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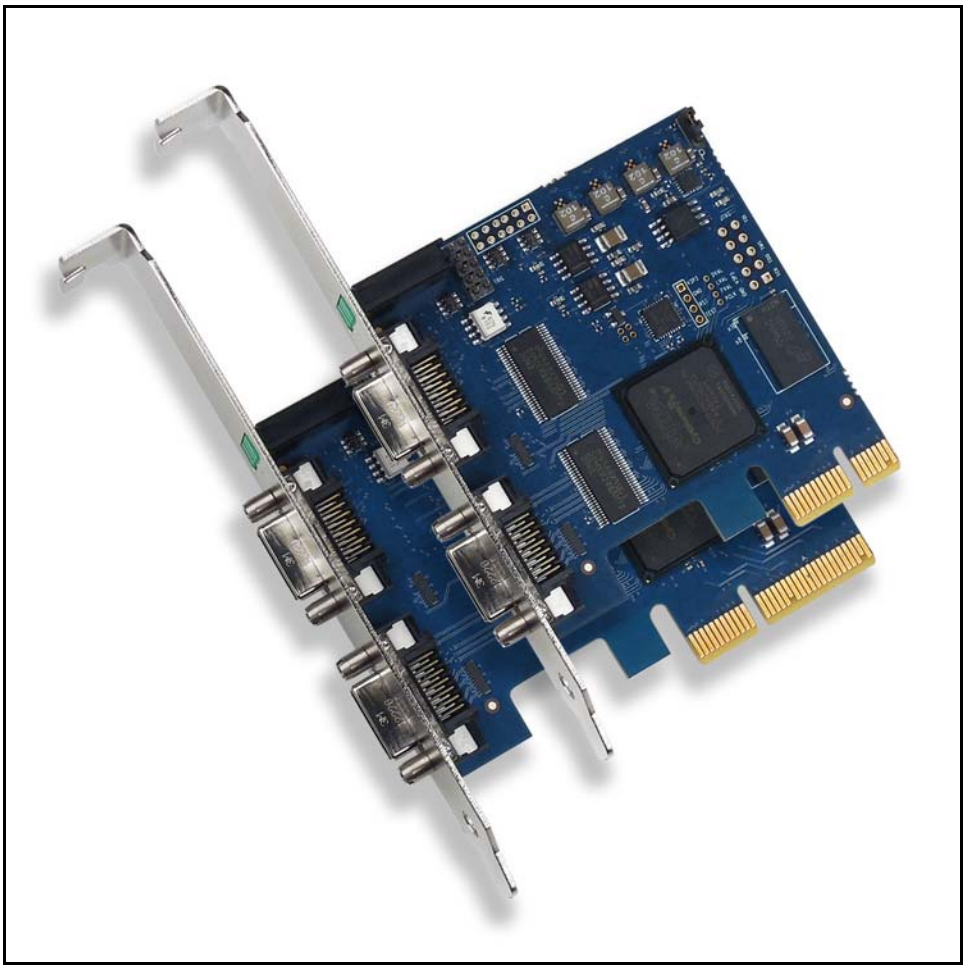
User's Guide

VisionLink F-Series



Camera Link Frame Grabbers for PCI Express

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VisionLink F-series

Overview

This guide covers EDT VisionLink F-series frame grabbers, which provide fast, high-resolution image capture and DMA between an external Camera Link camera and a host computer.

These frame grabbers are designed for PCIe Gen2 but can work with other PCIe generations; however, performance is limited by the generation of the board or slot, whichever is lower.

Companion products include remote camera extenders (RCX) over fiber; for details, see Related Resources on page 7. Available configurations for the F-series are shown in Table 1.

Table 1. VisionLink F-series frame grabbers for Camera Link

Product name	Bus spec x lanes	Camera Link modes	Part number	Product description
VisionLink F1	PCIe x1	Base	019-14853	Half-height backpanel, 1 SDR
			019-14854	Half-height backpanel, 2 SDRs, 128 MB DDR3, IRIG-B
			019-14836	Full-height backpanel, 1 SDR
			019-14852	Full-height backpanel, 2 SDRs, 128 MB DDR3, IRIG-B, Lemo
VisionLink F4	PCIe x4	Base–full	TBD	Half-height backpanel
			019-14856	Full-height backpanel
			019-14857	Full-height backpanel, Lemo

Included Files

For the above products, your EDT installation package includes README files for quick start information and special cases (`README.*`), as well as device drivers for supported operating systems and source code and binaries for...

- GUI capture and display applications (`vlviewer, pdvshow`)
- Standalone initialization applications (`initcam, camconfig`)
- Command-line capture and display applications (`take, simple_take, simplest_take, simple_*`)
- Command-line serial communication tool (`serial_cmd`)
- Diagnostic tools (`pciload, pciediag, dvinfo, pdb`)
- API libraries (`libpdv, libedt,` and associated source files)
- Makefiles for Windows and Linux (`makefile`)
- Visual Studio project and solution files (`*/*.vcproj, */*.sln`)
- Camera configuration files (`camera_config/*.cfg`)
- Board firmware files (`flash/*` directories)
- Windows silent install / uninstall example batch files (`wdf/install/*.bat`)

For detailed descriptions of selected programs, see Example and Utility Applications on page 13. For a more complete list of files and quick-start information, consult `README.pdv` in your EDT installation package (see Installation on page 8). For programming information, consult the EDT API (see Related Resources on page 7).

Power Over Camera Link (PoCL)

VisionLink frame grabbers support Power over Camera Link (PoCL) via the MSP430 using safe power. PoCL is enabled via software (implementation TBD). For PoCL pin assignments, see Appendix A: Pin Assignments on page 29.

Related Resources

To find product-specific information that is related to a particular EDT product, go to .edt.com and open the relevant product page. There you'll see links to that product's datasheet (specifications), user's guide, and other resources.

In addition, the resources below may be helpful or necessary for your applications.

EDT Resources

• Application programming interface (API)	edt.com/dv_api
• Installation packages (Windows, Linux)	edt.com/download-hub
• VisionLink F1 datasheet / specifications	edt.com/product/visionlink-f1
• VisionLink F4 datasheet / specifications	edt.com/product/visionlink-f4
• Companion products	edt.com/vision
• Camera configuration guide	edt.com/downloads/DeviceConfig.pdf
• Firmware reference	edt.com/downloads/dv-c-link-firmware-reference.pdf
• Cabling options	edt.com/clink-cables
• Tutorial video(s)	edt.com/vision

Third-Party Resources

• PCI Express (PCIe) specifications	www.pcisig.com
• Camera Link specifications	www.visiononline.org
• IRIG-B specifications	irigb.com

Requirements

EDT boards are high-speed DMA devices that require adequate bandwidth for reliable operation. The requirements will vary by camera (since different cameras run at different speeds), so you should select and configure your camera and system with the proper requirements in mind, as shown in Table 2.

Table 2. Requirements for I/O, bus type, throughput, cabling

	Bus type*	Throughput (observed)	Cabling	OS
VisionLink F1	x1 PCIe, Gen2	400MB/s	Standard Camera Link SDR NOTE: Cabling can be from EDT or a third party. For more documentation on cabling / pins, see Related Resources on page 7 and Appendix A: Pin Assignments on page 29.	Windows, Linux
	x1 PCIe, Gen1	175MB/s		
VisionLink F4	x4 PCIe, Gen2	1000MB/s		
	x4 PCIe, Gen1	700MB/s, preliminary		

* For bus type, observe these considerations to optimize performance...

- Typically, these products **will not** work in a bus slot dedicated to graphics (display) cards.
- Typically, these products **will** work in a bus slot with more, but not one with fewer, lanes than the number given here.
- Typically, although these products will work in a bus slot newer than PCIe Gen2 (such as Gen3), performance still will not exceed Gen2 specifications.

For details on requirements and bandwidth issues, see Problems With Bandwidth on page 27.

Installation

"Installation directory" in this guide refers to the directory in which your EDT installation package was saved.

Unless you opted to save it elsewhere, the package is saved in the default installation directory specified below.

- The Windows default installation directory is: `C:\EDT\pdv`
- The Linux default installation directory is: `/opt/EDTpdv`

To install your frame grabber software, follow the steps below.

1. Uninstall any previously installed EDT installation packages.
2. To use the latest possible package without creating version incompatibility issues, do one of the following...
   - For a new application, download the latest package from the EDT installation disk (included with the product), or from www.edt.com (see Related Resources on page 7).
   - For an application running third-party software, use the EDT installation package version with which the software was built, or recompile / relink the application with the latest package (see Related Resources on page 7).
   - For a new board used in applications developed for earlier boards (e.g., EDT DV/a series), recompile / relink the application with libraries / header files from an EDT device driver / SDK, version 5.4.5.8 or later.
3. Follow the installation instructions from your camera manufacturer and your host computer manufacturer.
4. Connect the frame grabber, using the cabling specified in Requirements on page 8.
5. To verify that the driver is installed and the board is recognized, run `pciload` from the command line (for details, see Example and Utility Applications on page 13).

NOTE If you need to provide an EDT silent Windows software installation as part of your own installation process, see the EDT Windows batch (`.bat`) files in the `wdf\install` subfolder of the EDT installation folder. The comments in the files explain how they can be used.

Setting the Camera Model

After installing the board and its driver, configure it for the camera you will use.

Your EDT installation package provides example configuration files for various camera models; if no file is provided for your camera, or if you wish to modify the directives of an existing configuration file, consult the EDT Camera Configuration Guide (see Related Resources on page 7).

Next, initialize (configure) the driver for your camera model, using one of the methods in Table 3.

