_30	3	1																		
OPTO_AUX_IN0	6	0																		
OPTO_AUX_IN1	7	0	•	•	•	•														
OPTO_AUX_IN8	0	0																		
OPTO_AUX_IN9	1	0	•	•	•	•														
OPTO_AUX_IN16	6	1																		
OPTO_AUX_IN17	7	1					•	•	•	•										
OPTO_AUX_IN24	0	1																		
OPTO_AUX_IN25	1	1					•	•	•	•										

			LVDS cam. ctrl								TTL Aux I/O Aux I/O Connector								LVDS Aux Out Aux I/O Connector	
			Camera Link Connector 0				Camera Link Connector 2				A			C	B*			D	A	B*
M_AUX_IO*x* or M_CC_IO*y* for M_DEV*z*†		**x**									8	9	2	3	8	9	2	3	12	13
		y	1	2	3	4	1	2	3	4										
		z	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	1
Auxiliary input signal (or auxiliary I/O signal set to input)	**M_AUX_IO*x***	**Acquisition path**	**CC1**	**CC2**	**CC3**	**CC4**	**CC1**	**CC2**	**CC3**	**CC4**	TTL_AUX_IO_4	TTL_AUX_IO_5	TTL_AUX_IO_6	TTL_AUX_IO_14	TTL_AUX_IO_20	TTL_AUX_IO_21	TTL_AUX_IO_22	TTL_AUX_IO_30	LVDS_AUX_OUT7	LVDS_AUX_OUT23
LVDS_AUX_IN2	10	0	•	•	•	•														
LVDS_AUX_IN3	11	0																		
LVDS_AUX_IN10	4	0																		
LVDS_AUX_IN11	5	0	•	•	•	•														
LVDS_AUX_IN18‡	10	1					•	•	•	•										
LVDS_AUX_IN19‡	11	1																		
LVDS_AUX_IN26	4	1																		
LVDS_AUX_IN27	5	1					•	•	•	•										

*. Zebra Radient eV-CL SF does not have this connector or signal.

†. MIL constant, where *x*, *y*, and *z* correspond to the numbers in the row. M_DEV*z* is the required device number of the digitizer (**MdigAlloc()**) that you must use to access this signal.

‡. Zebra Radient eV-CL SF does not have this signal.

Specifications of the auxiliary signals

Zebra Radient eV-CL has auxiliary signals in the following formats:

Signal Format	Total # of signals									
	eV-CL SF		eV-CL DF		eV-CL SB		eV-CL DB		eV-CL QB	
	No cable bracket	With cable bracket	No cable bracket	With cable bracket	No cable bracket	With cable bracket	No cable bracket	With cable bracket	No cable bracket	With cable bracket
Total number of auxiliary signals	8	24	16	32	8	24	8	24	16	32
TTL auxiliary input or output signals	3	9	6	12	3	9	3	9	6	12
Opto-isolated auxiliary input signals	2	6	4	8	2	6	2	6	4	8
LVDS auxiliary input signals	2	6	4	8	2	6	2	6	4	8
LVDS auxiliary output signals	1	3	2	4	1	3	1	3	2	4
LVDS camera control output signals	4	4	8	8	4	4	8	8	16	16

When you route an external signal to an auxiliary signal or vice versa, verify that the external signal meets the electrical specifications of the auxiliary signal.

When an auxiliary input signal is received in TTL format directly, it will be clamped at a maximum of 5.7 V and at a minimum of -0.7 V to protect the input buffer. Typically, the signal should have a maximum of 5 V and a minimum of 0 V. A signal over 2 V is considered high, while anything less than 0.8 V is considered low.

The opto-isolated auxiliary input signals pass through an opto-coupler, a device that protects the board from outside surges and different ground levels, and allows the frame grabber to be totally isolated. The voltage difference across the positive and negative components of the signal must be between 4.71 V and 9.165 V for logic high, and between -5.0 V and 0.8 V for logic low.

You can set the direction of an auxiliary I/O signal using the MIL-Lite function **MdigControl**() with **M_AUX_SIGNAL_MODE**.

You can set up the auxiliary signals in the DCF. Alternatively, for most commonly used functionalities, you can configure the auxiliary signals using the MIL-Lite function **MdigControl**() (for example, with **M_IO...**, **M_GRAB_TRIGGER...**, **M_TIMER...**, or **M_ROTARY_ENCODER...**).

Timers

Zebra Radient eV has four 16-bit timers, which operate on a specified clock source. Timer output signals allow you to control the exposure time and other external events related to the video source (such as a strobe). A timer output signal can be output on any of the auxiliary output signals or auxiliary I/O signals in output mode.

The timers can use one of the following as a clock source:

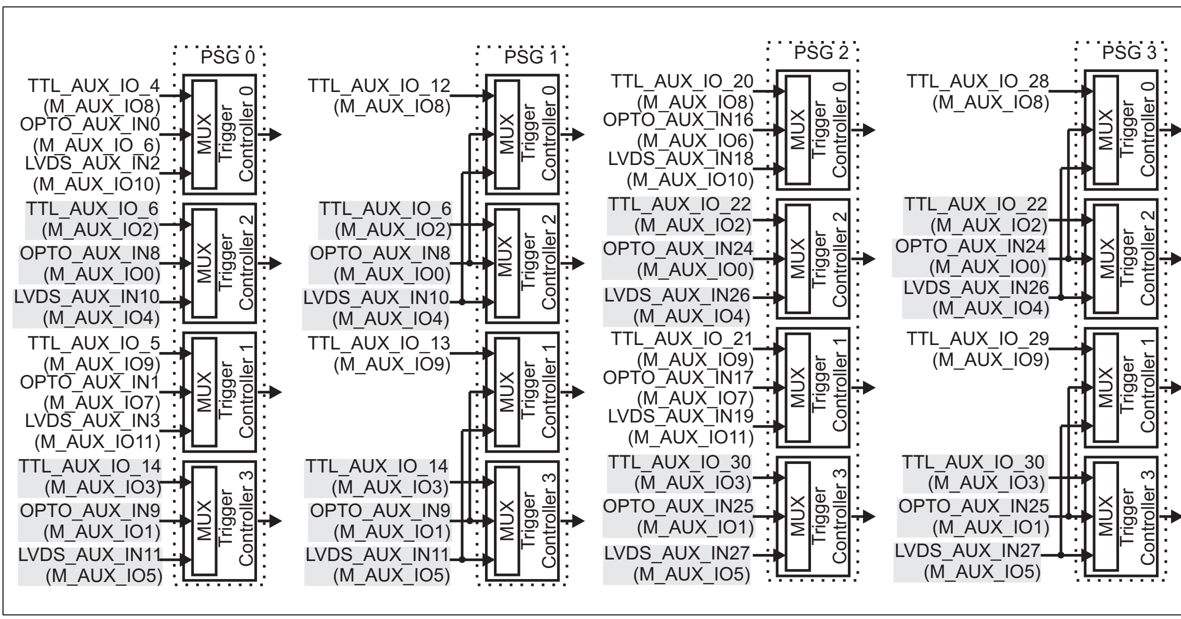
- **A 125 MHz internal clock source.**
- **A clock based on the output of another timer set in continuous mode.**
- **A clock based on the HSYNC or VSYNC signal of your camera.**
- **A clock based on the pixel clock signal of your camera.**

To route a timer output on an auxiliary signal, use the MIL-Lite function **MdigControl**() with **M_IO_SOURCE + M_AUX_IOn** set to **M_TIMERm**. To set up a timer, use **MdigControl**() with **M_TIMER_...**.

Trigger

You can use as a trigger any of the auxiliary input signals (or auxiliary I/O signals in input mode). A trigger signal can be used to initiate image acquisition or prompt an on-board event.

For Zebra Radient eV-CL, each PSG has 4 trigger controllers. Each trigger controller can trigger the image acquisition, the timers, and/or the synchronization signals of the PSG's acquisition path. Only one auxiliary signal per trigger controller can be programmed as a trigger input signal. The auxiliary signals are restricted to specific trigger controllers.



Timing requirements

When you use an auxiliary input signal as a trigger, the pulse width of the signal must be at least 16 nsec (2 clock periods at 125 MHz).

To enable grabbing upon a trigger, use the MIL-Lite function **MdigControl**() with **M_GRAB_TRIGGER_STATE.** To set the signal used to trigger the grab, use **MdigControl**() with **M_GRAB_TRIGGER_SOURCE.** To start a timer upon a trigger, use **MdigControl**() with **M_TIMER_TRIGGER_SOURCE**.

