COGNEX®

Cognex Vision Software

FireWire Cameras (IEEE 1394 DCAM)

User's Guide
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Cognex Software and FireWire Cameras

Cognex VisionPro and CVL software provide support for acquiring, processing, and displaying images from IEEE 1394 DCAM (FireWire) cameras. This document describes how to install and configure the drivers to support this capability under Windows 2000, Windows XP and Windows Vista.

Note: For information on using an IEEE 1394 DCAM camera with Cognex vision software, see the VisionPro or CVL documentation.

In addition, see the Cognex technical support site at www.cognex.com/support for more information on using FireWire for your machine vision application.

System Requirements

In addition to the standard software and hardware requirements listed in your Cognex software documentation, your PC must include an IEEE 1394 adapter and either a Cognex security dongle, a Cognex software license, or a Cognex frame grabber with the appropriate security bits enabled to ensure the software is properly licensed.

Note: If the IEEE 1394 adapter in your PC does not have a powered connector, you must use a camera that supports external power or supply power to the camera using a powered IEEE 1394 hub. Most laptop computers will require the use of a powered hub. Ensure any PCMCIA FireWire adapter in your laptop uses external power.

Cognex FireWire supports DCAM version 1.30 and later. Be sure you are using the latest firmware for your camera. Use the DCAM Doctor utility to view the current firmware for your camera, and check with your camera manufacturer as to how to obtain updates and install them.

Note: Be aware that Microsoft Vista supports only IEEE 1394a transmission speed for both CVL and VisionPro, regardless of the FireWire cameras and adapters you use.

Cognex FireWire DCAM Driver and Installation

Microsoft operating systems come with a built-in FireWire camera device driver, but Cognex supplies its own FireWire DCAM driver so that the vision software treats FireWire cameras as if they were frame grabbers. Although it is common for your FireWire camera to become associated with the Microsoft FireWire driver, you must use the Cognex FireWire DCAM driver to run Cognex vision software.

Note: To ensure that the Cognex driver is associated with your camera, install the IEEE 1394 adapter and camera(s) before starting the software installation. If the Windows "Found New Hardware Wizard" appears when you restart your PC, cancel it. Do not install any Windows drivers manually.

Install your Cognex vision software as described in your product installation documentation. The installation utility that is part of your Cognex vision software package includes the Cognex Drivers 2.6 installer, which installs the Cognex FireWire DCAM driver as part of the default installation. Only the Cognex FireWire DCAM driver will enable your DCAM cameras and adapters to work properly with Cognex software. If you did not connect your camera to the adapter before the driver installation, or if you change cameras or add an adapter later, you can associate the driver with the camera by following these steps:

1. Connect your camera to the adapter.

2. Open the **Add or Remove Programs** control panel (Windows XP) or the **Programs and Features** control panel (Windows Vista).

3. Select **Cognex Drivers 2.6** and click **Change**.

4. When the installer opens, click **Next**.

5. If the Cognex FireWire DCAM driver is currently installed, click **Repair**, then **Next**. The installer will associate the driver with any connected cameras.

6. If the Cognex FireWire DCAM driver is not currently installed, check **Modify** and install it.

Note: Wait at least 10 seconds after plugging in a camera before acquiring images with Cognex software.

Windows XP FireWire Bus Driver Downgrade

Microsoft Windows XP SP2 and SP3 do not correctly support IEEE 1394b FireWire adapters. Downgrading the Windows XP FireWire bus driver to the SP1 version is required for IEEE 1394a or 1394b FireWire cameras to work correctly on an IEEE 1394b adapter, or if you want to use a 1394b FireWire camera with an IEEE 1394a

adapter. The Cognex Drivers 2.6 installer will automatically launch the utility *XPDCAMFix.exe* if this downgrade is required. The utility will prompt you for the downgrade; click on **Downgrade**. The downgrade utility modifies only files needed for proper IEEE 1394b operation. It does not affect any other Microsoft XP bus drivers.
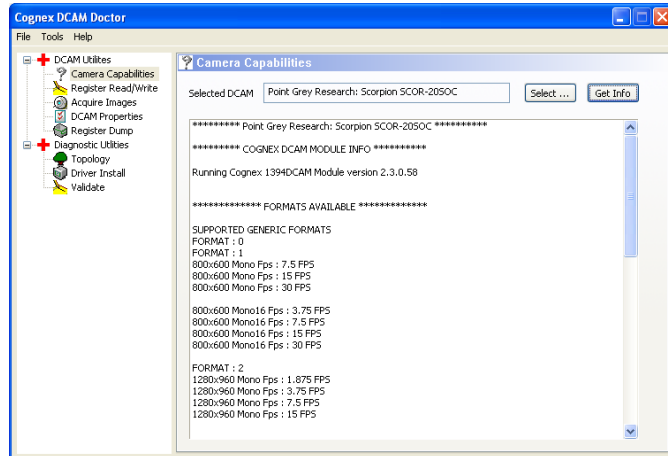
Using FireWire Cameras

