POINT GREY RESEARCH

PGR Scorpion

Technical Reference Manual

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1 Hardware Warranty

Point Grey Research Inc. (PGR) warrants to the Original Purchaser that the Camera Module provided with this package is guaranteed to be free from material and manufacturing defects for a period of one (1) year. Should a unit fail during this period, PGR will, at its option, repair or replace the damaged unit. Repaired or replaced units will be covered for the remainder of the original equipment warranty period. This warranty does not apply to units that, after being examined by PGR, have been found to have failed due to customer abuse, mishandling, alteration, improper installation or negligence.

Point Grey Research, Inc. expressly disclaims and excludes all other warranties, express, implied and statutory, including, but without limitation, warranty of merchantability and fitness for a particular application or purpose. In no event shall Point Grey Research, Inc. be liable to the Original Purchaser or any third party for direct, indirect, incidental, consequential, special or accidental damages, including without limitation damages for business interruption, loss of profits, revenue, data or bodily injury or death.

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5 Introduction

5.1. Scorpion Overview

The *Scorpion* IEEE-1394 camera platform, available with a variety of CMOS and CCD image sensors, is designed for demanding imaging applications. Common to each camera model is the form factor, the communication interface and the general purpose I/O.

All model-specific information presented in this manual reflects functionality available in the latest version of camera firmware. To determine this version, please refer to the Individual Model Specifications section.

This manual attempts to provide the user with a detailed specification of the *Scorpion* camera system. The reader should be aware that the camera system is a complex and dynamic system – if any errors or omissions are found during experimentation, please contact us (see section 12.4 *Contacting Technical Support*).

5.2. General Features

- **CCD and CMOS imaging sensors** provide a wide range of resolutions and frame rates
- **IEEE-1394 interface** for data transmission speeds up to 400Mbps
- **Region of interest** and **pixel binning** modes for faster frame rates
- **Camera settings control** of brightness, auto exposure, gain, shutter
- **GPIO connector** for external trigger, strobe and RS-232 serial I/O
- **Anodized aluminum case** with top, bottom and front mounting
- **Automatic sync** with other *Scorpion*'s on the same 1394 bus
- **Embed frame-specific info** in pixels of the image
- **Extended shutter times** up to several seconds
- **Firmware upgradeable** in field via IEEE-1394 interface

5.3. System Requirements

- Processor
  Recommended – Intel Pentium® 4 2.0 GHz or compatible processor
  Minimum – Intel Pentium® III 800 MHz or compatible processor
- Memory
  Recommended – 512 MB RAM
  Minimum - 64 MB RAM

- Desktop resolution
  Recommended - 1600 × 1200
  Minimum - 640 × 480
- AGP video card with 64 MB video memory (128 MB recommended)
- 32-bit standard PCI slot for the IEEE-1394 card
- Microsoft Windows XP Service Pack 1
- Microsoft Visual C++ 6.0 (to compile and run example code)

5.3.1. Laptop / Notebook Considerations

Some 1394 PCMCIA cards for laptop / notebook computers require a 4-pin cable. A 4-pin cable does not provide power and will therefore not work with PGR cameras, which require a 6-pin connector (the additional two pins provide power). For suggestions on how to provide power in these circumstances, consult the following knowledge base article:

KB Article 93: www.ptgrey.com/support/kb/index.asp?a=4&q=93

5.3.2. Macintosh and Linux OS Support

Users wishing to operate their PGR camera on the Macintosh OS/X or Linux operating systems should consult the following knowledge base articles:

Macintosh support: www.ptgrey.com/support/kb/index.asp?a=4&q=173
Linux support: www.ptgrey.com/support/kb/index.asp?a=4&q=17

5.4. Controlling the Camera

The *Scorpion* can be controlled by the following types of applications:

5.4.1. PGR FlyCapture FlyCap Demo Program

The FlyCap application is a generic streaming image viewer included with the PGR FlyCapture SDK that can be used to test many of the capabilities of your compatible PGR IEEE-1394 camera. It allows you to view a live video stream from the camera, save individual images or .avi movie clips, adjust the various video formats, frame rates, properties and settings of the camera, and access camera registers. It is an easy-to-use program that can be used to test many of the capabilities of your PGR IEEE-1394 camera system. Consult the *PGR FlyCapture User Manual* for more information.

5.4.2. Custom Applications Built with the PGR FlyCapture API

PGR FlyCapture includes a full Application Programming Interface that allows customers to create custom applications to control PGR Imaging Products. The SDK provides a number of sample programs and source code that is meant to help the advanced programmer get started using the FlyCapture API. Examples range from simple console programs that demonstrate the basic functionality of the API, such as PGRFlyCaptureTest, to more complex examples such as the MFC application FlyCap.