Quadrature decoder

Zebra Radient eV-CL features quadrature decoders. They are used to decode quadrature input received from a rotary or linear encoder with quadrature output. A rotary encoder is a device that provides information about the position and direction of a rotating shaft (for example, that of a conveyor belt); a linear encoder is a device that provides information about the position and direction of a moving sensor along a scale. Encoders with quadrature output transmit a two-bit code (also known as Gray code) on two pairs of LVDS wires for each change in position of the rotating shaft, or of the sensor along the scale. For a given direction, the encoder outputs the code in a precise sequence (either 00 - 01 - 11 - 10 or 00 - 10 - 11 - 01, depending on how the encoder is attached). If the rotating shaft, or sensor moving along the scale, changes direction, the rotary encoder transmits the Gray code in the reverse sequence (00 - 10 - 11 - 01 or 00 - 01- 11 - 10, respectively). Zebra Radient eV-CL has one quadrature decoder for each acquisition path.

Upon decoding a Gray code, the quadrature decoder increments or decrements its 32-bit internal counter, depending on the direction of movement. You can configure which Gray code sequence represents forward movement and increments the counter; the reverse Gray code sequence will then represent the backward direction and decrement the counter. You can specify the direction of movement occurring when the Gray code sequence is 00 - 01 - 11 - 10, using **MdigControl**() with **M_ROTARY_ENCODER_DIRECTION.**

The quadrature decoder supports encoder frequencies of up to 50 MHz. The LVDS receivers of the Zebra Radient eV-CL board support an input voltage from -4 V to +5 V on either LVDS signal, and a maximum differential of 3 V between the two LVDS signals.

❖ Note that an external source must be used to power the rotary encoder (for example, your computer’s 5 V power source).

You can configure the quadrature decoder’s settings, using the MIL-Lite function **MdigControl**() with **M_ROTARY_ENCODER...**, or by modifying the DCF file with Matrox Intellicam.

User signals

Auxiliary signals can also be used to transmit or receive application-specific user output and/or input.

If you want to start or stop an external event based on some calculation or analysis, you can manually set the state of any auxiliary output signal (or I/O signal set to output) to high or low. To do so, you set the state (on/off) of a bit in a user settable register (static-user-output register). When the bit is on, its associated auxiliary output signal will be high; when it is off, the auxiliary output signal will be low. This bit is referred to as a user-bit. To route the state of a user-bit to an auxiliary output signal, use **MdigControl**() with **M_IO_SOURCE** and **M_USER_BITn**; to set the state of a user-bit, use **MdigControl**() with **M_USER_BIT_STATE**.

Your application can also act upon and interpret the state of an auxiliary input signal (or I/O signal set to input). The state of an auxiliary input signal is not associated with a user-bit; you poll the state of the signal directly. To poll the state of an auxiliary input signal, use **MdigInquire**() with **M_IO_STATUS**. The state of an auxiliary input signal can also generate an interrupt; to do so, use **MdigControl**() with **M_IO_INTERRUPT_STATE** and then use **MdigHookFunction**() with **M_IO_CHANGE** to hook a function to this event (that is, to set up an event handler).

Acquisition memory

Zebra Radient eV-CL is equipped with DDR3 SDRAM acquisition memory, which is used to store acquired images. The memory interface has multiple input ports. Zebra Radient eV-CL has the following amount of memory and its memory interface has the following transfer rate:

Zebra Radient eV-CL board	DDR3 SDRAM	Memory interface data transfer rate
eV-CL SB	256 Mbytes	1.6 Gbytes/sec
eV-CL x4 DB	512 Mbytes	4.25 Gbytes/sec
eV-CL x8 DB	1 Gbytes	8.5 Gbytes/sec
eV-CL QB	1 Gbytes	8.5 Gbytes/sec
eV-CL x4 SF	512 Mbytes	4.25 Gbytes/sec
eV-CL x8 SF	1 Gbytes	8.5 Gbytes/sec
eV-CL DF	1 Gbytes	8.5 Gbytes/sec

All Zebra Radient eV-CL models have 128 Mbytes of memory mapped onto the PCIe bus, with the exception of Zebra Radient eV-CL SB which has 64 Mbytes. You can use a Host pointer to access this memory, or you can access it directly from another PCIe bus master; this memory is referred to as shared memory. To allocate a buffer in shared memory, use the MIL-Lite function **MbufAlloc...**() with **M_ON_BOARD + M_SHARED**.

Frame burst technology

Some modes* of Zebra Radient eV-CL support frame burst technology. This technology allows you to grab a group of sequential frames into a multi-frame image buffer with one grab command; the defined number of frames are stored contiguously in the same buffer. The end-of-grab event only occurs once the entire group of frames has been grabbed, reducing the number of events that need to be handled. This is useful in cases where you have a high frame rate and need to ensure that no frames are dropped.

Since Zebra Radient eV-CL will wait for the specified number of frames to complete before sending data to the Host, you could experience latency if the last frame has not reached the minimum frame count for a frame burst, or the acquisition of the last frame has stalled. To prevent frame-burst latency, you can use the state of an auxiliary I/O signal, adjust the frame count, or enable frame burst timeout.

To grab a group of sequential frames with one grab command (**MdigGrab**(), or one grab of **MdigProcess**()), grab into a multi-frame image buffer. To create such a buffer, allocate an image buffer with a height that is the product of the Y-size of an individual frame and the number of frames that will be grabbed into the buffer on each grab command. Then, set the number of frames to grab in the image buffer using **MdigControl**() with **M_GRAB_GRAME_BURST_SIZE** before calling the grab command.

*. Frame burst is available when using modes with all the taps adjacent. For information or requests regarding other modes, please contact Zebra customer support.

Data conversion

Data can be modified both before it is saved to on-board memory and as it is being transferred to the Host.

Lookup tables

Zebra Radient eV has on-board lookup tables (LUTs) that can be used to precondition input data at acquisition time, before it is stored in memory.

There is one LUT palette available per acquisition path (CoaXPress connection) for 8- and 10-bit monochrome or color data; for color data, all color components map through the same LUT palette. For 12-bit monochrome or color data, all acquisition paths use the same palette; for color data, the same palette is used for all color components. For 14- and 16-bit data, a transparent LUT palette is used. The LUTs are programmed using the MIL-Lite function **MdigControl**() with **M_LUT_ID**.

Bayer color decoder

As data from on-board memory is transmitted to the Host, it can pass through the Bayer color decoder. The Bayer color decoder converts Bayer color encoded images (GB, BG, GR, and RG pattern support) to multi-band RGB images using a 2x2 average demosaicing algorithm. The maximum line width for Bayer color conversion is 16 Kbytes.

Color space converter and image formatter

As data from on-board memory or the Bayer color decoder is transmitted to the Host, is passes through the color space converter and image formatter. The color space converter and image formatter can convert data in the following ways:

- **Subsampling.** Image data can be subsampled.

  The color space converter and image formatter can subsample in the horizontal and vertical directions by integer factors of 1 to 16. The color space converter and image formatter uses nearest-neighbor interpolation.

You can use any of the following MIL-Lite functions to subsample image data:

- **MdigControl**() with **M_GRAB_SCALE_X/Y** and the subsampling factors.

- **MimResize**() with ScaleFactorX and ScaleFactorY set to the subsampling factors.

- **MbufTransfer**() with **M_COPY + M_SCALE** and setting the destination buffer size smaller than the original image.

Note that Zebra Radient eV does not support cropping in hardware. However, you can have image data cropped during transfer to Host using **MdigControl**() with **M_SOURCE_SIZE_X/Y** and **M_SOURCE_OFFSET_X/Y.**

- **Flipping.** Images can be flipped horizontally or vertically, using the MIL-Lite function **MdigControl**() with **M_GRAB_DIRECTION_X/Y** or when calling **MimFlip**() from on-board buffer to Host.

- **Color space conversion.** The color space converter and image formatter formats an image based on its type and the bit-depth and color format of the destination buffer. You can set the bit depth and color format of the destination buffer when you allocate it using the MIL-Lite function **MbufAlloc...**(). The format of the source image is established in the DCF.

  Image data can be converted as follows:

Input format	Output format							
	8-bit monochrome	16-bit monochrome	24-bit packed BGR	32-bit packed BGRa	48-bit packed BGR	16-bit YUV (YUYV)	24-bit RGB planar	48-bit RGB planar
8-bit monochrome	yes		yes	yes		yes	yes	
16-bit monochrome	yes	yes	yes	yes	yes	yes	yes	yes
24-bit packed BGR	yes		yes	yes		yes	yes	
48-bit packed BGR	yes	yes	yes	yes	yes	yes	yes	yes

The equations for the YUV16 conversion are described in the following table. The value of *depth* is either 8 or 16 when converting BGR24 or BGR48 data, respectively. Note that while performing BGR48-to-YUV color space conversion, the operations are carried out on 16-bit data; then, each resulting YUV component is bit-shifted right by 8 bits (>> (*depth* - 8) where the value of *depth* is 16).