The manufacturer's documentation is the best source of information for your FireWire camera. Cognex vision software includes the diagnostic utility DCAM Doctor to test and examine properties and register values once your camera is properly connected to your PC and the necessary drivers have been installed. To launch DCAM Doctor using CVL or VisionPro:

CVL: Start->Programs->Cognex->CVL->Utilities->IEEE 1394 DCAM->DCAM Doctor

VisionPro: Start->Programs->Cognex->VisionPro->Utilities->IEEE 1394 DCAM->DCAM Doctor

The **Camera Capabilities** utility tells you which camera properties your Cognex software recognizes.


To use the **Camera Capabilities** utility:

1. Click **Select**.

2. Choose your FireWire camera from the list of cameras connected to this PC.

3. Click **Get Info**.

Validating the Cognex FireWire DCAM Driver

Select the **Driver Install** utility to validate your FireWire driver. The DCAM Doctor will display the FireWire cameras installed on your system and list the associated device driver for each:
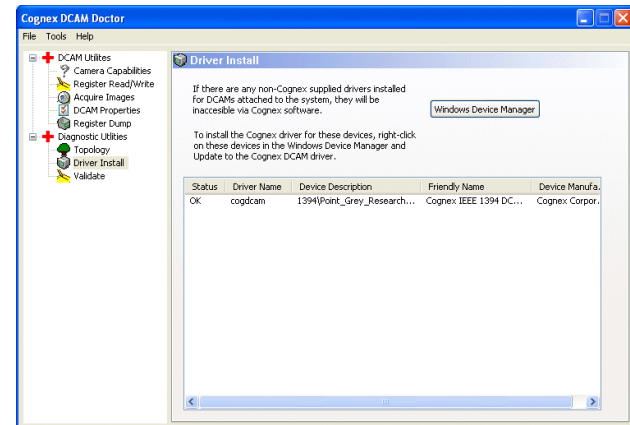

If any of your cameras are not associated with the Cognex device driver:

1. Click **Windows Device Manager**.

2. Open the entry for **Imaging Device**.

3. Right-click on **Generic 1394 Desktop Camera** and select **Update Driver**.

4. Choose the **Install from a list or specific location** option.

5. Choose the **Don't search. I will choose the driver to install.** option.

6. Install the **Cognex IEEE 1394 DCAM Driver**.

Acquiring Images

The Acquire Images utility lets you try out different camera configuration files (CCFs) and other acquisition parameters.
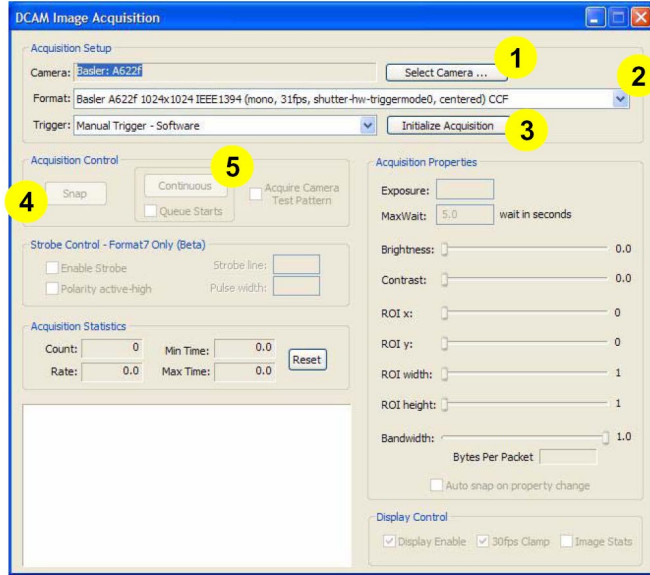
To use the Acquire Images utility:

1. Select your FireWire camera from the list.
2. Select a video format.
3. Initialize Acquisition.
4. Click **Snap** to acquire a single image.
5. Click **Continuous** to generate a live image.