Table 3. Configuring the driver for your camera

OS	Configuration via GUI	Configuration via command line
Windows	Click the desktop icon for *vlviewer*. When the camera selection dialog box appears, select your camera. After initial setup, access this dialog box any time via the Camera>Setup menu.	From the *pdv utilities* command shell, invoke the `initcam` utility... `initcam -f camera_config\`*`filename`*`.cfg` ...where *`filename`* is the camera configuration file that matches your camera model and operating mode. For specifying a non-default unit and channel and other options, see `initcam` (Example and Utility Applications on page 13) and the Camera Configuration Guide (Related Resources on page 7).
Linux	First, build *vlviewer* (see Compiling vlviewer on page 22). Then, in the installation directory (see Installation on page 8), enter... `vlviewer` When the camera selection dialog box appears, select your camera. After initial setup, access this dialog box any time via the Camera>Setup menu.	From a terminal window, navigate to the installation directory and follow the procedure for Windows, replacing "\" with "/". If you do not have "`.`" in your path, add "`./`" before each command – for example... `./initcam -f camera_config/`*`file`*`.cfg`

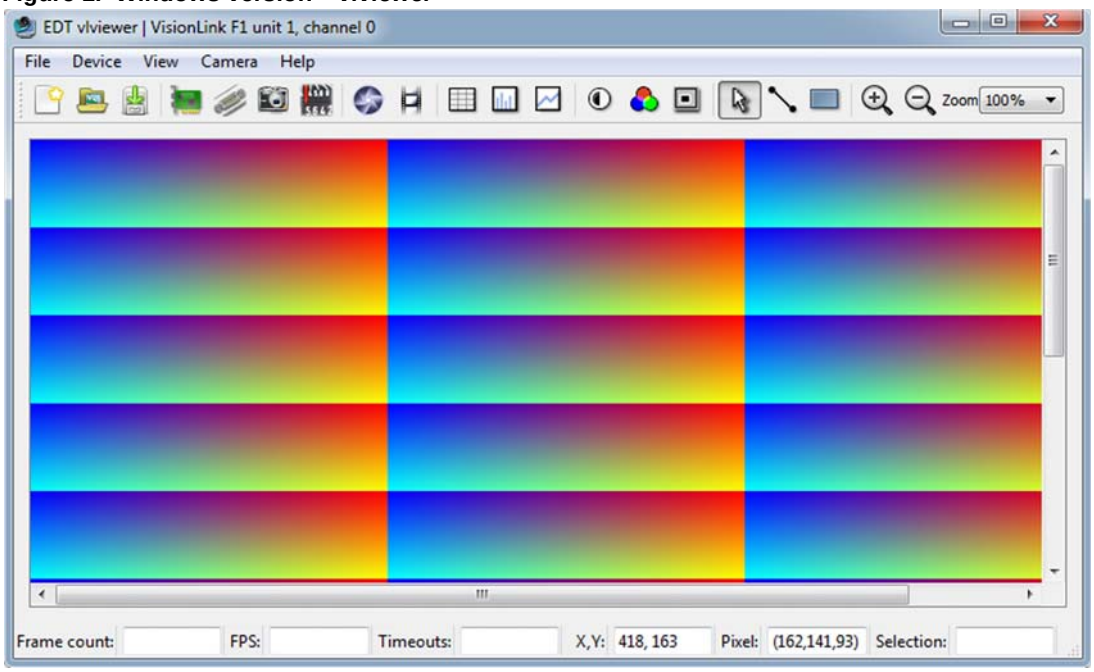
Image Capture and Display GUI

Your EDT software contains the GUI application *vlviewer*, a GUI application which allows you to:

- Configure the frame grabber for a specific camera.
- Capture, display and save (.bmp, .tif, .jpg or .raw) images from cameras connected to the frame grabber.
- Perform image processing and analysis on captured image data.
- Communicate with the camera via serial.
- Display information about the frame grabber hardware and device driver.

The Windows version of *vlviewer* is shown in Figure 1.

Figure 1. Windows version – *vlviewer*



To run the GUI...

- For Windows: Click the *vlviewer* desktop icon, or enter `vlviewer` at a command prompt.
- For Linux: Compile `vlviewer` (see Compiling vlviewer on page 22); then, in the installation directory (see Installation on page 8), enter...

```
vlviewer
```

To invoke with other than the default (0,0) unit and channel, run...

```
vlviewer -pdvU_C
```

...replacing *U* with the unit number (useful if you have more than one VisionLink device) and *C* with the channel number for multichannel devices (see Units, Connectors, and Channels on page 11).

For example, to run the GUI using board 0, channel 1, run...

```
vlviewer -pdv0_1
```

This example is useful if, for instance, you are using one board with two base-mode cameras and you want the GUI to access the camera on channel 1.

NOTE In Windows, the command line is a property of the icon.To use an icon to access a unit or channel other than 0 (the default): copy and rename the *vlviewer* icon; then change its shortcut properties to use the command line with the option `-pdvU_C` where *U* is the unit and *C* is the channel.

If you have not yet configured the device for your camera, select your camera or simulator from the list and click *OK*.

If the image window shows incorrect data (usually because the camera model has been changed since the last configuration), select *Camera* > *Setup* and choose the correct camera model.

To access camera controls, use the GUI toolbar and menus. For details on available options, run...

```
vlviewer --help
```

...or bring up *vlviewer* and select the *Help* menu.

Units, Connectors, and Channels

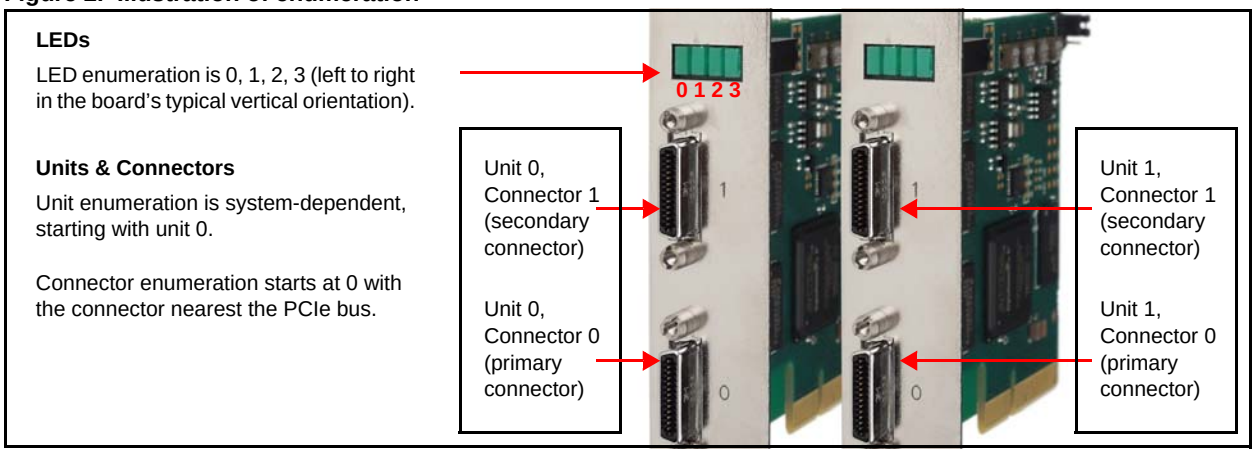
This section covers how to work with multiple units, connectors, and channels, defined and used as shown in Table 4.

Table 4. Definition, usage, and enumeration

	Definition	Usage and Enumeration
unit	physical board	If you install one board in your host system, the system will assign the default unit number (0) to that board. If you install multiple boards, the system will assign a unique unit number to each board, starting with 0 (the sequence is system-dependent). Typically, the unit number is an argument when invoking an application (such as `take` or `vlviewer`) or a parameter passed into one of the EDT subroutines.
connector	physical Camera Link connector	Each VisionLink board has one or two SDR connectors and one simulation channel. • In base mode, each camera requires one SDR connector on the EDT board, and each connector provides one channel. Therefore, in base mode, an EDT frame grabber with two connectors has two channels. • In medium or full mode, each camera requires two SDR connectors on the EDT board. In this case, the two connectors work together to support one channel. The software enumerates each SDR connector starting from the PCIe bus. So the first (primary) connector is “0” and the next (secondary) connector is “1.” The simulator channel is “2.” See Simulation and Testing on page 20.
channel	channel or, sometimes, simulation channel	

Figure 2 illustrates enumeration. Units (boards), connectors, and channels are always enumerated from 0. Figure 2 also shows the status indicator LEDs (see LEDs on page 12), which are enumerated in the same way.

Figure 2. Illustration of enumeration



If you are using multiple EDT boards (units), or multiple connectors on a single EDT board, the software assigns a unique handle to represent each unit and connector. Unless you specify a different unit number, connector number, or both, all EDT example and utility applications will default to unit 0, connector 0.

The way that you address the appropriate unit and channel will depend on what you are doing.

- In the EDT GUI (`vlviewer` or `pdvshow`), use `-pdvU_C` (see Image Capture and Display GUI on page 9.
- In the EDT example and utility applications, use `-u unit` and `-c channel` (see Example and Utility Applications on page 13).
- In the EDT API, use `pdv_open_channel(..., unit, channel)`. For each device, the open routine will return a pointer to the structure that represents the opened device (unit and channel); this pointer appears in EDT examples and documentation as `pdv_p`. Each unit / channel combination can be opened and manipulated independently by passing the appropriate pointer to the library subroutines. For details, consult the EDT API (see Related Resources on page 7).

LEDs

As shown in Figure 2, each frame grabber's backpanel has four LEDs (0, 1, 2, 3, left to right) to show status, as below.

Table 5. LED behavior and significance

LED #	Connector #	Status
0	0	Pixel clock: on = present; off = absent
1	0	PoCL output:: on = 12V; off = GND; fast blink = error; slow blink = floating / open / sensing
2	1	Pixel clock: on = present; off = absent
3	1	PoCL output:: on = 12V; off = GND; fast blink = error; slow blink = floating / open / sensing

Serial Communication

Most cameras have a manufacturer-defined serial command set for camera control and status. To utilize this capability, EDT boards implement serial transmit and receive using standard serial lines as defined by the Camera Link standard. You can use serial communication in a number of ways, as discussed below.

At Initialization

As mentioned in Installation on page 8, the initialization process uses directives in a configuration file to set the board registers and the driver variables to match your camera model and your operating mode. Additional directives (especially `serial_baud, serial_init, serial_binit,` and other `serial_*` directives) can be used to send serial commands when the system is initialized. These are described in the EDT Camera Configuration Guide (see Related Resources on page 7).

EDT provides several example configuration files that contain the serial commands needed to put a camera into the desired mode. You can edit these commands or copy them to a new configuration file.