Color space conversion	Equations
BGR-to-YUV	• $Y = (0.114B + 0.587G + 0.299R) >> (depth - 8)$ • $U = (0.500B - 0.331G - 0.169R + 2^{(depth-1)}) >> (depth - 8)$ • $V = (-0.081B - 0.419G + 0.500R + 2^{(depth-1)}) >> (depth - 8)$

Host interface

The Zebra Radient eV-CL PCIe 2.1 Host interface is capable of high-speed DMA transfers to Host memory, or other memory mapped onto the PCIe bus. The DMA write engine of the Host interface is capable of performing the transfers without the help of the Host CPU.

Zebra Radient eV-CL uses PCIe 2.1 technology to communicate with the Host with a 256-byte payload. The table below presents the peak transfer rate and optimal lanes for each board.

Zebra Radient eV-CL board	Peak transfer rate to the Host	Optimal active lanes
Zebra Radient eV-CL SB	500 Mbytes/sec*	2.x slot with 8 active lanes
Zebra Radient eV-CL x 4 DB	2 Gbytes/sec*	2.x slot with 4 active lanes
Zebra Radient eV-CL QB	4 Gbytes/sec*	2.x slot with 8 active lanes
Zebra Radient eV-CL x 4 SF	2 Gbytes/sec*	2.x slot with 4 active lanes
Zebra Radient eV-CL DF	4 Gbytes/sec*	2.x slot with 8 active lanes
Zebra Radient eV-CL SB	4 Gbytes/sec*	2.x slot with 1 active lane

*. Note that these are theoretical maximums. The actual maximum throughput is closer to 3 Gbytes/sec for eV-CL x8 DB, QB, x8 SF, and DF, 1.8 Gbytes/sec for eV-CL x4 DB and x4 SF, and 425 Mbytes/sec for eV-CL SB.

DMA write performance is chipset and computer dependent, and is slightly affected by the image size and alignment in Host memory.

The Zebra Radient eV-CL Host interface has four DMA write contexts, which act independently, simulating four DMA write engines running in parallel. The presence of multiple DMA contexts does not change the maximum bandwidth, but can help reduce latency.

Appendix A: Glossary

This appendix defines some of the specialized terms used in the Zebra Radient eV-CL documentation.

Glossary

- **Acquisition path.**

  A path that has the components to, for example, digitize or capture a video input signal. Some video sources require multiple acquisition paths.

- **ASPM.**

  Active State Power Management. A hardware PCIe mechanism that autonomously controls power consumption of the PCIe connectors in a computer. The actual power consumed by a PCIe device depends on the PCIe traffic and on the power-saving level to which the PCIe slot is configured. The power-saving level of the PCIe slot is initialized by the operating system.

- **Auxiliary I/O signals.**

  Auxiliary input/output signals. Non-video digital signals that can support one or more functionalities depending on the auxiliary signal (for example, trigger input or timer output).

- **Bandwidth.**

  A term describing the capacity to transfer data. Greater bandwidth is needed to sustain a higher transfer rate. Greater bandwidth can be achieved, for example, by using a wider bus or by increasing the clock frequency at which an interface or a processing core operates (for example, increasing the DDR3 SDRAM clock frequency).

- Camera Link.

  A serial communication protocol standard designed for computer vision applications based on the National Semiconductor interface Channel-link. It was designed for the purpose of standardizing scientific and industrial video products including cameras, cables and frame grabbers.

- **Contiguous memory.**

  A block of memory occupying a single, unbroken series of addresses.

- **DCF.**

  Digitizer configuration format. A format that defines how the video source and the frame grabber are configured. The video source and the frame grabber are set to the specified camera mode, which defines the format of transferred data. The DCF can also configure the triggers, timers, and quadrature decoders.

  DCF files have a *.dcf* extension.

- **DDR3 SDRAM.**

  Double-data-rate type 3 synchronous dynamic random-access memory. A type of general purpose consumer RAM. DDR3 SDRAM allows for data transfer at very high speeds, which is important for I/O-bound functions. This type of memory is inexpensive, high density, and very efficient as long as the data is accessed contiguously.

- **Digitizer configuration format.**

  See *DCF*.

- **Dynamic range.**

  The range of values present in a buffer. An unsigned 8-bit buffer, for example, has an allowable range of 0 to 255; its dynamic range can be any range within these values.

- **Exposure time.**

  Refers to the period during which the image sensor of a video source is exposed to light. As the length of this period increases, so does the image brightness.

- **Frame.**

  A single image grabbed from a video source.

- **Grab.**

  To acquire an image from a video source.

- **Latency.**

  The time from when a command is sent to when its operation is started.

- **Linear encoder.**

  A device that provides information about the linear position and direction of a moving sensor along a scale, either as an analog or digital code.

- **LVDS.**

  Low-voltage differential signaling. LVDS offers a general-purpose, high bandwidth interface standard for serial and parallel data interfaces that require increased bandwidth at high speed, with low noise and power consumption.

- **PCIe.**

  Peripheral Component Interconnect Express. The standard used for the computer bus that acts as an interface between hardware devices, such as Zebra Radient eV, and your computer.

- **Payload.**

  The amount of data transmitted to the PCIe bus within each data packet. Common payload sizes are 128, 256, 512, 1024, 2048, and 4096 bytes.

- **PoCL.**

  Power-over-CameraLink. Power-over-CameraLink is the term for power transmitted to a video source over a CameraLink cable using the CameraLink standard. Power can be provided to a video source, at up to 4.8 W per cable, at a nominal voltage of 12 V. An on-board fuse can sustain a current of 0.75 A.

- **Quadrature decoder.**

  A device that decodes input received from a linear or rotary encoder with quadrature output.

- **Real-time processing.**

  The processing of an image at the same speed or faster than the speed at which images are grabbed. Real-time processing ensures that no frames are missed.

  Also known as *live processing*.

- **Rotary encoder.**

  A device used to convert the angular position of a shaft or axle to an analog or digital code.

- **Timer output.**

  The signal generated by one of the programmable timers of the frame grabber. The timer output can be used to control external hardware. For example, it can be fed to the video source to control its exposure time or can be used to fire a strobe light.

Appendix B: Technical information

This appendix contains information that might be useful when installing your Zebra Radient eV-CL board.

Board summary

Global information

- Operating system: See your software manual for supported versions of Microsoft Windows and Linux.

- Minimum computer requirements:

  - PCIe 2.x x1, x4, x8, or x16 slot[*].

  - Processor with an Intel 64-bit architecture, or equivalent.

  - A relatively up-to-date PCIe chipset. A chipset that supports the PCIe 2.x standard is preferable.

  - A proper power supply. Refer to the *Electrical specifications* section.

Zebra does not guarantee compatibility with all computers that have the above specifications. Please consult with your local Zebra representative, local Zebra sales office, the Zebra web site, or the Zebra Customer Support Group at headquarters before using a specific computer.

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*. Note that you can install Zebra Radient eV-CL in any mechanical PCIe slot that fits your board (for example, connecting to open-ended connectors). The mechanical width of the connector does not always indicate the amount of electrically connected lanes it has. For example, you can install a x8 board in a PCIe x4 slot that has a mechanical x8 connector; however, the maximum transfer rate between Zebra Radient eV-CL and the Host is reduced by 50%. Also, if you install it in a PCIe slot that is of an earlier version than the capabilities of the board, then the maximum bandwidth/transfer rate will also be affected.

Technical features of Zebra Radient eV-CL boards

- Has a PCIe 2.1 x8[*] Host interface, except for the x4 version of Zebra Radient eV-CL SF and DB, and Zebra Radient eV-CL SB. The latter has a PCIe x1 Host interface.

- Zebra Radient eV-CL SB has a single acquisition path.
Zebra Radient eV-CL DB has two independent acquisition paths, and
Zebra Radient eV-CL QB has four independent acquisition paths. Each acquisition path supports a video source in the Camera Link Base configuration.

- Zebra Radient eV-CL SF has a single acquisition path;
Zebra Radient eV-CL DF has two acquisition paths. Each acquisition path supports a video source in the Camera Link Medium, Full, or 80-bit configuration.

- Can provide power over Camera Link (PoCL) with SafePower. The PoCL protection on-board fuse can sustain a current of 0.75 A.