5.4.3. Third-Party Software Applications

The following knowledge base article provides information on PGR IEEE-1394 camera compatibility with third-party software development kits, applications, camera drivers, and integrated development environments (IDEs):

KB Article 152: www.ptgrey.com/support/kb/index.asp?a=4&q=152

5.5. Camera Control Command Registers

For a complete description of the Camera Control Command Registers implemented on the *Scorpion*, please refer to the *PGR IEEE-1394 Digital Camera Register Reference*, included with the PGR FlyCapture SDK and downloadable from www.ptgrey.com/support/downloads/.

5.6. Handling Precautions and Camera Care

Do not open the camera housing. Doing so voids the Hardware Warranty *described at the beginning of this reference manual.*

Your PGR IEEE 1394 digital camera module is a precisely manufactured device and should be handled with care. Here are some tips on how to care for the device.

- Avoid electrostatic charging. Please consult the following knowledge base article for more details: www.ptgrey.com/support/kb/index.asp?a=4&q=42.

- Users who have purchased a bare board camera should be sure to take the following additional protective measures:

    - Either handle bare handed or use non-chargeable gloves, clothes or material. Also use conductive shoes.
    - Install a conductive mat on the floor or working table to prevent the generation of static electricity.

- When handling the camera unit, avoid touching the lenses. Fingerprints will affect the quality of the image produced by the device.

- To clean the lenses, use a standard camera lens cleaning kit or a clean dry cotton cloth. Do not apply excessive force.

- To clean the imaging surface of your CCD, follow the steps outlined in www.ptgrey.com/support/kb/index.asp?a=4&q=66.

- Our cameras are designed for an office environment or laboratory use. Extended exposure to bright sunlight, rain, dusty environments, etc. may cause problems with the electronics and the optics of the system.

- Avoid excessive shaking, dropping or any kind of mishandling of the device.

5.7. Camera Accessories

Accessories such as tripod mounts and lens holders are available from PGR – contact our Sales team at sales@ptgrey.com for additional information. Links to FireWire/IEEE-1394 and digital camera accessories can be found in the following knowledge base article:

KB Article 131: www.ptgrey.com/support/kb/index.asp?a=4&q=131.

5.8. Related Documentation and References

The following user manuals, technical references and application notes are referred to in this manual, and can be downloaded from www.ptgrey.com/support/downloads/:

- PGR IEEE-1394 Digital Camera Register Reference
- PGR FlyCapture User Manual
- TAN2004004: *Synchronizing to an external signal using DCAM 1.31 Trigger Mode_0*
- TAN2004001: *Configuring and testing the RS-232 serial port*
- TAN2005002: *Setting a GPIO pin to strobe using DCAM 1.31 Strobe Signal Output*
- TAN2005003: *Setting a GPIO pin to output a strobe signal pulse pattern*
- TAN2005004: *Buffering a GPIO pin output signal to drive an external device*

6 Camera Specifications and Properties

6.1. General Specifications

The *Scorpion* is available with a variety of CMOS and CCD image sensors. The following table details the specifications common to all *Scorpion* models, unless otherwise specified in *Individual Model Specifications*.

NOTES:

- **Signal-to-Noise Ratio** is calculated using the general methodology outlined in the following knowledge base article:
  KB Article 142: www.ptgrey.com/support/kb/index.asp?a=4&q=142

Specification	Description
Style	Silver anodized aluminum case
Interfaces	6-pin IEEE-1394 for camera control and video data transmission Hirose HR10 (12-pin) for external trigger, strobe, general purpose I/O and built-in RS232 serial port
Voltage Requirements	8-32V
External Trigger	DCAM v1.30 Trigger_Mode_0 (except SCOR-03KD)
Signal-To-Noise Ratio	55dB or better at minimum gain
Dimensions	50mm x 50mm x 40mm
Mass	125 grams, without a lens
Lens Adapter	C- or CS-mount lens
Camera Specification	IIDC 1394-based Digital Camera Specification v1.30
Emissions Compliance	Complies with CE rules and Part 15 Class A of FCC Rules.
Operating Temperature	0° to +45°C
Storage Temperature	-30° to +60°C
Camera Upgrades	Firmware upgrades in-field via IEEE-1394

6.2. Individual Model Specifications

Detailed image sensor information can be found in the individual sensor datasheets, which can be found at www.ptgrey.com/support/kb/index.asp?a=4&q=23. See the *Glossary Section* for definitions of terms included in this section.

NOTES:

- **Current Firmware** is the version currently being shipped on individual cameras; later versions may be found at www.ptgrey.com/support/downloads. To determine a camera's firmware version, consult the following knowledge base article:
  KB Article 94: www.ptgrey.com/support/kb/index.asp?a=4&q=94.
- **Frame Rate (max)** is the maximum frame rate possible using standard non-Format_7 video formats and modes.