For suggestions, see comments in the example configuration files `camera_config/generic`*`X`*`cl.cfg` (where *`X`* is replaced by a specific bits-per-pixel value – for example, `generic8cl.cfg`) in the EDT installation package.

From Command Line

The command-line utility `serial_cmd,` described in serial_cmd on page 15, allows you to send serial commands to a camera and receive its response, in either ASCII or hexadecimal format. Command-line help also can be accessed by entering `serial_cmd --help.`

If you wish to incorporate this functionality in your own application, see the source code provided in `serial_cmd.c` in the EDT installation package.

From EDT GUI

In *vlviewer*, from the *Camera* menu, select *Programming*. The resulting dialog allows you to send and receive serial commands from the camera. For details, see Image Capture and Display GUI on page 9.

From Your Application

To see all of the routines needed for user applications to send and receive serial commands: In the EDT API (see Related Resources on page 7), follow the link to the EDT digital imaging library, and then — under Modules at the bottom of the page — to Communications / Control.

From Camera Manufacturer's Application

Most Camera Link camera makers supply a Windows-based graphical camera control application that lets you send and receive serial commands using a board-specific serial dynamic link library (DLL). Your EDT installation package provides a DLL named `clseredt.dll` which, per the Camera Link 2.0 specification, is installed at...

- `%PROGRAMFILES%\Cameralink\Serial` (64-bit version); or
- `%PROGRAMFILES(X86)%\CameraLink\Serial` (32-bit version)

Camera GUIs typically provide some method for specifying the DLL pathname; for details, see your camera documentation.

If it becomes necessary to rename the file or copy it to a different location, be sure to recopy any newer versions of the file to the appropriate location when you reinstall the EDT installation package.

NOTE Some camera manufacturers' control applications do not use this DLL method but instead depend on COM port emulation for serial communication. In such cases, use the provided COM port emulation method; for details, see `README.pdvcom` in your installation directory.

Example and Utility Applications

EDT provides a variety of example, utility, and diagnostic applications. All can be run from the command line, using Unix-style options and arguments.

To help those developing applications, EDT provides C source code for all of the examples. The source code file is the name of the application with a `.c` extension (e.g., "`take.c`"). Starting with the source for `simple_take` or `simplest_take` is recommended.

The most commonly useful options for these programs are described below. Placeholders shown in italics should be replaced with your own values. For a complete list of usage options, at the command line, enter the application name with the `--help` option to display the help message.

pciload

Used to query the boards or, optionally, to update and verify the board's flash PROM. After installation, you may want to run `pciload` with no arguments and review the output to help verify that the board and driver did install correctly. To use `pciload` to update and verify the flash PROM, see Firmware: FPGA Configuration (.bit) Files on page 22.

setdebug

A debug and diagnostic utility. The options shown here may be useful to you. Options not shown here, as a rule, are specific to driver internals and are useful (and safe) only with guidance from EDT engineers.

`-u` *`unit`*	The unit number, if multiple boards are installed; default is 0 (first board).
`-c` *`channel`*	The channel, on multichannel boards; default is 0 (first channel).
`-d 0`	Unique to `setdebug`. Displays current board register values.
`-v`	Unique to `setdebug`. Displays version information for library and driver.
`-h`	Displays full list of options.

initcam

Command-line utility that initializes the board and device driver for a specific camera. It initializes board registers; sets various parameters (width, height, depth, etc.) to specific values; and optionally sends serial initialization commands to the camera from the referenced configuration file. Configuration files are in your EDT installation package under `camera_config`. The EDT camera selector GUI applications (*vlviewer, pdvshow*) are simply wrappers to provide a way to select the correct file, then shell out to call `initcam`. To initialize from your own application code, you can use `initcam.c` as example code.

For a detailed description of configuration files and directives, consult the Camera Configuration Guide (see Related Resources on page 7).

Several of the most useful options are...

`-u` *`unit`*	The unit number, if multiple boards are installed; default is 0 (first board).
`-c` *`channel`*	The channel, on multichannel boards; default is 0 (first channel).
`-f` *`pathname`*	The (required) name of the configuration file to use for initialization.

For example...

```
initcam -f camera_config/generic8cl.cfg
```

take

Used to acquire images and (optionally) save them to files. Though it does not display the images, it does provide many other options, making it a useful diagnostic tool. The source also shows how to change camera settings such as integration time; tune image acquisition in certain ways; and detect errors.

Several of the most useful options are...

`-u` *`unit`*	The unit number, if multiple boards are installed; default is 0 (first board).
`-c` *`channel`*	The channel, on multichannel boards; default is 0 (first channel).
`-b` *`file`*	The base name of the file in which to save the image, in Windows bitmap format for all systems (note – in EDT software packages later than 5.3.3.3, this option always will create files in Windows bitmap format, regardless of which operating system you are using). If only one image is taken, this is the filename; otherwise a two-digit number is appended to each file, starting with 00. The appropriate suffix is automatically added.
`-f` *`file`*	The name of the file in which to save the image, in raw format. The file includes only raw image data, with no formatting information.
`-l` *`loopcount`*	The number of consecutive pictures you wish to take. The default is one.
`-N` *`numbufs`*	The number of ring buffers (default is 1). A ring buffer is a portion of host memory preallocated for DMA and used in round-robin fashion. A setting of four optimizes pipelining — one ring buffer currently acquiring data, one ready for data, one getting ready, and one backup.
`-v`	Turns on verbose mode. The default is off.

As an example, to acquire 100 images as quickly as possible using four ring buffers, without saving to files, enter...

```
take -N 4 -l 100
```

As another example, if you have one VisionLink board connected to two base-mode cameras and you wish `take` to use the camera on channel 1, enter...

```
take -u 0 -c 1 -N 4 -l 100
```

simple_take

Shows how to use the API to acquire images from a camera linked to the board and (optionally) save the images to files.

To add image acquisition to an application, EDT recommends starting with this example, which shows how to use the ring buffer routines to improve performance by pipelining image acquisition and processing.

Several of the most useful options are...

`-u` *`unit`*	The unit number, if multiple boards are installed; default is 0 (first board).
`-c` *`channel`*	The channel, on multichannel boards; default is 0 (first channel).
`-b` *`file`*	The base name of the file in which to save the image. If only one image is taken, this is the filename; otherwise a two-digit number is appended to each file, starting with 00. The appropriate suffix is automatically added.
`-l` *`loopcount`*	The number of consecutive pictures you wish to take. The default is one.
`-N` *`numbufs`*	The number of ring buffers — by default, one. (A *ring buffer* is a portion of host memory preallocated for DMA and used in round-robin fashion.) A setting of four optimizes pipelining — one ring buffer currently acquiring data, one ready for data, one getting ready, and one backup.

For example, to acquire four images as fast as possible using four ring buffers, saving each to files named `picture00.bmp` through `picture03.bmp`, enter...

```
simple_take -N 4 -l 4 -b picture
```

simplest_take

The simplest example application, showing only how to open the device, acquire an image, check for timeouts, and close the device. For simplicity, there is no optimization for pipelining, no processing or extended error checking.

`simplest_take` reports a successful image acquisition, or any errors that occurred — useful for testing.

simple_sequence

Like `simple_take` but, instead of capturing and saving one file at a time, it captures a finite number of images (limited to available memory) into memory and then writes them all out at once.

serial_cmd

Sends serial commands to a camera through the board, using calls to routines in the API. By default, the application starts in command mode: the final argument to `serial_cmd` is the command to send to the camera. Delimit this command with either single or double quotation marks, but be consistent. For example...

```
serial_cmd "MDE?"
```

If you omit the command argument, the application enters interactive mode, in which you can type one command per line. To quit the application, enter Control-C.

Several of the most useful options are...

`-u` *`unit`*	The unit number, if multiple boards are installed; default is 0 (first board).
`-c` *`channel`*	The channel, on multichannel boards; default is 0 (first channel).
`-x`	Treats the command argument as a hexadecimal number, which is sent to the camera without terminating nulls or carriage returns. The default is ASCII with a terminating carriage return added.

For example (command mode usage)...

`% serial_cmd "MDE?"`	(Redlake "Query Mode" command)

```
MDE TR                  (camera response)
%
```

For example (interactive mode usage)...

```
% serial_cmd
>MDE?                   (Redlake "Query Mode" command)
MDE TR                  (camera response)
>
% serial_cmd -x         (for hexadecimal arguments)
> 03 06 02              (camera-dependent command)
> Control-C             (end the program)
```

To access a camera on channel 1, enter...

```
% serial_cmd -u 0 -c 1 "MDE?"
                        (Redlake "Query Mode" command)
MDE TR                  (camera response)
%
```

dvinfo

Gathers board-specific and system-specific technical data, runs various diagnostics, and writes the results to `dvinfo.out` in the current directory. Use the resulting ASCII text file to diagnose problems yourself, or send the file to EDT for technical support.

To run `dvinfo`...

1. Connect and power on the camera.
2. If possible, initialize the board with `initcam` or *vlviewer*.
3. Close all VisionLink applications (including `initcam`, *vlviewer*, *pdvshow*, etc.).
4. Run `dvinfo`. If multiple boards are installed, you may find it helpful to add the optional flag...

   `-u` *unit*

   ...replacing *`unit`* with the unit number. The default is 0 for the first board (for details, see Units, Connectors, and Channels on page 11).

Triggering

EDT provides configuration files for most cameras running in freerun mode (i.e., no triggering), and also some files for cameras running in triggered or pulse-width modes. This section describes common triggering modes supported by EDT, with abbreviated information on configuration file directives and subroutines. For more complete information, consult the EDT Camera Configuration Guide and API (see Related Resources on page 7) and your camera manual.

NOTE If you have issues, consult Troubleshooting on page 24.

No Triggering – Freerun (Continuous)

In this mode, the camera acquires images continuously without initiating or passing through any trigger or expose signals. Exposure time is controlled by the camera and typically is set via a camera-specific serial command.

For area or line scan cameras, use the following information...

Configuration file directives

`MODE_CNTL_NORM: 00` (default)
`serial_init:` Camera-specific serial command(s) to initialize for freerun. Use as needed (usually not needed because most cameras power on in freerun by default).
`serial_exposure:` Camera-specific serial command to set the exposure time; for example, use `"set"` for the Dalsa 1M60.