- Has four camera control signals (rerouting of specific auxiliary input signals, HSYNC output, VSYNC output, clock output, timer output, or user output) per acquisition path[†].

- Supports extended Camera Link cables, for a cable length up to 15 m at 85 MHz.

- Has up to 32 auxiliary signals that can be path independent or path dependent, depending on the functionality[‡] selected[*]. When path dependent, there are:

  - Three TTL auxiliary I/O signals (trigger input or user input, or timer output or user output) per acquisition path.

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*. Be aware that if you install it in a PCIe slot that has less PCIe lanes or is of an earlier version than the capabilities of the board, then the maximum bandwidth transfer rate will be affected.

†. See the *Camera control and auxiliary signals for Zebra Radient eV-CL SB/DB/QB* and *Camera control and auxiliary signals for Zebra Radient eV-CL SF/DF* sections in *Chapter 4: Zebra Radient eV-CL hardware reference* chapter for supported functionality.

‡. For example, for Zebra Radient eV-CL SB, eV-CL DB, and eV-CL QB, TTL_AUX_IO_14 can be used as a trigger input when grabbing from acquisition path 0 or 1; however, you can only route timer 2 of acquisition path 1 to this signal.

  - One LVDS auxiliary output signal (timer output or user output) per acquisition path.

  - Two LVDS auxiliary input signals (trigger input, timer-clock input, quadrature input, or user input) per acquisition path.

  - Two opto-isolated auxiliary input signals (trigger input or user input) per acquisition path.

- Supports area-scan and line-scan video sources. The minimum and maximum number of pixels per line are 33 and 65535, respectively.

- Supports video sources with a Bayer color filter. Bayer color encoded images (GB, BG, GR, and RG pattern support) are converted to multi-band RGB images using a 2x2 average demosaicing algorithm. The maximum line width for Bayer color conversion is 16 Kbytes.

- Supports frame burst technology. This technology allows you to grab a group of sequential frames into a multi-frame image buffer with one grab command.

- Can convert 8- or 16-bit monochrome or 24- or 48-bit packed BGR data to monochrome, packed or planar BGR, packed BGRa, or YUV (YUYV) format.

- Can perform horizontal or vertical flipping.

- Can subsample image data by integer subsampling factors of 1 to 16.

- Supports external 5 V linear or rotary encoders with quadrature output, and frequencies of up to 50 MHz. Zebra Radient eV-CL has one quadrature decoder for each acquisition path.

- Has a PoCL LED for each input connector, to identify whether the connector is receiving power. Zebra Radient eV-CL DB and QB have four PoCL LEDs, Zebra Radient eV-CL SF and DF have two, and Zebra Radient eV-CL SB has one.

- Has four board status LEDs to indicate the status of each of the following: power, PCIe, FPGA configured, firmware type loaded.

Electrical specifications

The following table describes the operating voltage and current for the different members of the Zebra Radient eV-CL family.

Operating voltage and current for Zebra Radient eV-CL boards		
Zebra Radient eV-CL		Max. PoCL per connector: 12.0 V, 400 mA: 4.8 W[*] (Current directly drawn from the slot. Power is not dissipated by the board; it is only used by the camera).
	Zebra Radient eV-CL SF/DF and DB/QB	Typical: 3.3 V, 1.4 A: 4.62 W Typical 12.0 V, 1.0 A: 12 W Total dissipated by the board: 4.62 W + 12 W =16.62 W (typical) Total dissipated by board and PoCL video sources = 16.62 W + 19.2 W = 35.82 W (typical)
	Zebra Radient eV-CL SB	Typical: 3.3 V, 225 mA: 0.74 W Typical 12.0 V, 325 mA: 3.9 W Total dissipated by the board: 0.74 W + 3.9 W =4.64 W (typical) Total dissipated by board and PoCL video sources = 16.62 W + 4.8W = 21.42 W (typical)

*. The PoCL protection fuse on Zebra Radient eV-CL can sustain a current of 0.75 A.

The following table describes the specifications for the auxiliary I/O signals on Zebra Radient eV-CL.

I/O Specifications		
	Minimum I/O jitter	+/- 8 ns, for any auxiliary input signal.
	Input signals in LVDS format	100 Ohm differential termination. Input current: -10 µA (min) to +10 µA (max). Common-mode: -4 V (min) to +5 V (max). Differential input: 0.1 V (min) to +3 V (max). Differential threshold: low of -50 mV (negative input voltage); high of +50 mV (positive input voltage).
	Output signals in LVDS format	No parallel termination. Output current: -10 µA to 10 µA. Output voltage: high (V_{oh}) 1.6 V (max), 1.33 V (typ); low (V_{ol}) 0.9 V (min), 1.02 V (typ) Differential output voltage (with load of 100 Ohm): 250 mV (min) to 450 mV (max). Offset voltage (common-mode): 1.125 V (min) to 1.375 V (max). Propagation delay: 2.8 ns (max).
	Input signals in TTL format	No series termination.Doc-10281 Pulled up to 3.3 V with 4.716 K Ohm. Clamped to -0.7 V to +5.7 V. Input current: 5 µA (max). Input voltage: low of 0.8 V (max); high of 2.0 V (min).
	Output signals in TTL format	27 Ohm series termination. High-level output current: -32 mA (max). Low-level output current: +64 mA (max). Output voltage: low of 0.55 V (max); high of 2.0 V (min).
	Opto-coupled input signals*	511 Ohm series termination (connected on the anode inputs of the opto-coupler device). Input current: low: 250 µA (max); high: 5 mA (min (thresholded)) to 15 mA (max) (6.3 to 10 mA recommended). Input voltage: low (V_{il}) of 0.8 V (max); high (V_{ih}) of 4.71 V (min) to 9.165 V (max). Input forward voltage (at 25 degrees C): 1.3 V (min), 1.8 V (max). Propagation delay (at 25 degrees C): 100 ns (max).

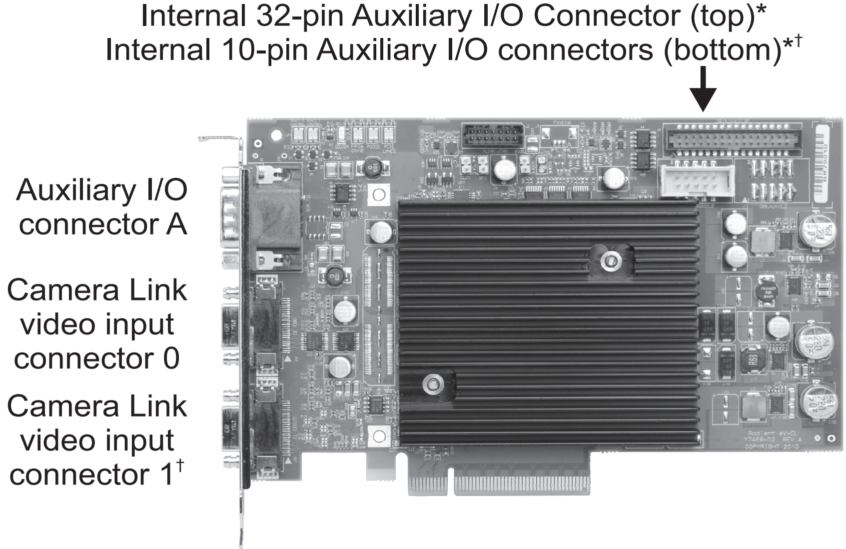
*. The Zebra Radient eV-CL opto-couplers are manufactured by Agilent or Avago Technologies (P/N HCPL-0631).

Dimensions and environmental specifications

- Dimensions from bottom edge of goldfinger to top edge of board. These values respect the dimensions of a PCIe half-length board:
  - Zebra Radient eV-CL SB is a low profile board that comes with a full height bracket: 16.76 L x 6.89 H x 1.871 W cm (6.6" x 2.713" x 0.737").
  - Zebra Radient eV-CL DF/QB: 16.76 L x 11.12 H x 1.871 W cm (6.6" x 4.376" x 0.737") from bottom edge of goldfinger to top edge of board.
- Ventilation: 200 LFM between boards.
- Minimum/maximum ambient operating temperature: 0°C to 55°C (32°F to 131°F).
- Minimum/maximum storage temperature: -40°C to 75°C (-40°F to 167°F).
- Operating relative humidity: up to 95% relative humidity (non-condensing).
- Storage humidity: up to 95% relative humidity (non-condensing).