6.2.1. SCOR-03SO

Specification	Description
Current Firmware	0.9 Release Candidate 40
Sensor Overview	Sony 1/2" ICX414 Progressive Scan CCD (Monochrome) Global shutter
Sensor Resolution	640x480
Sensor Size	Diagonal 8mm 1/2" CCD
Sensor Total Pixels	692(H) x 504(V) approx. 350K pixels
Sensor Effective Pixels	659(H) x 494(V) approx. 330K pixels
Sensor Active Pixels	n/a
Sensor Chip Size	7.48mm(H) x 6.15mm(V)
Sensor Unit Cell Size	9.9µm(H) x 9.9µm(V)
A/D Converter	Analog Devices AD9849AKST (12-bit A/D)
Video Output Signal	8 bits per pixel / 16 bits per pixel digital data
Power Consumption	Less than 2.6W
Frame Rate (max)	60FPS, 640x480
Brightness	0.00% to 6.23%
Gain	Automatic / Manual / One-Push modes (absolute values supported)
	-5.45 to 31dB
Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.02ms to 16.6ms @ 60FPS
Extended Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.02ms to 1919.74ms @ 60FPS
Gamma	0.50 to 4.00
Trigger Modes	DCAM v1.31 Trigger Modes 0,1 and 3

6.2.2. SCOR-14SO

Specification	Description
Current Firmware	0.9 Release Candidate 40
Sensor Overview	Sony 1/2" ICX267 Progressive Scan CCD (Monochrome or Color) Global shutter
Sensor Resolution	1360x1024
Sensor Size	Diagonal 8mm 1/2" CCD
Sensor Total Pixels	1434(H) x 1050(V) approx 1.5M pixels
Sensor Effective Pixels	1392(H) x 1040(V) approx. 1.45M pixels
Sensor Active Pixels	1360(H) x 1024(V) approx. 1.4M pixels
Sensor Chip Size	7.60mm(H) x 6.20mm(V)
Sensor Unit Cell Size	4.65µm(H) x 4.65µm(V)
A/D Converter	Analog Devices AD9849AKST (12-bit A/D)
Video Output Signal	8 bits per pixel / 16 bits per pixel digital data
Power Consumption	Less than 3.5W
Frame Rate (max)	15FPS, 1280x960
Brightness	0.00% to 6.23%
Gain	Automatic / Manual / One-Push modes (absolute values supported)
	-10 to 26dB

Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.02ms to 66ms @ 15FPS
Extended Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.02ms to 3337ms @ 15FPS
Gamma	0.50 to 4.00
Trigger Modes	DCAM v1.31 Trigger Modes 0,1 and 3

6.2.3. SCOR-20SO

Specification	Description
Current Firmware	0.9 Release Candidate 40
Sensor Overview	Sony 1/1.8" ICX274 Progressive Scan CCD (Monochrome or Color) Global shutter
Sensor Resolution	1600x1200
Sensor Size	Diagonal 8.923mm 1/1.8" CCD
Sensor Total Pixels	1688(H) x 1248(V) approx. 2.11M pixels
Sensor Effective Pixels	1628(H) x 1236(V) approx. 2.01M pixels
Sensor Active Pixels	1620(H) x 1220(V) approx. 1.98M pixels
Sensor Chip Size	8.50mm(H) x 6.80mm(V)
Sensor Unit Cell Size	4.4μm(H) x 4.4μm(V)
A/D Converter	Analog Devices AD9849AKST (12-bit A/D)
Video Output Signal	8 bits per pixel / 16 bits per pixel digital data
Power Consumption	Less than 3.5W
Frame Rates (max)	15FPS, 1600x1200
Brightness	0.00% to 6.23%
Gain	Automatic / Manual / One-Push modes (absolute values supported)
	-10 to 26dB
Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.03ms to 66.6ms @ 15FPS
Extended Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.02ms to 3296ms @ 15FPS
Gamma	0.50 to 4.00
Trigger Modes	DCAM v1.31 Trigger Modes 0,1 and 3

6.2.4. SCOR-13FF

Specification	Description
Latest Firmware	0.9 Release Candidate 40
Sensor Overview	FillFactory 2/3" IBIS-5A Progressive Scan CMOS (Monochrome or Color) Global / Rolling shutter
Sensor Resolution	1280x1024
Sensor Size	8.6 x 6.9mm 2/3" CMOS
Sensor Total Pixels	1280(H) x 1024(V) approx. 1.31M pixels
Sensor Effective Pixels	1280(H) x 1024(V) approx. 1.31M pixels
Sensor Active Pixels	1280(H) x 1024(V) approx. 1.31M pixels