API subroutine

`pdv_set_exposure(),` Camera-specific range and units.

Triggered by EDT Board (On-Demand)

In this mode, the camera sends a 1-millisecond trigger pulse over a camera control line, typically CC1, each time a request for acquisition is made – such as when `pdv_start_images()` is called. Exposure time is controlled by the camera, and typically is set via a camera-specific serial command.

For area or line scan cameras, use the following information...

Configuration file directives

`MODE_CNTL_NORM: 10`
`method_camera_shutter_timing: AIA_SER` (default)
`serial_init:` Camera-specific serial argument to enable triggering via CC1.
`serial_exposure:` Camera-specific serial command to set the exposure time; for example, use `"set"` for the Dalsa 1M60.

API subroutine

`pdv_set_exposure(),` Camera-specific range and units.

Triggered by EDT Board (Fixed Period)

In this mode, the board sends a fixed periodic trigger signal over a camera control line, typically CC1, for each frame or line of image data.

For area scan cameras, use the following information...

Configuration file directives

`MODE_CNTL_NORM: 10`
`CL_CFG2_NORM:` The default is 00, which selects current channels counter; use 80 to select other channels counter (i.e., if synchronized trigger output is desired).
`method_frame_timing: FMRATE_ENABLE`
`frame_period:` Microsecond units (range 0–16777215).
`photo_trig: 1`
`serial_init:` Camera-specific serial command to enable triggering via CC1.

API subroutine

`pdv_set_frame_period(),` Microsecond units (range 0–16777215).

For line scan cameras, use the following information...

Configuration file directives

`MODE_CNTL_NORM: 10`
`CL_CFG_NORM: 14`
`CL_CFG2_NORM:` The default is 00, which selects current channels counter; use 80 to select other channels counter (i.e., if synchronized trigger output is desired).
`xregwrite_16: 40`
`method_frame_timing: FMRATE_ENABLE`
`frame_period:` Microsecond units (range 0–16777215).
`serial_init:` Camera-specific serial command to enable triggering via CC1.

API subroutine

`pdv_set_frame_period(),` Microsecond units (range 0–16777215).

Pulse-Width Triggered (Controlled or Level)

In this mode, exposure duration is determined by how long the camera control line, typically CC1, is held TRUE (high).

For area scan or line scan cameras, use the following information...

Configuration file directives

`MODE_CNTL_NORM: 10`

`method_camera_shutter_timing: AIA_MCL`

`default_shutter_speed:` Millisecond units (range 0–25500).

`serial_init:` Camera-specific serial command to enable pulse-width exposure control via CC1.

API subroutine

`pdv_set_exposure(),` Millisecond units (range 0–25500).

For line scan cameras with very fast shutters accepting exposure times in microseconds, use the argument `100US` for `method_camera_shutter_timing` in order to set `pdv_set_exposure()` for microseconds, not milliseconds...

Configuration file directives

`MODE_CNTL_NORM: 10`

`method_camera_shutter_timing: AIA_MCL_100US` (to change to miicroseconds)

`default_shutter_speed:` Microsecond units (range 0–25500).

`serial_init:` Camera-specific serial command to enable pulse-width exposure control via CC1.

API subroutine

`pdv_set_exposure(),` Microsecond units (range 0–25500).

External Trigger Direct to Camera

In this mode, a trigger is sent from an external source directly to the camera, bypassing the board. The board can be configured as in freerun mode; however, be aware of the Note on Software Timeouts below.

For area scan or line scan cameras, use the following information...

Configuration file directives

`MODE_CNTL_NORM: 00`

`user_timeout:` See Note on Software Timeouts below.

API subroutine

`pdv_set_timeout(),` Millisecond units (range 0–65535).

Note on Software Timeouts

If your application experiences timeouts it is safe to ignore them, but if you do, you won't know if they were caused by a problem or by the gap length between triggers. To avoid timeouts due to gap length, do one of the following...

- If the maximum gap length between triggers is known: Enter a `user_timeout` value which exceeds that value.
- If application blocking is acceptable: Enter a `user_timeout` value of zero (`user_timeout: 0`)to tell the application never to time out but instead to keep waiting for the next trigger.

External Trigger Passthrough

In this mode, a trigger is sent from an external source directly to the board, which passes it to the camera on a camera control line, typically CC1.

For area scan cameras, use the following information...

Configuration file directives

`MODE_CNTL_NORM: A0`

`xregwrite_16:` Use optionally to select trigger input. The default is trigger input 0 but if trigger input 1 is desired, use 80. For details, consult the Firmware Addendum, register 0x10 (see Related Resources on page 7).

`user_timeout:` See Note on Software Timeouts in External Trigger Direct to Camera.

`serial_init:` Camera-specific serial command to enable triggering via CC1.

API subroutine

`pdv_set_timeout(),` millisecond units (range 0–65535)

For line scan cameras using normal external trigger passthrough, use the following information...

Configuration file directives

`MODE_CNTL_NORM: A0`

`CL_CFG_NORM: 14`

`xregwrite_16:` Use optionally to select trigger input. The default is trigger input 0 but if trigger input 1 is desired, use 80. For details, consult the Firmware Addendum, register 0x10 (see Related Resources on page 7).

`photo_trig: 1`

`user_timeout:` See Note on Software Timeouts in External Trigger Direct to Camera.

`serial_init:` Camera-specific serial command; enables triggering via CC1.

API subroutine

`pdv_set_timeout(),` millisecond units (range 0–65535)

For line scan cameras using external trigger passthrough with acquisition arming (not supported for area scan), the information is similar to the above. A TTL signal is sent from an external source to the board via trigger 0 and then is passed from the board to the camera via a camera control line (typically CC1) to trigger line output. Additionally, a secondary TTL signal is sent from an external device to the board via trigger 1, which arms the board for acquisition. For example, the “A” pulse from an encoder is input on trigger 0 and passed through to the camera via a camera control line (typically CC1), thus triggering a line to be output from the camera. Additionally, the index pulse from the encoder is input on trigger 1 to arm or rearm the board for acquisition, ensuring that acquired images are synchronized to the encoder’s rotational position. The acquired image always starts at the encoder index. Use the following information...

Configuration file directives

`MODE_CNTL_NORM: A0`

`CL_CFG_NORM: 14`

`CL_CFG2_NORM: 04`

`photo_trig: 1`

`user_timeout:` See Note on Software Timeouts in External Trigger Direct to Camera.

`serial_init:` Camera-specific serial command to enable triggering via CC1.

API subroutine

`pdv_set_timeout(),` Millisecond units ((range 0–65535)

External Triggering Pins

The pins to which you connect the trigger source are shown in Appendix B: Diagrams – Boards and Cabling.

With two cameras, trigger 0 can trigger both cameras, or triggers 0 and 1 can trigger cameras 0 and 1 independently; for details on setting the bits, refer to the directive `xregwrite_16` or consult the Firmware Addendum (see Related Resources on page 7), register 0x10, bit 7.

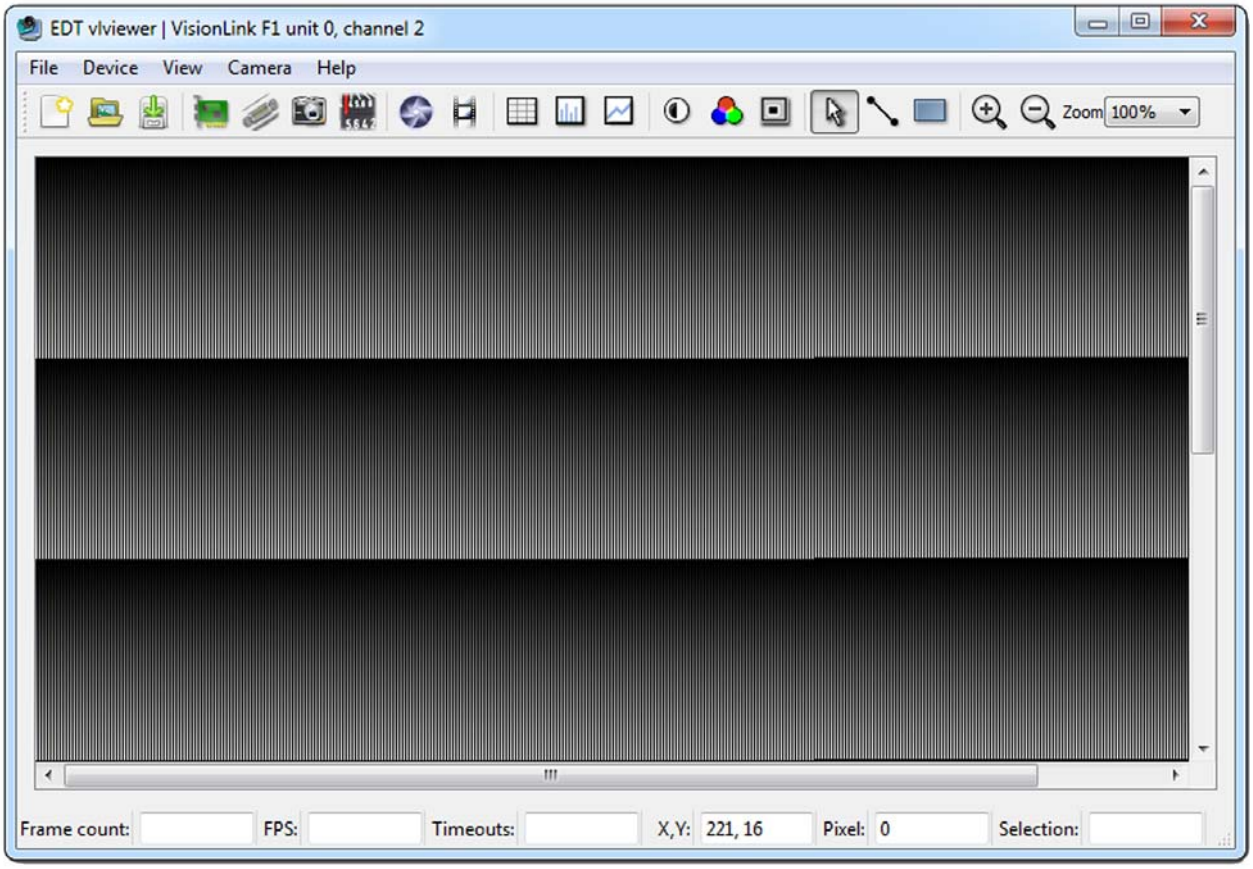
Fire the trigger by applying a TTL signal lasting at least 200 nanoseconds to these pins, which in turn will output a signal of the appropriate level to a camera control line, typically CC1.