During a continuous acquisition you can change other values, such as the exposure time. Be aware that although DCAM Doctor can be used to test that your FireWire cameras are working, you cannot save these acquisition settings for use in your CVL or VisionPro application.

Video Formats

The DCAM specification lists several generic video formats and makes provisions for custom video formats (Format 7).

When you use a camera configuration file (CCF) that was written specifically for your FireWire camera, it uses Format 7. This format is optimized for maximum frame rate and image size for use with Cognex vision software. In addition, in most cases, the camera-specific CCF lets you specify exposure times in absolute values.

If your application requires it, you can specify the Generic 1394DCAM CCFs to use the standard DCAM video formats. Your Cognex vision software includes several generic CCFs for different image sizes and frame rates.

Your Cognex vision software also includes the CITDCAM application, which lets you create your own FireWire CCF files. You should be completely familiar with DCAM specifics before you attempt to create your own CCF. To launch CITDCAM using CVL or VisionPro:

CVL: Start->Programs->Cognex->CVL->Utilities->IEEE 1394 DCAM->CITDCAM

VisionPro: Start->Programs->Cognex->VisionPro->Utilities->IEEE 1394 DCAM->CITDCAM

Supported DCAM Properties

Cognex vision software supports many of the commonly used DCAM properties through the Cognex vision software API, such as Shutter, Trigger Mode, Trigger Delay and so on. See the Acquiring Images: Application Notes chapter of the CVL User's Guide for a complete list. For VisionPro see the Acquisition:DCAM section of the online User's Guide.

Always set DCAM properties using a Cognex API if one exists. However, if a Cognex API does not exist for a DCAM property, you can read and write DCAM camera registers directly. See your Cognex vision software API documentation for how to read and write DCAM camera registers. The QuickBuild feature of VisionPro provides direct access to DCAM registers through the Image Source dialog box, as shown:
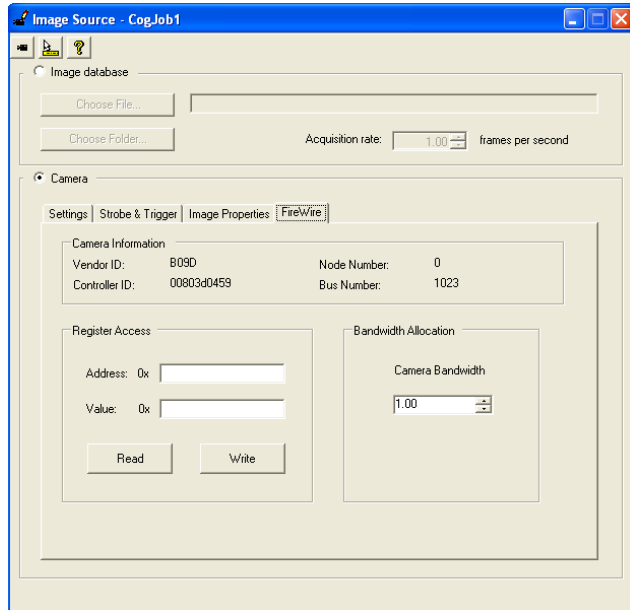
Exposure Settings

Some cameras let you specify absolute exposure values in seconds or fractional seconds. Other cameras use register values that map to exposure times. Your camera documentation will list which exposure model it uses.

In many cases using the Cognex-supplied CCF lets you specify absolute exposure values. However, if you use the "Generic 1394DCAM" CCFs, you will need to specify exposure values in the native terms of the camera. The **Acquire Images** utility of DCAM Doctor reports the maximum and minimum exposure settings and whether it supports absolute seconds, fractional seconds or register values. Note that

for VisionPro, when the units are unspecified next to the Edit Box, it means that the units are in register units specific to the camera. Check your camera specification for the units expected and use units*1000 for the exposure setting.

Region of Interest (ROI)

Cognex vision software lets you specify a region of interest (ROI) to use when you acquire images. If your camera supports setting ROI, and you are using a Format 7 video format, you will see an increased frame rate. If not, Cognex vision software acquires full sized images and reduces them in software, returning an image of the user-specified ROI.

If you use the Generic 1394DCAM CCFs, ROI is always done in software, even if the camera supports it in hardware. DCAM Doctor can be used to measure the camera frame rate for specific ROI values.