Sensor Chip Size	8.6mm(H) x 6.9mm(V)
Sensor Unit Cell Size	6.7µm(H) x 6.7µm(V)
A/D Converter	On-board the CMOS sensor - 10-bit A/D converter
Video Output Signal	8 bits per pixel digital data
Power Consumption	Less than 2W
Frame Rates (max)	15FPS, 1280x960
Brightness	0 to 127
Gain	Automatic / Manual / One-Push modes (absolute values supported)
	3 to 14.3dB
Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.07ms to 66.6ms @ 15Hz
Extended Shutter	Automatic / Manual / One-Push modes (absolute values supported)
	0.07ms to 2213ms @ 1.875FPS
Gamma	0.50 to 4.00
Trigger Modes	DCAM v1.31 Trigger Modes 0 and 1

6.2.5. SCOR-03KD

Specification	Description
Current Firmware	0.0 Beta 48
Sensor Overview	Kodak 1/3" KAC-9618/KAC-9628 Progressive Scan CMOS (Monochrome or Color) Rolling shutter
Sensor Resolution	640x480
Sensor Size	Diagonal 6mm 1/3" CMOS
Sensor Total Pixels	Not available in datasheet
Sensor Effective Pixels	664(H) x 504(V) approx. 335K pixels
Sensor Active Pixels	648 (H) x 488(V) approx. 316K pixels
Sensor Chip Size	Not available in datasheet
Sensor Unit Cell Size	7.5µm(H) x 7.5µm(V)
A/D Converter	On-board the CMOS sensor – non-linear 12-bit A/D converter
Video Output Signal	8 bits per pixel / 16 bits per pixel digital data
Power Consumption	Less than 1.6W
Frame Rates (max)	30FPS, 640x480
Gain	Automatic/Manual modes
	0 to 28dB
Shutter	Automatic/Manual/Extended Shutter modes
	0.060ms to 33ms @ 30Hz
Signal-To-Noise Ratio	45dB or better at minimum gain

6.2.6. SCOR-13SM

Specification	Description
Current Firmware	0.0 Alpha 33
Sensor Overview	Symagery 2/3" VCA1281 Progressive Scan CMOS (Monochrome or Color) Rolling shutter

Sensor Resolution	1280x1024
Sensor Size	Diagonal 11.5mm 2/3" CMOS
Sensor Total Pixels	n/a
Sensor Effective Pixels	1284(H) x 1028(V) approx. 1.32M pixels
Sensor Active Pixels	1280(H) x 1024(V) approx. 1.31M pixels
Sensor Chip Size	Not available in datasheet
Sensor Unit Cell Size	7μm(H) x 7μm(V)
A/D Converter	On-board the CMOS sensor - 10-bit A/D converter
Video Output Signal	8 bits per pixel digital data
Power Consumption	Less than 4W
Frame Rates (max)	30FPS, 1280x960
Gain	Automatic/Manual modes
	DPGA 1 to 25
Shutter	Automatic/Manual/Extended Shutter modes
	0.100ms to 44ms @ 15FPS
Signal-To-Noise Ratio	40dB or better at minimum gain

6.3. Physical Description

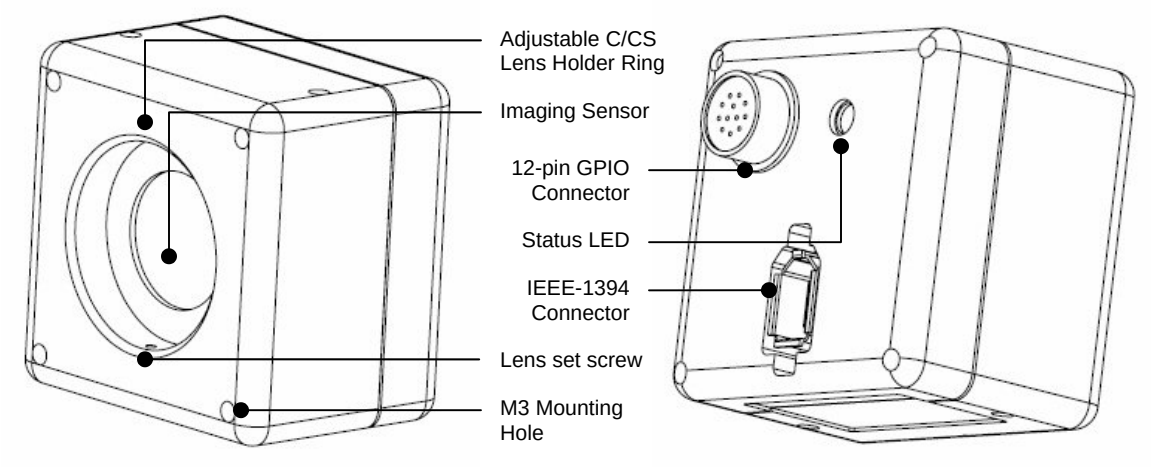

Figure 1: Picture of Scorpion module (front and back)