Connectors on Zebra Radient eV-CL boards

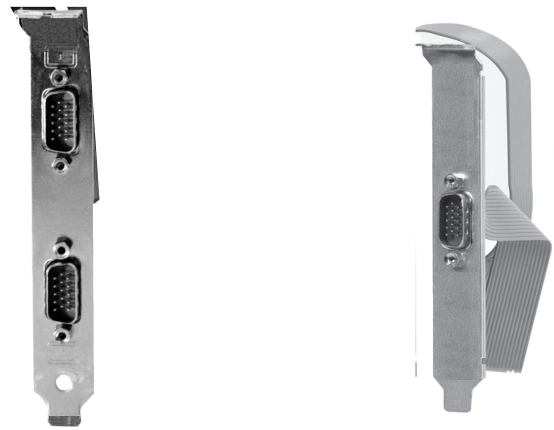
On the Zebra Radient eV-CL boards, there are several interface connectors. On the bracket of Zebra Radient eV-CL SB, there is one Camera Link video input connector and an auxiliary I/O connector. On the bracket of Zebra Radient eV-CL DB and eV-CL SF, there are two Camera Link video input connectors and an auxiliary I/O connector. On the double bracket of Zebra Radient eV-CL QB and eV-CL DF, there are two pairs of Camera Link video input connectors and two auxiliary I/O connectors. In addition, close to the top edge of the main board, there is an internal 32-pin auxiliary I/O connector.



*Use the 32-pin auxiliary I/O connector to connect to the HD-15 cable adapter bracket; Use the 10-pin auxiliary I/O connectors to connect to the DB-9 cable adapter bracket.

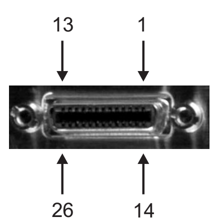
† This 10-pin connector is not available on Zebra Radient eV-CL SB.

On the Zebra Radient eV-CL cable adapter bracket, there is either two HD-15 auxiliary I/O connectors or one DB-9 auxiliary I/O connector*; these allow you to access the signals of the internal auxiliary I/O connector from outside the computer enclosure. See the *External auxiliary I/O connectors* section below for information on how to connect these adapter brackets.



Camera Link video input connectors

The Camera Link video input connectors are 26-pin high-density female mini Camera Link connectors. They are used to receive video input, timing, and synchronization signals and transmit/receive communication signals between the video source and the frame grabber.



The number of Camera Link video input connectors and their pinout depends on the version of Zebra Radient eV-CL and the configuration. The pinout of these connectors follows the Camera Link standard.

*. Note that eV-CL SB does not support the bracket with the DB-9 auxiliary I/O connector.

Zebra Radient eV-CL SB, eV-CL DB, and eV-CL QB

On Zebra Radient eV-CL SB, there is one Camera Link connector. On Zebra Radient eV-CL DB, there are two Camera Link connectors; whereas on Zebra Radient eV-CL QB, there are four Camera Link connectors. Each Camera Link connector supports one video source in Base configuration, and has the same pinout; this pinout is listed in the following table.

Pin	Hardware signal name	MIL constant for auxiliary signal	Description
1	Inner shield		Ground (inner shield), or +12V to camera in PoCL mode.
3+,16-	CC3	M_CC_IO3	Camera control output 3 for acquisition path n, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEVn), user output (M_USER_BIT_CC_IO0/M_USER_BIT_CC_IO1 on M_DEVn), VSYNC, HSYNC, clock output, or rerouting of specific auxiliary input signals*.
5+,18-	CC1	M_CC_IO1	Camera control output 1 for acquisition path n, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEVn), user output (M_USER_BIT_CC_IO0/M_USER_BIT_CC_IO1 on M_DEVn), VSYNC, HSYNC, clock output, or rerouting of specific auxiliary input signals†.
6+,19-	SerTFG		Serial port to frame grabber (UART).
8+,21-	X3		Video input data X3.
9+,22-	Xclk		Clock input X.
10+,23-	X2		Video input data X2.
11+,24-	X1		Video input data X1.
12+,25-	X0		Video input data X0.
13	Inner shield		Ground.
14	Inner shield		Ground.
15+,2-	CC4	M_CC_IO4	Camera control output 4 for acquisition path n, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEVn), user output (M_USER_BIT_CC_IO0/M_USER_BIT_CC_IO1 on M_DEVn), VSYNC, HSYNC, clock output, or rerouting of specific auxiliary input signals†.
17+,4-	CC2	M_CC_IO2	Camera control output 2 for acquisition path n, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEVn), user output (M_USER_BIT_CC_IO0/M_USER_BIT_CC_IO1 on M_DEVn), VSYNC, HSYNC, clock output, or rerouting of specific auxiliary input signals†.
20+,7-	SerTC		Serial port to video source (UART).
26	Inner shield		Ground (inner shield), or +12V to camera in PoCL mode.

*. See the table in the *Auxiliary signals* section of *Chapter 4: Zebra Radient eV-CL hardware reference* for more information on which auxiliary input signals (or auxiliary I/O signals set to input) can be rerouted onto the camera control output signals. Also note that for Zebra Radient eV-CL SB, eV-CL DB and eV-CL QB, n should be replaced by the number of the Camera Link connector to which the video source is connected.

Zebra Radient eV-CL SF and eV-CL DF

On Zebra Radient eV-CL SF, there is one pair (0-1) of Camera Link connectors, whereas on Zebra Radient eV-CL DF, there are two pairs (0-1 and 2-3) of Camera Link connectors. To each pair of connectors, you can connect one video source in Medium, Full, or 80-bit configuration. Each of the connector pairs uses a single acquisition path. In MIL, the (0-1) connector pair uses acquisition path 0 (M_DEV0), and the (2-3) connector pair uses acquisition path 1 (M_DEV1). The top Camera Link connector of each pair has the pinout described above (except replace n with the number of the acquisition path for the connector pair), while the bottom Camera Link connector of each pair has the following pinout.

Warning

❖ When connecting a video source in Medium, Full, or 80-bit configuration, ensure that you are connecting its cables to the appropriate connector. Accidentally connecting the cables to the wrong connector can damage the board or your video source. Pins 2-5 and pins 15-18 are output pins on the top connector (0 and 2), while they are input pins on the bottom connector (1 and 3).

Pin	Hardware signal name	Description
1	GND or PWR_OUT	Ground (inner shield), or +12V to camera in PoCL mode.
2+, 15-	Z3	Video input data Z3.*
3+, 16-	Zclk	Clock input Z.*
4+, 17-	Z2	Video input data Z2.*
5+, 18-	Z1	Video input data Z1.*
6+, 19-	Z0	Video input data Z0.*
7	terminated	Unused.*
8+, 21-	Y3	Video input data Y3.
9+, 22-	Yclk	Clock input Y.
10+, 23-	Y2	Video input data Y2.
11+, 24-	Y1	Video input data Y1.
12+, 25-	Y0	Video input data Y0.
13	Inner shield	Ground.
14	Inner shield	Ground.
20	100 Ω	Unused.*
26	GND or PWR_OUT	Ground (inner shield), or +12V to camera in PoCL mode.

*. When the board is set to the Medium configuration, these pins are reserved.

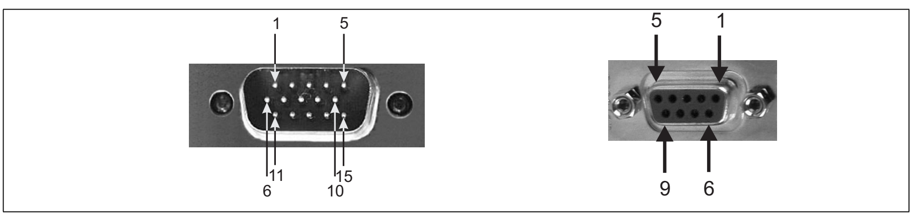
To interface with the above connectors, use a standard Camera Link cable with a 26-pin high-density male mini Camera Link connector (HDR or SDR) at one end. You can purchase such a cable from your video source manufacturer, Components Express inc., 3M Interconnect Solutions for Factory Automation, Intercon 1, or other third parties. Note that this cable is not available from Zebra.

❖ If using both Camera Link connectors to connect to the same video source (Medium configuration or Full configuration), the cables you choose should be of the same type and length. Note, however, if they are not, Zebra Radient eV-CL will adapt to any delay caused by reasonable differences in length.

External auxiliary I/O connectors

The external auxiliary I/O connectors on the Zebra Radient eV-CL bracket and the cable adapter bracket are high-density D-subminiature 15-pin (HD-15*) male connectors. Alternatively, you can use a cable adapter bracket with a standard D-subminiature 9-pin (DB-9) female connector† for auxiliary I/O connectors B and D. The external auxiliary I/O connectors are used to transmit/receive auxiliary signals.