The two pins of each trigger drive a Fairchild HCPL062N optocoupler through a 130-ohm series resistor. This optocoupler is provided to allow coupling to electromechanical systems in which major ground spikes can occur when electrical devices such as motors, for example, turn on or off.

Simulation and Testing

In addition to the physical channels 0 and 1, each VisionLink frame grabber has a "phantom" channel 2 that reads self-generated sample data, useful for testing the board hardware and software with no camera attached. This channel uses a simple counter to generate 16-bit pixel data; the pixels start as black and fade to white, as shown in Figure 3.

Figure 3. Simulated channel 2 test image in *vlviewer*



To use the channel 2 simulator with *vlviewer...*

1. Start the application with, for example...

   ```
   vlviewer -pdv0_2
   ```

2. Select the *Camera* > *Setup* menu item.

3. Select the desired configuration.

To use the channel 2 simulator with your own application...

1. Use the initialization application `initcam,` specifying channel 2 and the camera configuration file for your camera. From a command prompt, enter...

   `initcam -c 2 -f camera_config/`*`yourCamera`*`.cfg`

   ...replacing *`yourCamera`* with the appropriate configuration file name for your camera and application.

NOTE For general testing, use one of the `generic`*`XX`*`cl.cfg` files provided with your board.

2. Open the device with a call to `pdv_open_channel` and pass it `NULL` for the device, your value for the unit number (board), and 2 for the channel – as in this example (showing a unit number of 0)...

   ```
   PdvDev *pdv_p = pdv_open_channel(NULL, 0, 2);
   ```

   The pointer returned from this call points to the simulated data; any image acquisition calls, such as `pdv_wait_image,` that pass this pointer will access the simulated data.

Because data is generated as fast as possible, you can also use the channel 2 simulator to measure the maximum bus bandwidth, using the utility application `cl_speed.` This utility takes the unit number as an argument and begins channel 2 simulation on the specified board; it then reports the data speeds achieved.

Programming

EDT installation packages include libraries, examples and C / C++ source code that can be used by programmers to modify and develop applications for EDT VisionLink frame grabbers and related devices.

EDT provides a common application programming interface (API) for all supported operating systems, so an application written for one EDT product is designed to work with other EDT products with minimal modification; any exceptions – such as for various operating systems – are noted in this guide.

NOTE To interface to the VisionLink board, use subroutines from the EDT digital imaging library (`libpdv`) and, if necessary, from the EDT DMA library (`libedt`); routines in both libraries are documented in the EDT API.

- The EDT digital imaging library `pdv_` subroutines provide a C language interface to your VisionLink board, and it also handles error recovery, bookkeeping, and camera shutter triggering and timing. EDT recommends using it for all programming specific to VisionLink products.
- The lower-level EDT DMA library `edt_` subroutines should be accessed directly only when they provide needed functionality that is not provided in the EDT digital imaging library.

All of these resources are provided in your EDT installation package (see Related Resources on page 7).

Building or Rebuilding an Application

EDT's installation package includes C source and executables for all of the provided examples, diagnostics, and utilities. To build or rebuild a program, use a build method which is appropriate for your operating system, as shown in Table 6.

NOTE Applications which access EDT boards must be compiled and linked to match the platform in use (32- or 64-bit). Applications linked with 32-bit EDT libraries will not run correctly on 64-bit systems, or vice versa. The EDT driver / software installation script detects whether the system is running 32- or 64-bit, and installs the appropriate files.

Table 6. Building or rebuilding an application – methods by operating system

	Windows	Linux
Compiler	Use a C compiler; EDT provides project files and makefiles for Microsoft Visual C.	Use the `gcc` compiler, typically included with the standard C development tools.

Build method 1	Use the included `makefile`:
	At a Windows command prompt, per Microsoft requirements, verify your system is set for 32- or 64-bit builds by running, for example, `vcvarsall.bat amd64` from your Visual Studio directory. Then, in the installation directory (see Installation on page 8), run one of the following...
	• To build a specific executable:
	`nmake file.exe`
	• To build all of the examples and utilities:
	`nmake`
		Use the included `makefile`:
		In the installation directory (see Installation on page 8), run one of the following...
		• To build a specific executable:
		`make file`
		• To build all of the examples and utilities:
		`make`

Build method 2	Use the Microsoft Visual Studio 2008 projects and solutions in `projects.vs2008`	[n/a]

Compiling vlviewer

To compile and experiment with the *vlviewer* source code, you will need the appropriate compiler and Qt (4.6 or later) installed on your system and in your path; at a minimum, the Qt Core and Development libraries are required. See `http://qt-project.org` for Qt information and downloads.

The method for installing Qt4 varies depending on the operating system; check your OS-specific documentation for the proper installation method for Q4 software (i.e., `yum`, `apt-get`, etc.). For the current Qt package installation requirements as we know them, read the file `README.lnx.reqs` in your installation directory.

- For Linux: In the installation directory (see Installation on page 8), run...

  `make vlviewer`

- For Windows: Navigate to the EDT installation directory (by default, `C:\EDT\Pdv`) and run `nmake vlviewer` – or, alternatively, use the Microsoft Visual Studio (VS2008, v9.0) project in the `vlv` subdirectory. The build and the version of Qt must match your platform (32-bit or 64-bit).

NOTE For tutorial videos showing how to compile and use EDT applications, see Related Resources on page 7.

Firmware: FPGA Configuration (.bit) Files

At times, you may need to reprogram the PCIe interface flash memory using `pciload` – for instance...

- if you want to switch from one mode to another (base, medium, full) on certain EDT boards;
- if you need to use an FPGA configuration file that has special functionality;
- if you update to a new installation package that includes a required update for your board; or
- if the firmware becomes corrupted.

To do so, follow the instructions in the sections below.

Checking and Loading the Firmware

The following procedure applies to standard firmware only. If you are running custom firmware and need to update it, first get a custom firmware configuration file from EDT.

NOTE Do not update the firmware simply because you see a newer firmware file with a new driver; instead, consult the `README` file in the package, which will tell you if there is a required update.

- For Windows, `pciload` is an application in the installation directory (see Installation on page 8); double-click the *Pdv Utilities* icon to bring up a command shell.
- For Linux, `pciload` is an application in the installation directory (see Installation on page 8).

To see currently installed and recognized EDT boards and firmware, enter...

```
pciload
```

The program outputs the date and revision number of the firmware in the flash memory.

To compare the firmware in the package to the firmware loaded in flash on the board, enter...

```
pciload verify
```

If the two match, the firmware on the board is the same as the firmware in the installation package. If they differ, you'll see an error message, but this does not necessarily indicate problems; if your application is working correctly, probably there is no need to update the firmware.

If you do wish to update the standard firmware, enter...

```
pciload update
```

To update or switch to a specific firmware file, enter...

```
pciload firmware
```

...replacing *`firmware`* with the filename of the desired firmware, up to but not including the `.bit` extension.

NOTE Firmware is product-specific (not interchangeable), so be sure to use the correct firmware, as shown in Table 7.

Table 7. Arguments to pciload for VisionLink firmware

Board name	Command
VisionLink F1	`pciload visionlinkf1` (base mode)
VisionLink F4	`pciload visionlinkf4` (base through full mode)

For example, to load full-mode firmware on a VisionLink F1 frame grabber, run...

```
pciload visionlinkf1
```

The board reloads the firmware from the flash memory only during power-on – so after running `pciload`, the previous firmware is in the PCIe FPGA until the system has powercycled.

NOTE Updating the firmware requires a complete powercycle, not simply a reboot.

For a list of all `pciload` options, see the tables below or enter...

```
pciload --help
```

Corrupted Firmware

In rare cases, the board firmware may become corrupted. Typically, the symptom is that the board is not recognized by the operating system, or the computer itself will not boot with the board in it. In such cases, booting from the protected (backup) sector will allow the board to be seen so that you can reprogram the programmable sector.

Each EDT frame grabber has both a protected (backup) and a programmable flash memory boot sector. The sector from which the board will boot is determined by a jumper, which is preset to the programmable sector. If that sector becomes corrupted, you can move the jumper so the board will boot from the protected sector.

Most often, firmware corruption is the result of an interrupted load process or an unanticipated interaction with the host computer; if so, following the procedure below should solve the problem.

If the firmware file itself has become corrupted, first contact EDT for the current firmware you'll need to replace it, and then follow this procedure.

To reboot from the protected sector...

1. If needed, move the new firmware file to the installation directory or to the appropriate `flash/`*`fpga`* subdirectory.
2. Power off the host and board.
3. To avoid later confusion, remove any other EDT boards from the host.
4. On the EDT board with the corrupted firmware, move the jumper from its programmable to its protected setting (to locate this setting on your board, see Firmware: FPGA Configuration (.bit) Files on page 22).
5. Power up the host and board.
6. In the installation directory (see Installation on page 8), run...

   ```
   pciload
   ```

   The program outputs the date and revision number of the firmware in the flash memory — in this case, the date and revision number that shipped as of your purchase date. If no errors are reported, you have successfully booted from the protected sector.
7. With the system still powered on, move the jumper back to its original position.
8. Run...

   ```
   pciload firmware
   ```

   ...replacing *`firmware`* with the correct filename, as indicated in Table 7. If the feedback shows no errors, the new firmware has been installed, although it is not yet running.
9. Power off the host and board again.
10. Power on the system.
11. Run `pciload` with no arguments to verify the board is recognized and is running with the new firmware.