6.4. Camera Dimensions

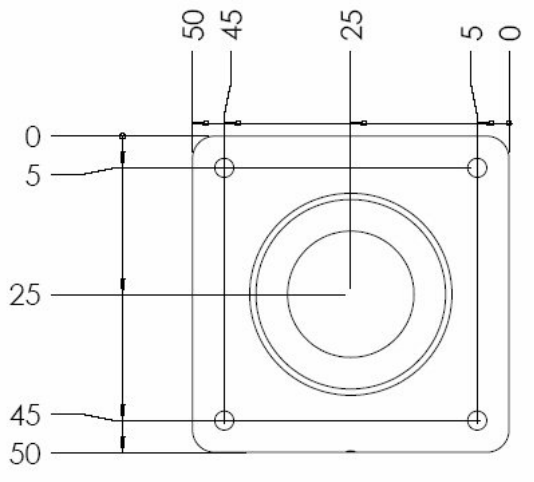

Figure 2: Scorpion case dimensions (front)

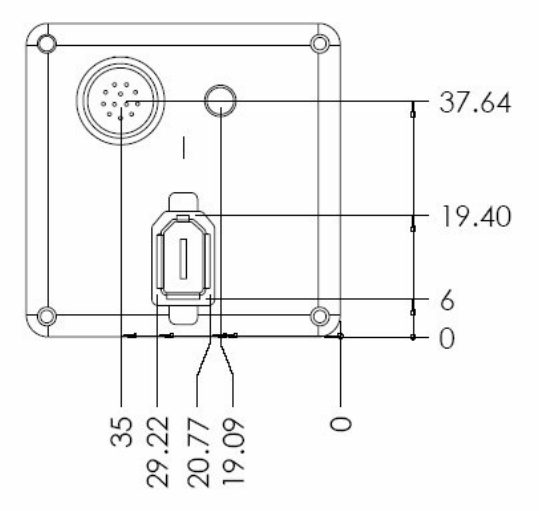

Figure 3: Scorpion case dimensions (back)

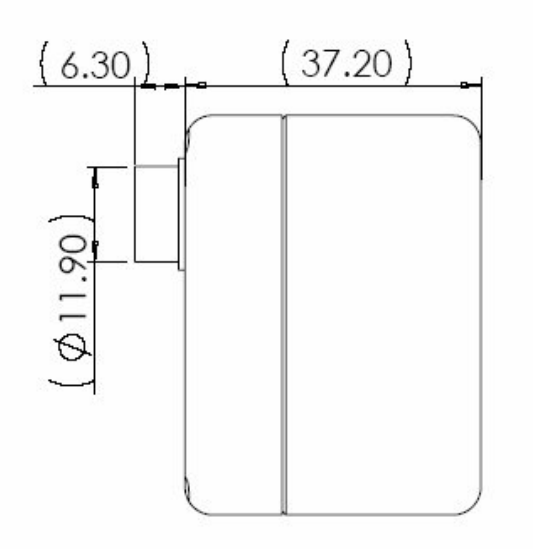

Figure 4: Scorpion case dimensions (side)

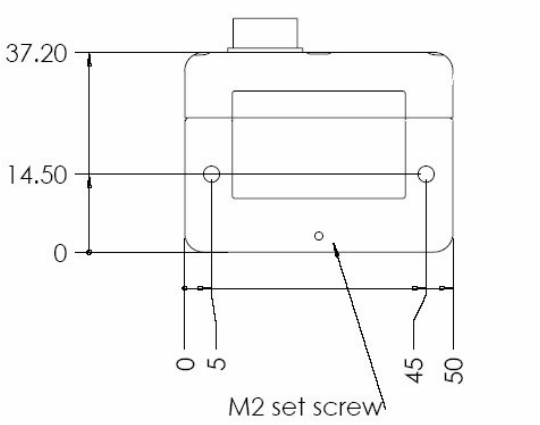

Figure 5: Scorpion case dimensions (bottom)

6.5. Mounting

6.5.1. Top and Bottom Mounts

The *Scorpion* is equipped with two M3 mounting holes on each of the top and bottom faces of the case (4 holes total). These holes can be used to attach the camera directly to a custom mount or to the *Scorpion* tripod mounting bracket, which can be purchased by contacting sales@ptgrey.com.

6.5.2. Front Mount

The *Scorpion* is equipped with four M3 mounting holes on the front (sensor) face that can be used to attach the camera directly to a custom fixture.