❖ The auxiliary I/O connectors on Zebra Radient eV-CL are not compatible with display devices. Connecting one of the HD-15 connectors on Zebra Radient eV-CL to a VGA monitor or any other display device might damage both the device and the Zebra Radient eV-CL board.



The dual HD-15 connector must be connected to the 32-pin internal connector and the DB-9 connector must be connected to the internal 10-pin connector†. On the cable adapter bracket, the connectors are panel mount connectors.

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*. Sometimes referred to as DB-15, but more accurately known as DE-15.

†. Note that eV-CL SB does not support the bracket with the DB-9 auxiliary I/O connector.

The auxiliary signals can be path independent or path dependent, depending on the functionality selected. For more information, see the *Camera control and auxiliary signals for Zebra Radient eV-CL SB/DB/QB* and *Camera control and auxiliary signals for Zebra Radient eV-CL SF/DF* sections in *Chapter 4: Zebra Radient eV-CL hardware reference* for supported functionality.

Pinouts for auxiliary I/O connectors of Zebra Radient eV-CL SB, eV-CL DB, and eV-CL QB

The pinout for auxiliary I/O connector A is as follows for Zebra Radient eV-CL SB, eV-CL DB, and eV-CL QB.

Pin on HD-15	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	TTL_AUX_IO_4	M_AUX_IO8	M_DEV0	TTL auxiliary signal (input/output) for acquisition path 0, which supports: user input, user output (M_USER_BIT2 on M_DEV0), trigger input (trigger controller 0 on acq path 0).
2	TTL_AUX_IO_5	M_AUX_IO9	M_DEV0	TTL auxiliary signal (input/output) for acquisition path 0, which supports: timer output (M_TIMER1 on M_DEV0), trigger input (trigger controller 1 on acq path 0), user input, or user output (M_USER_BIT3 on M_DEV0).
3	TTL_AUX_IO_6	M_AUX_IO2	M_DEV0/ M_DEV1	TTL auxiliary signal (input/output), shared between acquisition paths 0 and 1 for trigger input (trigger control 2 on acq path 0; 2 on acq path 1*), user input, user output (M_USER_BIT4 on M_DEV0/M_DEV1), and dedicated to acquisition path 0 for timer output (M_TIMER2 on M_DEV0).
4+,5-	LVDS_AUX_IN2	M_AUX_IO10	M_DEV0	LVDS auxiliary signal (input) for acquisition path 0, which supports: trigger input (trigger controller 0 on acq path 0), user input, or quadrature input bit 0.
6+,8-	LVDS_AUX_IN3	M_AUX_IO11	M_DEV0	LVDS auxiliary signal (input) for acquisition path 0, which supports: user input, trigger input (trigger controller 1 on acq path 0), timer-clock input, or quadrature input bit 1.
7	GND	N/A	N/A	Ground.
10	GND	N/A	N/A	Ground.
12+,11-	OPTO_AUX_IN1	M_AUX_IO7	M_DEV0	Opto-isolated auxiliary signal (input) for acquisition path 0, which supports: user input or trigger input (trigger controller 1 on acq path 0).
13+,14-	LVDS_AUX_OUT7	M_AUX_IO12	M_DEV0	LVDS auxiliary signal (output) for acquisition path 0, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEV0) or user output (M_USER_BIT0 on M_DEV0).
15+,9-	OPTO_AUX_IN0	M_AUX_IO6	M_DEV0	Opto-isolated auxiliary signal (input) for acquisition path 0, which supports: user input or trigger input (trigger controller 0 on acq path 0).

*. Trigger controller 2 on acq path 1 is only supported on Zebra Radient eV-CL DB (for hardware signal TTL_AUX_IO_6).

The pinout for auxiliary I/O connector B is as follows for Zebra Radient eV-CL QB.

Pin on HD-15	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	TTL_AUX_IO_20	M_AUX_IO8	M_DEV2	TTL auxiliary signal (input/output) for acquisition path 2, which supports: user input, user output (M_USER_BIT2 on M_DEV2), or trigger input (trigger controller 0 on acq path 2).
2	TTL_AUX_IO_21	M_AUX_IO9	M_DEV2	TTL auxiliary signal (input/output) for acquisition path 2, which supports: timer output (M_TIMER1 on M_DEV2), trigger input (trigger controller 1 on acq path 2), user input, or user output (M_USER_BIT3 on M_DEV2).
3	TTL_AUX_IO_22	M_AUX_IO2	M_DEV2/ M_DEV3	TTL auxiliary signal (input/output), shared between acquisition paths 2 and 3 for trigger input (trigger controller 2 on acq path 2; 2 on acq path 3), user input, user output (M_USER_BIT4 on M_DEV2/M_DEV3), and dedicated to acquisition path 2 for timer output (M_TIMER2 on M_DEV2).
4+,5-	LVDS_AUX_IN18	M_AUX_IO10	M_DEV2	LVDS auxiliary signal (input) for acquisition path 2, which supports: trigger input (trigger controller 0 on acq path 2), user input, or quadrature input bit 0.
6+,8-	LVDS_AUX_IN19	M_AUX_IO11	M_DEV2	LVDS auxiliary signal (input) for acquisition path 2, which supports: user input, trigger input (trigger controller 1 on acq path 2), timer-clock input, or quadrature input bit 1.
7	GND	N/A	N/A	Ground.
10	GND	N/A	N/A	Ground.
12+,11-	OPTO_AUX_IN17	M_AUX_IO7	M_DEV2	Opto-isolated auxiliary signal (input) for acquisition path 2, which supports: user input or trigger input (trigger controller 1 on acq path 2).
13+,14-	LVDS_AUX_OUT23	M_AUX_IO12	M_DEV2	LVDS auxiliary signal (output) for acquisition path 2, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEV2) or user output (M_USER_BIT0 on M_DEV2).
15+,9-	OPTO_AUX_IN16	M_AUX_IO6	M_DEV2	Opto-isolated auxiliary signal (input) for acquisition path 2, which supports: user input or trigger input (trigger controller 0 on acq path 2).

The pinout for auxiliary I/O connector C is as follows for Zebra Radient eV-CL DB and eV-CL QB. It can be accessed through either a HD-15 or DB-9 connector using one of the two adapter brackets.

Pin on HD-15	Pin on DB-9	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	1	TTL_AUX_IO_12	M_AUX_IO8	M_DEV1	TTL auxiliary signal (input/output) for acquisition path 1, which supports: user input, user output (M_USER_BIT2 on M_DEV1), or trigger input (trigger controller 0 on acq path 1).
2	-	TTL_AUX_IO_13	M_AUX_IO9	M_DEV1	TTL auxiliary signal (input/output) for acquisition path 1, which supports: timer output (M_TIMER1 on M_DEV1), trigger input (trigger controller 1 on acq path 1), user input, or user output (M_USER_BIT3 on M_DEV1).
3	-	TTL_AUX_IO_14	M_AUX_IO3	M_DEV0/ M_DEV1	TTL auxiliary signal (input/output), shared between acquisition paths 0 and 1 for trigger input (trigger controller 3 on acq path 0; 3 on acq path 1), user input, user output (M_USER_BIT5 on M_DEV0/M_DEV1), and dedicated to acquisition path 1 for timer output (M_TIMER2 on M_DEV1).
4+,5-	8+,3-	LVDS_AUX_IN10	M_AUX_IO4	M_DEV0/ M_DEV1	LVDS auxiliary signal (input), shared between acquisition paths 0 and 1 for trigger input (trigger controller 2 on acq path 0; 2 or 0 on acq path 1) or user input, and dedicated to acquisition path 1 for quadrature input bit 0.
6+,8-	-	LVDS_AUX_IN11	M_AUX_IO5	M_DEV0/ M_DEV1	LVDS auxiliary signal (input), shared between acquisition paths 0 and 1 for trigger input (trigger controller 1 or 3 on acq path 1; 3 on acq path 0) or user input, and dedicated to acquisition path 1 for timer-clock input or quadrature input bit 1.
7	6	GND	N/A	N/A	Ground.
10	-	GND	N/A	N/A	Ground.
12+,11-	4+,5-	OPTO_AUX_IN9	M_AUX_IO1	M_DEV0/ M_DEV1	Opto-isolated auxiliary signal (input), shared between acquisition paths 0 and 1 for trigger input (trigger controller 1 or 3 on acq path 1; 3 on acq path 0) or user input.
13+,14-	-	LVDS_AUX_OUT15	M_AUX_IO12	M_DEV1	LVDS auxiliary signal (output) for acquisition path 1, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEV1) or user output (M_USER_BIT0 on M_DEV1).
15+,9-	7+,2-	OPTO_AUX_IN8	M_AUX_IO0	M_DEV0/ M_DEV1	Opto-isolated auxiliary signal (input), shared between acquisition paths 0 and 1 for trigger input (trigger controller 0 or 2 on acq path 1; 2 on acq path 0) or user input.
-	9	NC			Not connected.