Troubleshooting

The EDT installation package includes numerous diagnostic programs, the most useful of which are briefly described in Example and Utility Applications on page 13. You can use these programs to search for problems yourself or to

generate output files to provide to EDT for technical support. For further technical help, visit the EDT support webpage (see Related Resources on page 7).

NOTE When contacting EDT for support, always provide output from the most relevant diagnostic programs – especially `dvinfo`, which gathers board- and system-specific information, runs tests, and writes the results to the file `dvinfo.out` in the current directory (see dvinfo on page 16).

Also, be sure to observe all Requirements on page 8 for optimal results.

Board Not Seen

To verify that the firmware is installed correctly and can access each board, run `pciload` (in the EDT installation package) with no arguments. You should see information on each EDT board that can be seen.

If a board is not seen by the system...

- Verify that your EDT installation package is version 5.4.5.8 or later; earlier versions do not fully support VisionLink boards. Run `setdebug -v` to see which version is installed.
- Try uninstalling and reinstalling the EDT package (and remember to reboot after each install).
- Try moving the board to a different slot.
- Perform a full power cycle (not just a reboot) on the system – especially important after a firmware update.
- Try checking for these possible problems...
  - — Typically, a VisionLink board will not work in a slot dedicated to graphics display cards, or a slot wired for fewer lanes than the number specified – for instance, a four-lane board will not work properly in a slot wired for only one lane (see Requirements on page 8).
  - — EDT drivers typically will not work with “guest only” accounts, so if you are using such an account, change to an account with greater access.

See also Problems With Bandwidth on page 27 and Problems With Firmware on page 28.

Problems With Software Installation

Many software installation problems may be solved by downloading the latest EDT installation package (see Installation on page 8).

NOTE Be sure to remove any previous installation packages before installing a new or updated package.

Windows

Try any of the following...

- If a board is not recognized, use the *Windows Device Manager* to see if the board is present as an “unknown device.” If so, right-click on the unknown device and choose *Uninstall* to uninstall it; then, from the *Action* menu, select *Scan for Hardware Changes*.
- Uninstall and then reinstall your existing EDT installation package.
- Download and install the latest EDT installation package (see Installation on page 8).

NOTE Do not extract and install files by hand; doing so will circumvent the installation process, which automatically updates system files, establishes links, and creates new files. Similarly, do not remove files by hand. Instead, use the *Add or Remove Programs* facility in the Windows control panel.

Linux

Try any of the following...

- Failure during installation may be due to system package dependencies. Make sure the following packages are installed on your system...

  ```
  make
  gcc
  libtiff
  linux kernel headers
  ```

  For example – on Ubuntu, to install the `libtiff` library, enter...

  ```
  sudo apt-get install libtiff4-dev
  ```

  After all needed packages are in place, run `make` from the installation directory (see Installation on page 8) to complete installation.

- Uninstall and then reinstall your existing EDT installation package. To uninstall, use the programs in the installation directory (see Installation on page 8),...

  — If the package was installed using *`package`*`.run`, remove it with `./uninstall.sh`.

  — If the package was installed using `rpm --install package,` remove it with `rpm --erase` *`package`*.

- Download and install the latest EDT installation package (see Installation on page 8).

NOTE New Linux versions often require an updated device driver, so if you are using a new or updated Linux kernel and you have trouble with the EDT installation or device access, check to see if a new EDT installation package is available.

Corrupted Images, Slow Acquisition, Timeouts, Data Loss

Corrupted images, slow acquisition rates, repeated timeouts, or data loss usually indicate that the bus is too slow or the driver is misconfigured. To correct this issue...

- Verify that the camera configuration file is the correct one for your camera and operating mode; see Setting the Camera Model on page 9.
- Verify that the EDT board is in a PCIe slot that is wired electrically (not just physically) to support the number of lanes provided by the board. For example, a four-lane board requires a slot that has four or more lanes. Also, note that some motherboards will “split” lanes between two slots, so that two x8 slots will become x4 if both are occupied.
- Determine the bandwidth required by your camera, and then ensure that both the board and the host can sustain the required throughput. For fastest full-mode cameras, your frame grabber and your host bus both must support eight lanes. For multiple camera installations, the combined data rates should not exceed that of the board(s) installed.
- Verify that the firmware file you loaded is the correct one for your camera and your mode of operation (base, medium, or full mode); see Firmware: FPGA Configuration (.bit) Files on page 22.
- Eliminate other devices, if any, that may be reducing the available bus bandwidth.
- Consult Requirements on page 8 to verify that your setup meets bus and throughput requirements.
- When updating to a new device driver, always recompile and relink applications that use EDT libraries (see Firmware: FPGA Configuration (.bit) Files on page 22).

For more information, see Problems With Bandwidth.

Problems With Bandwidth

To prevent timeouts and data loss caused by bandwidth problems, you'll need to determine the bandwidth required by your camera and verify that the board and the host system can sustain the required throughput.

Bandwidth requirements depend on the camera's pixel clock speed, the number of bytes per pixel, the number of taps, and the number of channels. To calculate bandwidth requirements, use this equation...

```
pixel clock speed * taps * bytes/pixel = total bandwidth
```

NOTE The pixel clock speed, not the frame rate, affects bandwidth requirements. If data loss is a problem, increasing the delay between frames probably will not help.

Cameras that output 10–16 bits per pixel will require two bytes per pixel of bandwidth. Therefore, a camera that has a 40 MHz pixel clock, two taps, and 12 bits per pixel requires system bandwidth of...

```
40 * 2 * 2 = 160 MB per second
```

You can ease this constraint by running the camera in a less demanding mode — for example, you can often run two-tap cameras in single-tap mode, or 12-bit cameras in 8-bit mode.

Other tips on solving bandwidth problems include...

- Consult Requirements on page 8 to verify that your setup meets bus and throughput requirements.
- Consider the number of cameras and the speed of the cameras you are using. The bus bandwidth may be adequate for some configurations, but inadequate for configurations with more or faster cameras.
- Consider the number of frame grabbers or other devices connected to the bus; using multiple devices on a single bus can reduce bandwidth, sometimes considerably.
- Verify that your bus has the minimum number of required (fully connected and usable) lanes – that is, at least four lanes for the F4 board.

Problems Acquiring Images With EDT Applications

If you have problems with image acquisition when using EDT applications, try the suggestions below.

- Verify that the camera device is on and is receiving power.
- Verify that all interface cable connections are working properly: Turn off the camera and power off the system; unplug the cable at both ends; reattach the cable at both ends; and turn on the system and camera again.
- Try a different cable, if available.
- Try a different camera, if available.
- Verify that the EDT installation package was installed correctly and that the driver is running and can see the board. To do so, in the installation directory (see Installation on page 8), go to the command line and enter...

  ```
  pciload
  ```

  If you see no information about your EDT board, then a problem occurred during installation.

  To resolve it, one at a time, try...

  — cycling system power;
  — moving the board to a different slot;
  — uninstalling and reinstalling the driver.

For best performance, install your EDT board in a bus that is not shared with any other devices and that meets the board's speed requirements, as discussed in Requirements on page 8.

Problems With Your Applications

In applications using EDT libraries, a mismatch between driver and library software versions can cause application or system failures. Thus, when updating a device driver, always recompile and relink applications which use EDT libraries.

Use the PDVDEBUG and EDTDEBUG environment variables to enable debug console output from the EDT libraries. Both libraries are documented on the EDT website.

Applications that use the EDT digital imaging library can set the PDVDEBUG environment variable to 1 or 2. A value of 1 turns on call trace information from most (though not all) library routines; a value of 2 enables more verbose trace information. A value of 0 turns off debug output. Setting the EDTDEBUG environment variable to one or two will provide even more detailed debug output from the underlying EDT DMA library.

The EDT message handler library provides generalized error- and message-handling for EDT software libraries and can be helpful in debugging your programs. See the EDT message handler library in the API for specific routines and usage.

Before seeking technical support, try to reproduce the problem with such EDT applications as `take, simple_take,` or `vlviewer`; if you cannot do so, then compare your code with EDT code to see if you can find the issue.

A simple example program that demonstrates the problem also is helpful.

Problems With Threads

The driver and libraries for your VisionLink product use threads. If you are using third-party software that is not thread-safe, contact your third-party vendor to determine if a thread-safe version is available.

Problems With Firmware

You may need to update the PCIe interface flash memory with `pciload` under these conditions...

- If you install a new device driver or switch to an FPGA configuration file with special functionality;
- If your firmware becomes corrupted;
- If the board is not seen in the system or is missing functionality that is in newer boards;
- If the firmware loaded on the board does not match the camera mode.

For details, see Firmware: FPGA Configuration (.bit) Files on page 22.

Appendix A: Pin Assignments

Table 8 shows the SDR26 pin assignments for Camera Link signals.

Table 8. Pin assignments – SDR26 connector

Camera or simulator end	Frame grabber end	Camera Link signal (base mode, primary connector)	Camera Link signal (medium mode, secondary connector)	Camera Link signal (full mode, secondary connector)
1*	1*	inner shield / ground*	inner shield / ground*	inner shield / ground*
14*	14*	inner shield / ground*	inner shield / ground*	inner shield / ground*
2	25	X0–	Y0–	Y0–
15	12	X0+	Y0+	Y0+
3	24	X1–	Y1–	Y1–
16	11	X1+	Y1+	Y1+
4	23	X2–	Y2–	Y2–
17	10	X2+	Y2+	Y2+
5	22	Xclk–	Yclk–	Yclk–
18	9	Xclk+	Yclk+	Yclk+
6	21	X3–	Y3–	Y3–
19	8	X3+	Y3+	Y3+
7	20	SerTC+	unused	100 ohms
20	7	SerTC–	unused	terminated
8	19	SerTFG–	unused	Z0–
21	6	SerTFG+	unused	Z0+
9	18	CC1–	unused	Z1–
22	5	CC1+	unused	Z1+
10	17	CC2+	unused	Z2–
23	4	CC2–	unused	Z2+
11	16	CC3–	unused	Zclk–
24	3	CC3+	unused	Zclk+
12	15	CC4+	unused	Z3–
25	2	CC4–	unused	Z3+
13*	13*	inner shield / ground*	inner shield / ground*	inner shield / ground*
26*	26*	inner shield / ground*	inner shield / ground*	inner shield / ground*

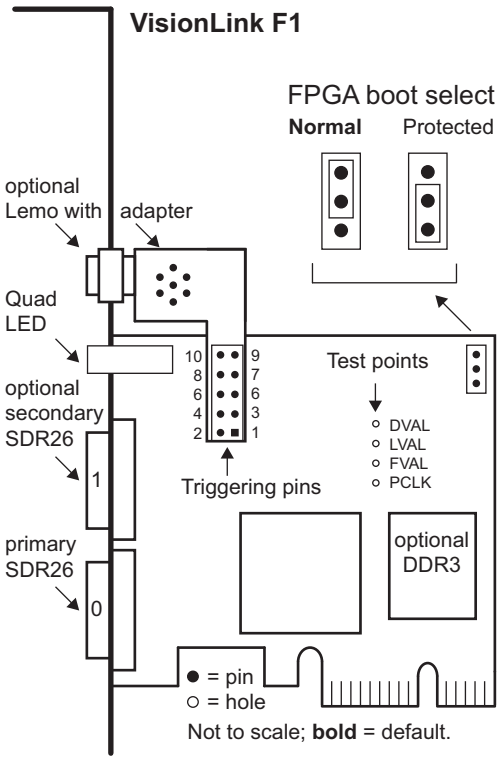
* For PoCL, pins 1 and 26 change to +12V DC power, while pins 13 and 14 change to +12V DC power return.