Triggers

Most DCAM cameras have trigger inputs into the camera itself. Cognex software will automatically put the camera into the hardware triggering mode when you set the appropriate trigger model. The camera will then wait for an external signal to come in before an acquisition is initiated.

Trigger Mode 0 is the most basic and practical one. The exposure duration is programmed into a register in the camera. The trigger input initiates the exposure and the camera controls the exposure duration, as determined by the register value.

Various cameras respond differently when the trigger rate exceeds the frame rate of the camera. Some cameras ignore triggers when this occurs, resulting in lost images. Consult the documentation for your DCAM camera to understand how it handles overtriggering.

Strobes

The DCAM v.1.30 specification does not define any strobe functionality, but it was added in version 1.31. For cameras that are only DCAM v.1.30-compliant, a constant illumination light source may be the only lighting option. However, this arrangement can be problematic if you require a very short exposure time to freeze motion for reliable image capture, especially under high magnification.

In this case upgrading to a DCAM v.1.31-compliant IEEE 1394 camera

might be the only reliable and sensible solution. DCAM v.1.31-compliant IEEE 1394 cameras can fire a strobe via an output pin on the camera itself. There is control for signal polarity, duration of strobe pulse, and the delay of the strobe signal relative to when the exposure began, all accessible via software. You can use Cognex software to control the strobe on cameras that support the DCAM 1.31 specification by programming the software's API (acquisition properties). CVL 6.3 and later versions, plus VisionPro 4.1 and later versions, support the following strobe properties:

- Strobe enable

- Strobe polarity

- Strobe duration

- Strobe delay

Not all cameras that claim to meet the DCAM 1.31 specification support DCAM standard strobe control features. See your camera's documentation for strobe support information. Also be aware that the CCF may contain information about controlling strobe output.

Adapters and Cables

You should use an IEEE 1394a adapter for IEEE 1394a cameras and an IEEE 1394b adapter for IEEE 1394b cameras. Some adapters support a combination of 1394a and 1394b cameras. If you plan to use a mix of IEEE 1394a and IEEE 1394b cameras, use separate adapters if possible. Be aware that the adapter will operate at the speed of the slowest device connected to it.

An IEEE 1394a connection uses a 6-conductor cable. Most host adapters and cameras use a 6-pin connector, though some devices may use a smaller 4-pin connector. Such devices will need a separate power supply. The maximum data rate for IEEE 1394a devices is 400 Mbits/second.

An IEEE 1394b connection uses a 9-conductor cable. The connectors are 9-pin and are not compatible with the 6-pin IEEE 1394a connectors. Although it will reduce the bus speed, if you want to connect an IEEE 1394a camera to an IEEE 1394b port, you can use a 9-to-6 pin adapter or a cable with a 9-pin connector on one end and a 6-pin connector on the other end. The maximum data rate for IEEE 1394b devices is 800Mbits/second.

The IEEE 1394 standard limits cable length to 4.5 meters, although Cognex has successfully tested cables up to 10 meters in length. The standard allows sharing of up to 63 devices (using hubs) with a total data rate of 400 Mbits/second (for IEEE 1394a) or 800 Mbits/second (for IEEE 1394b) per adapter. Using multiple adapters can increase your total bandwidth. Note that an IEEE 1394 bus will operate at the speed of the slowest device on the bus.

Most FireWire adapters have more than one port. All OHCI-compliant adapters (which are required for Cognex vision software) support a minimum of 4 DMA channels. For simultaneous acquisition, a DMA channel is required for each camera. The maximum number of cameras that can acquire at the same time is limited by the number of available DMA channels, the available IEEE 1394 bus bandwidth, as well as by the available PCI bus bandwidth on the PC.

Camera Ordering (Multi-Camera Applications)

If your application uses multiple cameras, each camera is referred to by a unique index value. The association of individual cameras with index values is called *camera ordering*.

When you connect multiple IEEE 1394 DCAM cameras to a single PC, the camera order is determined by each camera's position on the IEEE-1394 bus. For simple configurations, the camera order is simply the port order (the first port is camera 0). For more complex bus configurations involving multiple adapters, hubs, or repeaters, the bus assumes a tree configuration with branch nodes (devices with ports) and leaf nodes (cameras). This entire tree is traversed, and the camera ordering begins with the first leaf node on the most distant branch node.

This method of camera ordering has the following characteristics:

- For a given IEEE 1394 bus configuration, the camera order is fixed by the port into which each camera is plugged. You can replace a camera, even with a camera of a different type or manufacturer, and the camera will have the same index.