6.6. Lens Setup and Compatibility

The *Scorpion* is compatible with both C- and CS-mount lenses. Lenses are not included with the *Scorpion* camera. To differentiate between C- and CS-mount lenses, consult the following article:

KB Article 98: ptgrey.com/support/kb/index.asp?a=4&q=98

6.6.1. Adjusting Lens Focus

A lens M2 set screw is located on the underside of the *Scorpion* camera body, toward the side closest to the lens (see the *Camera Dimensions* section). The set screw is used to hold the adjustable C/CS lens holder ring (see the *Physical Description* section) in place once the lens is focused. The *Scorpion* comes pre-focused to the standard CS-mount lens focal length (12.52mm). Should you need to adjust the back focal length, loosen the set screw with the 0.035" (inch) hex driver provided with the camera before adjusting the focal length.

For more information on lens focusing, consult the following knowledge base article:

KB Article 122: ptgrey.com/support/kb/index.asp?a=4&q=122

6.7. Dust Protection

Cameras are sealed when they are shipped. To avoid contamination, seals should not be broken until cameras are ready for assembly at customer's site.

The case is designed to prevent dust from falling directly onto the CCD's protective glass surface. This is achieved by placing a piece of glass that is 2.5mm above the surface of the CCD's glass (see figure below). By increasing the distance between the imaging surface and the location of the potential dust particles, the likelihood of interference from the dust (assuming non-collimated light) and the possibility of damage to the sensor during cleaning is reduced.

Do not remove the protective glass. Doing so can void the Hardware Warranty *described at the beginning of this reference manual.*

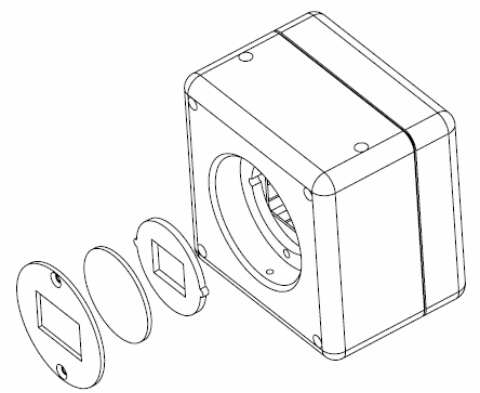

Figure 6: Protective glass above CCD

6.8. Typical Spectral Response

The spectral response curves for each sensor are in the technical datasheets available from the individual sensor manufacturers. Datasheet links for these sensors can be found in the following knowledge base article:

KB Article 23: ptgrey.com/support/kb/index.asp?a=4&q=23

6.9. Infrared Cut-Off Filters

Scorpion cameras equipped with color sensors have an additional infrared cut-off filter included. The approximate properties of this filter are illustrated by the IRC30 curve in the graph below.

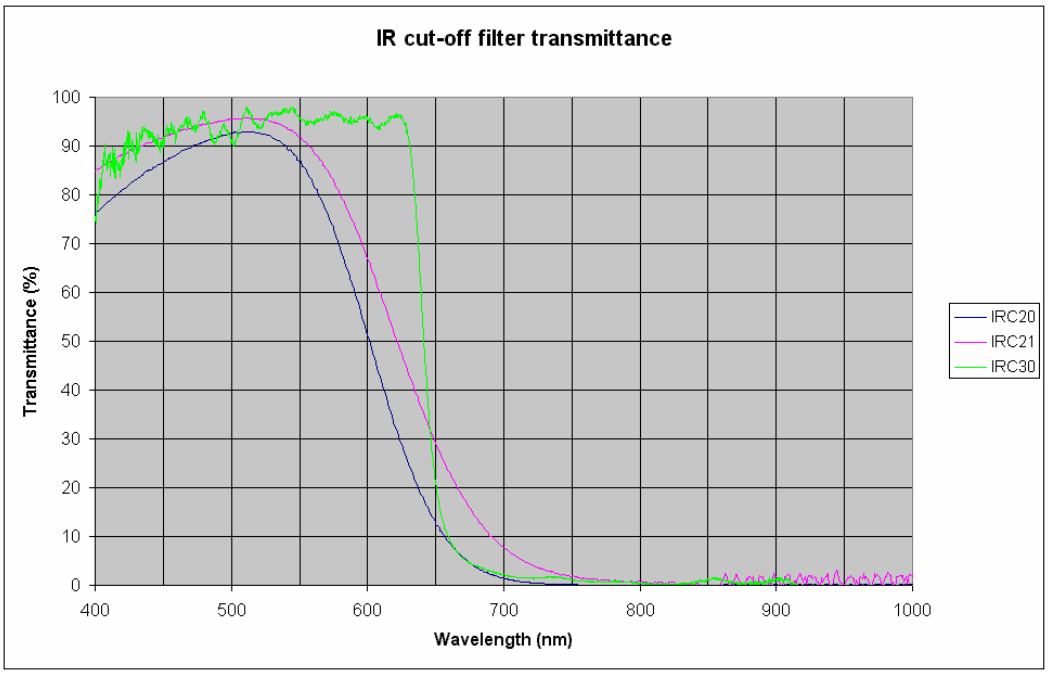

Figure 7: IR filter transmittance graph

6.10. Analog-to-Digital Converter

The *Scorpion* SCOR-20SO, SCOR-14SO and SCOR-03SO models incorporate an Analog Devices AD9849AKST A/D converter in order to digitize the images produced by the CCD. The following table illustrates the most important aspects of the processor. For more information, please refer to the Analog Devices website at www.analog.com/.