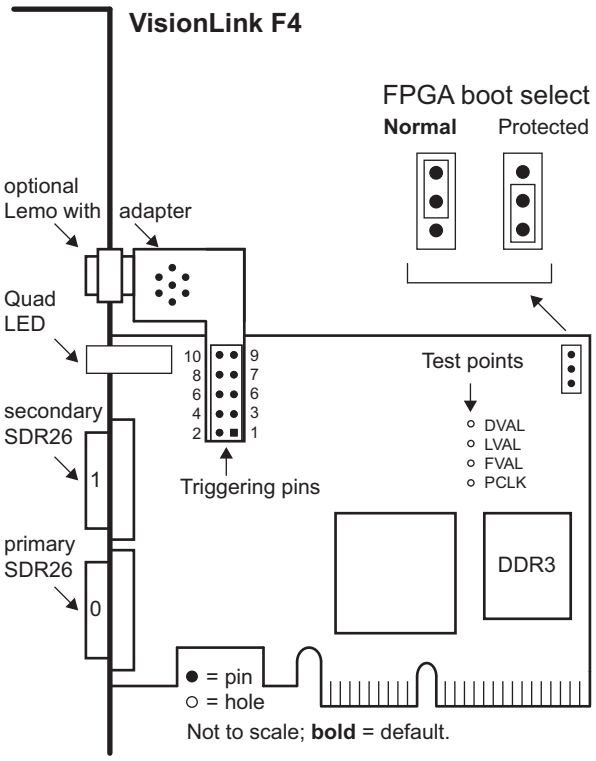
Appendix B: Diagrams – Boards and Cabling

This section shows diagrams and key features of VisionLink frame grabbers and cables.

VisionLink F-Series Frame Grabbers

F1 and F4



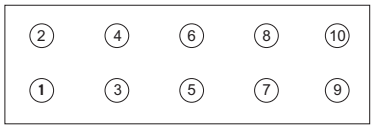


Additional External Inputs

Via Berg or Optional Lemo Connector

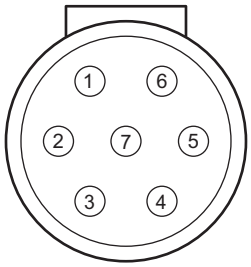
VisionLink frame grabbers offer two connectors that can be used for external control (triggers and other inputs, such as IRIG-B for timestamping): one Berg, and one optional seven-pin Lemo. Pin assignments are shown below.

BERG CONNECTOR [STANDARD]



Pin	VisionLink F1	VisionLink F4
1	Trigger 0+	Trigger 0+
2	Trigger 0-	Trigger 0-
3	Trigger 1+	Trigger 1+
4	Trigger 1-	Trigger 1-
5	Reserved or (optional) IRIG-B	IRIG-B
6	3.3V	3.3V
7	Reserved	Reserved
8	Reserved	Reserved
9	Reserved	Reserved
10	Ground	Ground

LEMO CONNECTOR [OPTIONAL]



Pin	VisionLink F1	VisionLink F4
1	Trigger 1+	Trigger 1+
2	3.3V	3.3V
3	Trigger 0+	Trigger 0+
4	Trigger 0-	Trigger 0-
5	IRIG-B	IRIG-B
6	Trigger 1-	Trigger 1-
7	Ground	Ground

Via Optional Cable Assembly

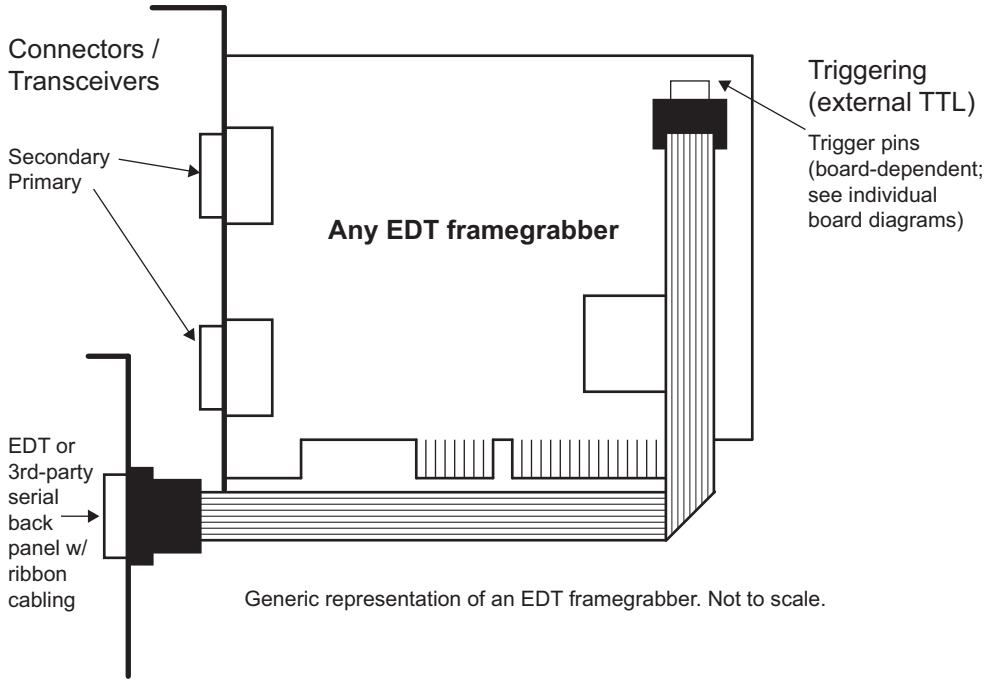
An optional EDT-built cable assembly is available for triggering, timestamping, or both; below are the pin assignments (see also Appendix C: Timestamping).

EDT p/n 016-13840 (June 2010)	*[color]*	*Lemo*	*D9*	*Function*	*BNC*	*BNC Label*
	green	1	2	trigger 1+	center conductor	TRIG 1
	red	2	9	reserved	–	–
	orange	3	7	trigger 0+	center conductor	TRIG 0
	brown	4	8	trigger 0-	shield	TRIG 0
	white	5	4	IRIG IN	center conductor	IRIGB
	blue	6	3	trigger 1-	shield	TRIG 1
	black	7	5	ground	shield	IRIGB

For length, Lemo to D9 = 1 ft.; three BNCs out to D9 = each 6 in. or less.

Via Ribbon Cabling and D9 Connectors

If you do not have the optional Lemo connector, you can use a serial backpanel equipped with ribbon cabling and one or two 9-pin D-connectors. The diagram below illustrates the single D-connector setup.



Generic representation of an EDT framegrabber. Not to scale.

Appendix C: Timestamping

For VisionLink F-series frame grabbers, timestamping is provided via the standard Berg or the optional Lemo connector. On F4 boards, this timestamping function is included; on F1 boards, it can be ordered as an option.

This function enables a precise IRIG-B timestamp to be inserted, directly into the data, for each image frame at the moment of capture. The timestamp is included in a 32-byte footer after the end of the image data; no image data is overwritten. For example, a camera with 1000 x 1000 8-bit pixels would produce 1,000,032 bytes of DMA data.

Although the footer is at the end of the DMA data, the time is captured at the beginning of the frame on the rising edge of the frame valid signal. The time thus captured combines the time derived from an IRIG-B input with a high-resolution counter for computing fractional seconds.

NOTE EDT's current IRIG-B format (IRIG2) is the second such format used for VisionLink frame grabbers. EDT's former IRIG-B format (IRIG1) is now obsolete.

In addition to the IRIG time value, the footer contains a frame counter, as well as space for a 64-bit timestamp computed as Unix seconds and fractional seconds.

For information on cable connectors and pinouts, see Additional External Inputs on page 31.

Camera Configuration File Directives

To enable the IRIG timestamp, add to a camera configuration file...

```
method_header_type: IRIG2
```

To enable packed BCD timestamps in the configuration file, use...

```
irig_raw: 1
```

To specify that this board is using input from another board rather than direct input, use...

```
irig_slave: 1
```

Footer Format

The IRIG2 footer is 32 bytes appended to the image data transferred by DMA from the frame grabber. It includes a frame counter and a timestamp from IRIG input.

Time values down to the microsecond are counted using the 40 MHz oscillator on the board. The time is latched at the beginning of transfer from the camera when the board sees the rising edge of frame valid.

After frame capture, the time in Unix seconds is computed, including the fractional time determined by dividing the current 40 MHz count by the number of 40 MHz clocks in a second. The IRIG time is determined on the board as either Unix seconds, or as the IRIG BCD values packed into a 32-bit integer.

Table 9 shows the structure elements of the IRIG2 footer.