- You can change the camera ordering by simply connecting cameras to different ports.

- If you change the IEEE 1394 bus configuration, the camera ordering will change. For example, if you replace a two-port adapter with an IEEE 1394 hub, the cameras will have different indexes.

Note: In releases up to and including VisionPro 4.4 and CVL 6.5, camera ordering was based on a globally unique identifier

embedded in each camera. This earlier ordering method meant that any time a camera was replaced, even with an identical camera from the same manufacturer, the camera ordering was likely to change. It also meant that it was impossible to alter the camera ordering for a given set of cameras.

The change in how cameras are ordered means that any application using multiple IEEE 1394 cameras created prior to VisionPro 5.0 will not have the same camera ordering under this VisionPro release.

You can force VisionPro to use the pre-VisionPro 5.0 method of ordering changing the **visionpro.ini** configuration file. For more information, see the topic **Configuring VisionPro.ini** in the VisionPro documentation. Cognex recommends, however, that users modify any existing applications to work with the current ordering method. For detailed information on how to do this, see Cognex Technical Technical Bulletin TB-07-002 *FireWire Camera Ordering Changes*, available from Cognex Customer Support.

Multi-Camera Applications and Bandwidth Considerations

As long as you are using the Cognex IEEE DCAM driver, you can use multiple adapters as well as multiple cameras (even from different vendors) in your application.

If your application uses more than one FireWire camera on a single FireWire bus, you may want to reduce the bus bandwidth used by each camera. Cognex vision software provides a bandwidth control property that sets the number of bytes per-packet used by a camera. This is useful when cameras need to acquire images at the same time and the total bandwidth required by the cameras, before bandwidth property adjustment, exceeds the total available IEEE 1394a/b bus bandwidth.

Note: For detailed information on IEEE 1394 bandwidth considerations, see Cognex Technical bulletin TB-07-004, *FireWire Bandwidth Calculations*, available from Cognex Technical Support.

Hot-Plugging

Cognex vision software does not support camera hot-plugging. If you plug in a camera after you start your Cognex vision application, you must shutdown and restart the application for it to see the camera.

In addition, be aware that adding or removing any device (not just cameras) while a vision application is running is not supported and will require restarting the application.

FireWire Hubs

Cognex supports the use of a FireWire hub to expand the number of IEEE 1394 DCAM cameras you can attach to your FireWire adapter, as shown:
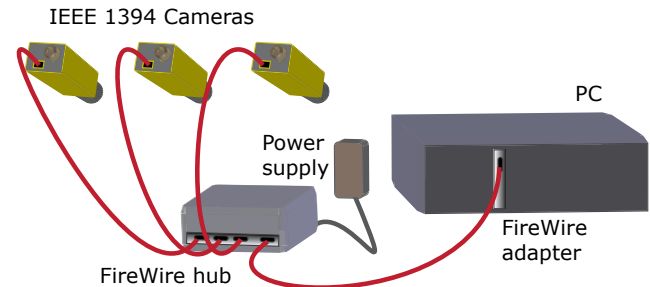
FireWire hubs can also be used in series to extend the distance between FireWire cameras and the FireWire adapter. In general, a maximum of six FireWire hubs can be used to extend the total distance of FireWire camera to PC to 31 meters.

Various FireWire hubs support either IEEE 1394a or IEEE 1394b cameras, or a combination of both. Be aware that the hub will transfer data at the speed of the slowest device connected to it. Contact your Cognex sales representative for information on the FireWire hubs available from Cognex.

IEEE-1394 Bus Configuration Change Event

Cognex software supports an IEEE-1394 bus configuration changed event to notify the user when a configuration change occurs on the IEEE-1394 bus to which the camera/adapter is connected. A changed event indicates one of two occurrences:

- The camera has been unplugged.

- The camera, or another device connected to the same IEEE-1394 bus, has initiated a bus reset. When this occurs the Cognex software will generate additional pieces of information, such as the identifying node number of the device and the number of nodes on the IEEE-1394 bus after the reset.

If your Cognex software detects an IEEE-1394 bus configuration changed event, it can display the following error dialog box:

Once the event has been detected, the state of the acquisition hardware and software may no longer be consistent. In general, the only appropriate application-level response to this event is to gracefully shut down and then restart your vision application.

Note: Cognex does not support the IEEE-1394 bus configuration changed event on Windows 2000.