The pinout for auxiliary I/O connector D is as follows for Zebra Radient eV-CL QB. It can be accessed through either a HD-15 or DB-9 connector using one of the two adapter brackets.

Pin on HD-15	Pin on DB-9	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	1	TTL_AUX_IO_28	M_AUX_IO8	M_DEV3	TTL auxiliary signal (input/output) for acquisition path 3, which supports: user input, user output (M_USER_BIT2 on M_DEV3), or trigger input (trigger controller 0 on acq path 3).
2	-	TTL_AUX_IO_29	M_AUX_IO9	M_DEV3	TTL auxiliary signal (input/output) for acquisition path 3, which supports: timer output (M_TIMER1 on M_DEV3), trigger input (trigger controller 1 on acq path 3), user input, or user output (M_USER_BIT3 on M_DEV3).
3	-	TTL_AUX_IO_30	M_AUX_IO3	M_DEV2/ M_DEV3	TTL auxiliary signal (input/output), shared between acquisition paths 2 and 3 for trigger input (trigger controller 3 on acq path 2; 3 on acq path 3), user input, user output (M_USER_BIT5 on M_DEV2/M_DEV3), and dedicated to acquisition path 3 for timer output (M_TIMER2 on M_DEV3).
4+,5-	8+,3-	LVDS_AUX_IN26	M_AUX_IO4	M_DEV2/ M_DEV3	LVDS auxiliary signal (input), shared between acquisition paths 2 and 3 for trigger input (trigger controller 0 or 2 on acq path 3; 2 on acq path 2) or user input, and dedicated to acquisition path 3 for quadrature input bit 0.
6+,8-	-	LVDS_AUX_IN27	M_AUX_IO5	M_DEV2/ M_DEV3	LVDS auxiliary signal (input), shared between acquisition paths 2 and 3 for trigger input (trigger controller 1 or 3 on acq path 3; 3 on acq path 2) or user input, and dedicated to acquisition path 3 for timer-clock input or quadrature input bit 1.
7	6	GND	N/A	N/A	Ground.
10	-	GND	N/A	N/A	Ground.
12+,11-	4+,5-	OPTO_AUX_IN25	M_AUX_IO1	M_DEV2/ M_DEV3	Opto-isolated auxiliary signal (input), shared between acquisition paths 2 and 3 for trigger input (trigger controller 1 or 3 on acq path 3; 3 on acq path 2) or user input.
13+,14-	-	LVDS_AUX_OUT31	M_AUX_IO12	M_DEV3	LVDS auxiliary signal (output) for acquisition path 3, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEV3) or user output (M_USER_BIT0 on M_DEV3).
15+,9-	7+,2-	OPTO_AUX_IN24	M_AUX_IO0	M_DEV2/ M_DEV3	Opto-isolated auxiliary signal (input), shared between acquisition paths 2 and 3 for trigger input (trigger controller 0 or 2 on acq path 3; 2 on acq path 2) or user input.
	9	NC			Not connected.

Pinouts for auxiliary I/O connectors of Zebra Radient eV-CL SF and eV-CL DF

The pinout for auxiliary I/O connector A is as follows for Zebra Radient eV-CL SF and eV-CL DF.

Pin on HD-15	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	TTL_AUX_IO_4	M_AUX_IO8	M_DEV0	TTL auxiliary signal (input/output) for acquisition path 0, which supports: user input, user output (M_USER_BIT2 on M_DEV0), trigger input (trigger controller 0 on acq path 0).
2	TTL_AUX_IO_5	M_AUX_IO9	M_DEV0	TTL auxiliary signal (input/output) for acquisition path 0, which supports: timer output (M_TIMER1 on M_DEV0), trigger input (trigger controller 1 on acq path 0), user input, or user output (M_USER_BIT3 on M_DEV0).
3	TTL_AUX_IO_6	M_AUX_IO2	M_DEV0	TTL auxiliary signal (input/output), for acquisition paths 0, which supports: trigger input (trigger control 2 on acq path 0), user input, user output (M_USER_BIT4 on M_DEV0), or timer output (M_TIMER2 on M_DEV0).
4+,5-	LVDS_AUX_IN2	M_AUX_IO10	M_DEV0	LVDS auxiliary signal (input) for acquisition path 0, which supports: trigger input (trigger controller 0 on acq path 0), user input, or quadrature input bit 0.
6+,8-	LVDS_AUX_IN3	M_AUX_IO11	M_DEV0	LVDS auxiliary signal (input) for acquisition path 0, which supports: user input, trigger input (trigger controller 1 on acq path 0), timer-clock input, or quadrature input bit 1.
7	GND	N/A	N/A	Ground.
10	GND	N/A	N/A	Ground.
12+,11-	OPTO_AUX_IN1	M_AUX_IO7	M_DEV0	Opto-isolated auxiliary signal (input) for acquisition path 0, which supports: user input or trigger input (trigger controller 1 on acq path 0).
13+,14-	LVDS_AUX_OUT7	M_AUX_IO12	M_DEV0	LVDS auxiliary signal (output) for acquisition path 0, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEV0) or user output (M_USER_BIT0 on M_DEV0).
15+,9-	OPTO_AUX_IN0	M_AUX_IO6	M_DEV0	Opto-isolated auxiliary signal (input) for acquisition path 0, which supports: user input or trigger input (trigger controller 0 on acq path 0).

The pinout for auxiliary I/O connector B is as follows for Zebra Radient eV-CL DF.

Pin on HD-15	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	TTL_AUX_IO_20	M_AUX_IO8	M_DEV1	TTL auxiliary signal (input/output) for acquisition path 1, which supports: user input, user output (M_USER_BIT2 on M_DEV1), or trigger input (trigger controller 0 on acq path 1).
2	TTL_AUX_IO_21	M_AUX_IO9	M_DEV1	TTL auxiliary signal (input/output) for acquisition path 1, which supports: timer output (M_TIMER1 on M_DEV1), trigger input (trigger controller 1 on acq path 1), user input, or user output (M_USER_BIT3 on M_DEV1).
3	TTL_AUX_IO_22	M_AUX_IO2	M_DEV1	TTL auxiliary signal (input/output), for acquisition paths 1 which supports trigger input (trigger controller 2 on acq path 1), user input, user output (M_USER_BIT4 on M_DEV1), and timer output (M_TIMER2 on M_DEV1).
4+,5-	LVDS_AUX_IN18	M_AUX_IO10	M_DEV1	LVDS auxiliary signal (input) for acquisition path 1, which supports: trigger input (trigger controller 0 on acq path 1), user input, or quadrature input bit 0.
6+,8-	LVDS_AUX_IN19	M_AUX_IO11	M_DEV1	LVDS auxiliary signal (input) for acquisition path 1, which supports: user input, trigger input (trigger controller 1 on acq path 1), timer-clock input, or quadrature input bit 1.
7	GND	N/A	N/A	Ground.
10	GND	N/A	N/A	Ground.
12+,11-	OPTO_AUX_IN17	M_AUX_IO7	M_DEV1	Opto-isolated auxiliary signal (input) for acquisition path 1, which supports: user input or trigger input (trigger controller 1 on acq path 1).
13+,14-	LVDS_AUX_OUT23	M_AUX_IO12	M_DEV1	LVDS auxiliary signal (output) for acquisition path 1, which supports: timer output (M_TIMER1/M_TIMER2 on M_DEV1) or user output (M_USER_BIT0 on M_DEV1).
15+,9-	OPTO_AUX_IN16	M_AUX_IO6	M_DEV1	Opto-isolated auxiliary signal (input) for acquisition path 1, which supports: user input or trigger input (trigger controller 0 on acq path 1).

The pinout for auxiliary I/O connector C is as follows for Zebra Radient eV-CL SF and eV-CL DF. It can be accessed through either a HD-15 or DB-9 connector using one of the two adapter brackets.