Table 9. Elements of IRIG2 Footer

Element	Offset	Size	Type	Notes
Magic	0	4	u_int	This should be ASCII “EDT” followed by 01 (or 0x45445401).
Frame	4	4	u_int	This is the frame counter, which is reset when reset_intfc bit is cleared – normally at the start of acquisition.
IRIG time	8	4	One of two types: packed raw BCD, or Unix seconds. Type is indicated by a bit in the status register.	For IRIG time, the raw format is: 6 bits seconds 6 bits minutes 5 bits hours 9 bits days 6 bits years Unix seconds = seconds since 1/1/1970 (without leap seconds)
40 MHz count	12	4	u_int	Counts using onboard 40 MHz clock since last pulse per second
40 MHz maximum ticks at last pulse	16	4	u_int	Counts at last pulse per second (pps).
Status	20	1	u_char	Status bits: 0–3 = footer type (3 = Unix seconds; 5 = IRIG BCD) 4 = has valid IRIG data 5 = is synched with pps 6 = has seen IRIG error 7 = has seen pps error
Reserved	21	3	u_char	Reserved.
Monotonic Unix time with fractional seconds	24	8	double	This value is computed and filled in by the library after DMA. Fractional time is the 40 MHz count divided by 40 MHz max count

The following C++ struct encapsulates this footer structure, including showing the struct with bit fields representing the packed BCD values from the IRIG signal.

```
// ts_raw_t is defined in libedt_timing.h
// Packed BCD from IRIGB
typedefstruct { // Raw timecode format
u_long seconds:6;
u_long minutes:6;
u_long hours:5;
u_long days:9; // days in the year
u_long years:6;
} ts_raw_t;
// This structure is defined in pdv_irig.h
typedef struct Irig2Record {
u_int magic; /* magic */
u_int framecnt; /* starts at 0 */
/* There are two modes - seconds from 1970 (Unix time) or BCD mode, in which the BCD
values from IRIG are packed into 32 bits in the raw structure */
union {u_int seconds;
ts_raw_t raw;
} t;
u_int clocks; /* how many 40 MHz ticks in last second */
u_int tickspps; /* 40 MHz ticks since last second */
struct { /* status bits */
u_char type: 4;
u_char irig_ok:1;
u_char pps_ok:1;
u_char had_irig_error:1;
u_char had_pps_error:1;
} status;
u_char reserved[3];
double timestamp; /* holds a 64-bit unix seconds time */
/* This must be filled in by software */
} Irig2Record;
```

IRIG API

In the EDT digital imaging library routines, extra data added by the board or software (outside of the defined image) typically is called a *header*. In this case, however, such data is at the end, so it is called a *footer*.

EDT's software development kit for the IRIG option includes various files and library routines specific to IRIG, including but not necessarily limited to those described below.

simple_irig2.c

Example application that shows how to access IRIG information from frames captured using IRIG configuration.

libpdv.c

In addition to subroutines and functions for other purposes, `libpdv.c` includes the IRIG functions below.

To return the full size of the DMA (image data plus the 32-byte IRIG footer), enter...

```
int pdv_get_dmasize(PdvDev *pdv_p)
```

To return the footer's byte offset from the beginning of the image data, enter...

```
int pdv_get_header_offset(PdvDev *pdv_p)
```

For the IRIG footer, this will be...

```
image width x height x bytes per pixel
```

NOTE For VisionLink frame grabbers, the DMA size must be a multiple of 8 bytes; therefore, with or without the IRIG option enabled, the image size must be a multiple of 8 bytes.

To automatically enable IRIG functionality, you can use `pdv_set_header_type`:

```
int pdv_set_header_type(PdvDev *pdv_p, int header_type, int irig_slave, int irig_off-
set, int irig_raw)
```

For example...

```
int ret = pdv_set_header_type(pdv_p, HDR_TYPE_IRIG2, 1, 2, 0);
```

See the `simple_irig2.c` source code file for example code that shows how to use this functionality.

pdv_irig.c, pdv_irig.h

The functions below are included in `pdv_irig.c.`

To reset the frame counter to 0, enter...

```
int pdv_reset_dma_framecount(PdvDev *pdv_p)
```

To set the IRIG format to packed BCD values if the value *bcd* is not zero (otherwise the format is Unix seconds since 1/1/1970), enter...

```
int pdv_irig_set_bcd(PdvDev *pdv_p, int bcd)
```

To compute the offset of the IRIG footer and return a pointer to its memory (since this in the DMA stream from the board, this pointer will be overwritten when this buffer is used again), enter...

```
irig2Record *pdv_irig_get_footer(PdvDev *pdv_p, u_char *imagedata)
```

To compute the Unix time from the counts values in the footer and places the result in footer > timestamp (and the timestamp value is also returned by the function), enter...

```
double pdv_irig_process_time(Irig2Record *footer)
```

To clear the error flags `had_irig_error` and `had_pps_error (`“sticky” bits, indicating respective errors in the IRIG transfer or the 1 pps signal), enter...

```
void pdv_irig_reset_errors(PdvDev *pdv)
```

To set the board in slave mode to use 1 pps or IRIG-B values received from another EDT board, rather than from the Lemo connector (note – this function requires a special cable from EDT), enter...

```
void pdv_irig_set_slave(PdvDev *pdv_p, int onoff)
```

To use the direct register access to the current time value to fill in an Irig2Record structure (with the valid elements being counts, tickspps, status, and the IRIG seconds / bcd values), enter...

```
void pdv_irig_get_current(PdvDev *pdv_p, Irig2Record *footer)
```

irigdump.c

The EDT PDV driver also contains a simple example program named `irigdump.c.` This program, based on `simple_take.c,` exercises most of the functions described above.

To display the command line arguments, run `irigdump -help.`

Revision Log

Below is a history of modifications to this guide.

Date	By	Rev.	Pp	Detail
20160822	PH,RH	0011	6	Under Included Files, revised introductory text as follows: "~~For products covered in this guide, your EDT installation package includes device drivers for supported operating systems, as well as~~ *For the above products, your EDT installation package includes README files for quick start information and special cases (README.*), as well as device drivers for supported operating systems and* source code and binaries for..."
20160822	PH,RH	0011	8-9	Under Installation, added details about silent vs. standard installation of software.
20160822	PH,CH	0011	19	Under External Triggering Pins, revised this paragraph as shown... "Fire the trigger by applying a TTL signal lasting ~~10 microseconds~~ *at least 200 nanoseconds* to these pins, which in turn will output a signal of the appropriate level to a camera control line, typically CC1. ~~The trigger cable can drive either pin high with respect to the other; no particular polarity is required~~."
20160303	PH,RH	0010	All	Changed "DMA channel(s)" to "channel(s).
			6	Included Files: At end, added bullet about Windows silent install.
			9-10	Image Capture and Display GUI(s): Deleted the "s" in that heading since pdvshow is no longer mentioned there, so there's only one GUI covered under it. Also deleted "To invoke vlviewer, enter vlviewer from a command line in a terminal window, or, in Windows, from the vlviewer desktop icon. To see the available command-line options, enter vlviewer --help from a Pdv Utilities command window or Linux terminal window in the installation directory. A comprehensive user guide for vlviewer is available via the application's Help menu." and replaced "To specify options, run..." with "To invoke with other than the default (0,0) unit and channel, run..."
20160129	PH,RH	0009	Title	Product photo: Replaced older green boards with newer blue boards.
			All	Deleted all data for Mac, and most for (legacy) pdvshow except some in: Image Capture and Display GUIs; Units, Connectors, Channels; Example and Utility Applications.
			6	Overview: Table 1 - updated headings; Included files - updated bullets.
			7	Related Resources: Updated links.
			9	Setting the Camera Model: Table 3 - updated "command-line" data; deleted Mac data.
			9-10	Image Capture & Display GUIs: Updated introductory text and bullets (before Figure 1 of vlviewer) and last sentence about vlviewer help.
			11	Units, Connectors, Channels: Updated text about apps defaulting to unit 0, connector 0.
			22	Programming: Building or Rebuilding an Application, Table 6 - put makefile method first, before Windows Visual Studio method; under Compiling vlviewer - updated Qt details. Firmware: Dropped "PCI" from "PCI / PCIe" reference.
			28	Problems with Software Installation [Linux]: Corrected "rpm -erase...' to "rpm --erase...".
20141110	PH,RH	0008	Title	Deleted unused document number (008-xxxxx-xx).
			All	Conformed "framegrabber" to "frame grabber" and "fiberoptic" to "fiber-optic."
			11-12	Added LED information: –p. 11, Units, Connectors, and Channels: Added LED detailsin Figure 2. –p. 12, LEDs: Added this new section.
			22	Building or Rebuilding an Application: Added note re. 32- vs. 64-bit.
20140922	PH,CK	0007	22	Compiling vlviewer, para1: Corrected `apt-get install qt-4-dev-tools` to `apt-get install qt4-dev-tools`.
20140818	PH,CH	0006	6	Overview, Table 1, VisionLink F1 full-height: Corrected part #s to -14836 and -14852.
20140729	PH,CH	0005	6	Overview: Added Table 1 (part numbers and descriptions).
20140729	PH,CH	0005	32,34	Additional External Inputs (top) & Appendix C (top): slightly clarified timestamping text.
20140713	PH,RH	0005	13	Serial Communication > From Camera Manufacturer's Application: Added Note.

Date	By	Rev.	Pp	Detail
20140702	PH,RH	0004	7, 22	–p. 7, Related Resources – updated table & added a line and link about tutorial videos. –p. 22, Compiling vlviewer – added note about tutorial videos.
20140630	PH,CH	0003	31, 32	Appendix B, Diagrams – Boards and Cabling: –p. 31, VisionLink F-series Frame Grabbers" – to F1 diagram, added optional Lemo. –p. 32, Additional External Inputs, Via Berg or Optional Lemo... – updated pinouts.
20140630	PH,CH	0003	8	In Table 1, for VisionLink F4, Gen2, updated 850MB/s to 1000MB/s.
20140630	PH,RH	0003	7	Simplified Related Resources.
20140512	PH,RH	0002	1-7, 31	Made more minor / cosmetic improvements.
20140509	PH,RH	0001	All	Replaced product diagrams and made other minor / cosmetic improvements.
20140508	PH,RH	0000	All	Created this VisionLink F-series UG with no document number (we no longer use one).