Resolution	12-bit, 30MHz
Description	The AD9849 is a highly integrated CCD signal processor for digital still camera applications. It includes a complete analog front end with A/D conversion, combined with a programmable timing driver. The Precision Timing core allows adjustment of high-speed clocks with approximately 1 ns resolution.
Pixel Gain Amplifier	4dB +/- 6dB 6-bit
Variable Gain Amplifier	2dB to 36dB 10-bit
Black Level Clamp	0 LSB to 255 LSB

7 Camera Interface

7.1. IEEE-1394 Connector

The *Scorpion* has a standard 6-pin IEEE-1394 connector (pin configuration shown below) that is used for data transmission, camera control and powering the camera.

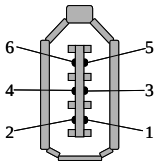

Figure 8: IEEE-1394 connector pin configuration

Pin	Function
1	Power Input (+8 to +32 VDC)
2	DC GND
3	TPB-
4	TPB+
5	TPA-
6	TPA+

Table 1: IEEE-1394 connector pin configuration

7.2. Cables

The maximum 1394a cable length between any 1394 node (e.g. camera to PCI card, PCI card to hub, etc.) is 4.5m, as specified by the IEEE-1394 Trade Association. Standard, shielded twisted pair copper cables must be used. Consult the following knowledge base article for information on how to extend the physical distance between the camera and the controlling host system:

KB Article 197: www.ptgrey.com/support/kb/index.asp?a=4&q=197

7.3. Host Adapter Card

All *Scorpion* camera kits (e.g. SCOR-xxxx-KIT) come with a 3-port IEEE-1394 PCI host adapter card built using a Texas Instruments (TI) Open Host Controller Interface. For more information regarding the differences between various 1394 host adapters, consult the following knowledge base article:

KB Article 146: www.ptgrey.com/support/kb/index.asp?a=4&q=146

7.4. Camera Power

The 6-pin 1394 connector connects to a standard IEEE-1394 (FireWire) 6-pin cable and provides a power connection between the camera and the host computer. The ideal input voltage is 12V DC; however, the camera is designed to handle voltages between 8V and 32V DC according to the IEEE 1394 standard. The power consumption of the *Scorpion* varies depending on the model (see *Individual Model Specifications* section).

Some systems - such as laptop computers or those with several FireWire devices connected - require an external power supply to power the camera. For suggestions on how to provide power in these circumstances, consult the following knowledge base article:

KB Article 93: www.ptgrey.com/support/kb/index.asp?a=4&q=93

Some *Scorpion* models allow the user to power-up or power-down components of the camera using the DCAM CAMERA_POWER register 0x610. The exact components, e.g. image sensor, A/D converter, other board electronics, will vary between camera models. Consult the *PGR IEEE-1394 Digital Camera Register Reference* for more information.

7.5. General Purpose Input/Output (GPIO)

The *Scorpion* has a set of eight (8) general-purpose IO pins that can be accessed via the Hirose HR10 (12-pin) external interface shown in *Figure 1: Picture of Scorpion module (front and back)*. These IO pins can be configured to accept an input signal to externally trigger the camera or to send an output signal or strobe to an external device. To determine how to configure the GPIO pins, please consult the *PGR IEEE-1394 Digital Camera Register Reference*.

GPIO pins IO0 to IO3 can be used for external triggering, general input/output, strobe output, or Pulse Width Modulation (PWM) output. GPIO pins IO4 to IO7 are used for the built-in RS232 serial port. For more information on using the RS232 serial port, download Technical Application Note TAN2004001 from www.ptgrey.com/support/downloads/.

7.5.1. GPIO Connector Pin Layout

The following diagram shows the pin layout for the Hirose HR10 12-pin female circular connector (Manufacturer Part Number: **HR10A-10R-12SB**) used on all *Scorpion* models. The male counterpart Manufacturer Part Number is **HR10A-10P-12P**. For more information about this connector visit the Hirose website.