Pin on HD-15	Pin on DB-9	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	1	RESERVED			Reserved. Do not connect.
2	-	RESERVED			Reserved. Do not connect.
3	-	TTL_AUX_IO_14	M_AUX_IO3	M_DEV0	TTL auxiliary signal (input/output), for acquisition path 0, which supports: trigger input (trigger controller 3 on acq path 0), user input, or user output (M_USER_BIT5 on M_DEV0).
4+,5-	8+,3-	LVDS_AUX_IN10	M_AUX_IO4	M_DEV0	LVDS auxiliary signal (input), for acquisition path 0, which supports: trigger input (trigger controller 2 on acq path 0) or user input.
6+,8-	-	LVDS_AUX_IN11	M_AUX_IO5	M_DEV0	LVDS auxiliary signal (input), for acquisition path 0, which supports: trigger input (trigger controller 3 on acq path 0) or user input.
7	6	GND	N/A	N/A	Ground.
10	-	GND	N/A	N/A	Ground.
12+,11-	4+,5-	OPTO_AUX_IN9	M_AUX_IO1	M_DEV0	Opto-isolated auxiliary signal (input), for acquisition path 0,which supports: trigger input (trigger controller 3 on acq path 0) or user input.
13	-	RESERVED			Reserved. Do not connect.
14	7+,2-	RESERVED			Reserved. Do not connect.
15+,9-	-	OPTO_AUX_IN8	M_AUX_IO0	M_DEV0	Opto-isolated auxiliary signal (input), for acquisition path 0, which supports: trigger input (trigger controller 2 on acq path 0) or user input.
-	9	NC			Not connected.

The pinout for auxiliary I/O connector D is as follows for Zebra Radient eV-CL DF. It can be accessed through either a HD-15 or DB-9 connector using one of the two adapter brackets.

Pin on HD-15	Pin on DB-9	Hardware signal name	MIL constant for auxiliary signal	Digitizer device number for auxiliary signal	Description
1	1	RESERVED			Reserved. Do not connect.
2	-	RESERVED			Reserved. Do not connect.
3	-	TTL_AUX_IO_30	M_AUX_IO3	M_DEV1	TTL auxiliary signal (input/output), for acquisition path 1, which supports: trigger input (trigger controller 3 on acq path 1), user input, or user output (M_USER_BIT5 on M_DEV1).
4+,5-	8+,3-	LVDS_AUX_IN26	M_AUX_IO4	M_DEV1	LVDS auxiliary signal (input), for acquisition path 1, which supports: trigger input (trigger controller 2 on acq path 1) or user input.
6+,8-	-	LVDS_AUX_IN27	M_AUX_IO5	M_DEV1	LVDS auxiliary signal (input), for acquisition path 1, which supports: trigger input (trigger controller 3 on acq path 1) or user input.
7	6	GND	N/A	N/A	Ground.
10	-	GND	N/A	N/A	Ground.
12+,11-	4+,5-	OPTO_AUX_IN25	M_AUX_IO1	M_DEV1	Opto-isolated auxiliary signal (input), for acquisition path 1, which supports: trigger input (trigger controller 3 on acq path 1) or user input.
13	-	RESERVED			Reserved. Do not connect.
14	7+,2-	RESERVED			Reserved. Do not connect.
15+,9-	-	OPTO_AUX_IN24	M_AUX_IO0	M_DEV1	Opto-isolated auxiliary signal (input), for acquisition path 1, which supports: trigger input (trigger controller 2 on acq path 1) or user input.
-	9	NC			Not connected.

To build your own cable, you can purchase the following parts:

	Mating information
Manufacturer:	NorComp, Inc.
Connector:	180-015-203L001
Backshell:	970-015-010-011

These parts can be purchased from third parties such as Digi-Key Corporation (www.digikey.com).

LEDs on Zebra Radient eV-CL

Zebra Radient eV-CL has a series of LEDs to display the status of the PoCL connections, the on-board power, the board configuration, the PCIe (Host) slot, and the firmware configuration.

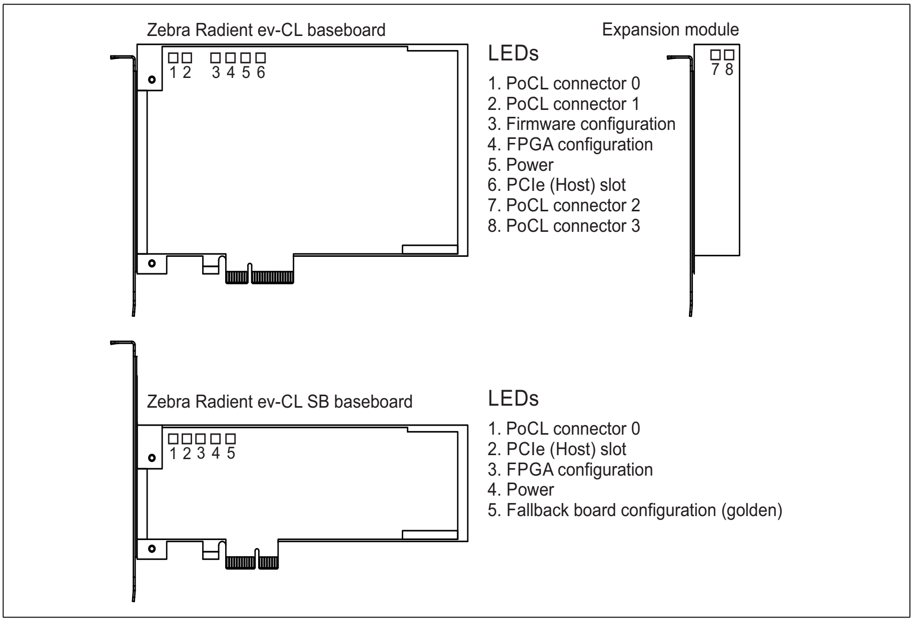
PoCL LEDs

The Zebra Radient eV-CL main board has two PoCL LEDs, except for the eV-CL SB which only has 1. In addition, Zebra Radient eV-CL DF and QB have 2 PoCL LEDs on the Zebra Radient eV expansion module. Each LED indicates the status of the PoCL device attached to that connector.

LED color and state	Description
Off	Zebra Radient eV-CL is not providing power to the camera.
Red, solid	Zebra Radient eV-CL is sensing for a PoCL-compliant device.
Green, solid	Zebra Radient eV-CL is providing power to the camera.

Board status LEDs

Zebra Radient eV-CL main board has four additional status LEDs to indicate the status of each of the following: the firmware configuration, the FPGA configuration, the power, and PCIe (Host) slot.



The table below outlines the possible colors for each LED, and their definitions.

LED type	LED color and state	Description
3. Firmware configuration	Off	The board is configured with the recommended user's firmware.
	Red	The board is configured with the golden firmware (a fall-back configuration).
4. FPGA configuration	Green	The FPGA is configured.
	Red	The FPGA is not configured.
5. Power	Off/Red	One or more of the on-board voltage regulators did not start. If your computer is on and this LED state occurs, there is an issue with the voltage regulators on your Zebra Radient eV-CL. Contact Zebra technical support.
	Green	All of the on-board voltage regulators are working properly.
6. PCIe slot	Off	The type of slot cannot be established. The PCIe link is down.
	Red, solid	Slot is PCIe Gen 1 and all lanes are in use.
	Red, blinking	Slot is PCIe Gen 1 and less than the maximum lanes are in use.
	Orange, solid	Slot is PCIe Gen 2 and all lanes are in use.
	Orange, blinking	Slot is PCIe Gen 2 and less than the maximum lanes are in use.

Appendix C: Acknowledgments

This appendix lists the copyright information regarding third-party material used to implement components on the Zebra Radient eV-CL board.

UART copyright information

The following is the copyright notice for the UART design used on the Zebra Radient eV-CL boards.

Appendix D: Listing of Zebra Radient eV-CL boards

This appendix lists the key feature changes to the Zebra Radient eV-CL boards.

Key feature changes

Part number	Version	Description
RAD EV 2M CLSB	003	First shipping version of Zebra Radient eV-CL SB.
RAD EV 1G CLDB	001	First shipping version of Zebra Radient eV-CL DB.
	201	User firmware updated.
	301	Flash (EOL) replacement.
RAD EV 1G CLSF	001	First shipping version of Zebra Radient eV-CL SF.
	201	Heatsink updated.
	202	User firmware updated.
	301	Flash (EOL) replacement.
RAD EV 1G CLQB	001	First shipping version of Zebra Radient eV-CL QB.
	005	Heatsink updated.
	007	User firmware updated.
	301	Flash (EOL) replacement.
RAD EV 1G CLDF	001	First shipping version of Zebra Radient eV-CL DF.
	005	Heatsink updated.
	007	User firmware updated.
	301	Flash (EOL) replacement.
RAD EV 5M CLDB	001	First shipping version of Zebra Radient eV-CLx4 DB with 512 Mbytes of memory.
RAD EV 5M CLSF	001	First shipping version of Zebra Radient eV-CLx4 SF with 512 Mbytes of memory.