Pin	GPIO	Function	Abbreviation
1	IO0	Input/trigger or output/strobe (default trigger)	
2	IO1	Input/trigger or output/strobe	
3	IO2	Input/trigger or output/strobe	
4	IO3	Input/trigger or output/strobe	
5	IO4	RS232 Request to Send	RTS
6	IO5	RS232 Clear to Send	CTS
7	IO6	RS232 Transmit (Output)	TD or TX or TXD
8	IO7	RS232 Receive (Input)	RD or RX or RXD
9 / 10	GND		
11 / 12	+3.3V		

Table 2: GPIO pin assignments

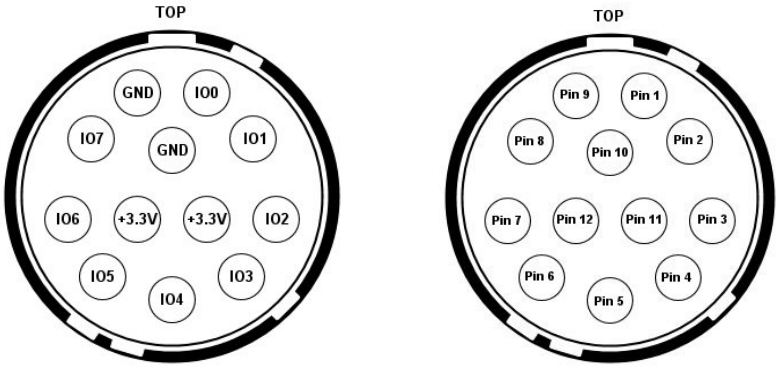

Figure 9: GPIO pin layout

7.5.2. GPIO Electrical Characteristics

The *Scorpion* GPIO pins are TTL 3.3V pins protected by two diodes to +3.3V and GND in parallel. There is also a 10K resistor in series to limit current. When configured as input, the pins can be directly driven from a 3.3V or 5V logic output. For output, each GPIO pin has almost no drive strength (they are high impedance) and needs to be buffered with a transistor or driver to lower its impedance. Consult the following article for information on buffering an output signal:

KB Article 200: www.ptgrey.com/support/kb/index.asp?a=4&q=200

The IO pins are protected from both over and under voltage. It is recommended, however, that they only be connected to 5V or 3.3V digital logic signals.

GPIO pins IO4 to IO7 are used for the built-in RS232 serial port, and provide RS-232-compatible signal (voltage) levels. The +3.3V pins on the Scorpion GPIO connector are fused at 200mA. External devices connected to +3.3V should not attempt to pull anything greater than that.

7.6. Status Indicator LED

The LED on the back of the *Scorpion* module provides the following general status messages:

LED Status	Description
Off	Not receiving power
Steady on	Receiving power and successful camera initialization
Steady on and very bright	Acquiring / transmitting images
Flashing bright, then brighter	Camera registers being accessed (no image acquisition)
Steady flashing on and off	Indicates possible camera problem
Slow flashing on and off	Indicates possible camera problem

Table 3: Status indicator LED descriptions

8 Camera Operations and Features

The *Scorpion* line of IEEE-1394 cameras complies with the *IIDC 1394-based Digital Camera (DCAM) Specification Version v1.30*. In addition, some *Scorpion* models implement functionality and video formats and frame rates outlined in the *IIDC 1394-based Digital Camera (DCAM) Specification Version v1.31*. This includes improved frame rate control, trigger, parallel input/output (PIO), serial input/output (SIO) and strobe functionality.

To determine the specific DCAM v1.31 features implemented in a particular *Scorpion* model, consult the following sections of the *PGR IEEE-1394 Digital Camera Register Reference*.

- Inquiry Registers for Basic Functions
- Inquiry Registers for Feature Presence
- Inquiry Registers for Feature Elements

You can query the registers described in these sections to identify whether specific features have been implemented. For a complete description of the Camera Control Command Registers implemented on the *Scorpion*, please refer to the *PGR IEEE-1394 Digital Camera Register Reference*, included with the PGR FlyCapture SDK and downloadable from www.ptgrey.com/support/downloads/.

8.1. Supported Data Formats and Modes

8.1.1. Standard Formats, Modes and Frame Rates

The following sections enumerate the different non-Format 7 data formats and modes contained in the IEEE-1394 specification that are supported by the various *Scorpion* models. See the *Customizable Formats and Modes* section for supported Format 7 modes.

Camera	Format	Mode	Frame Rate (fps)							Mode Description
			1.875	3.75	7.5	15	30	60	120	
SCOR-13FF	0	5	•	•	•	•	•	•		640x480 Y8 (Mono)
	0	6	•	•	•	•	•			640x480 Y16 (Mono)
	1	5	•	•	•	•	•			1024x768 Y8 (Mono)
	1	7	•	•	•	•				1024x768 Y16 (Mono)
	2	2	•	•	•	•				1280x960 Y8 (Mono)
	2	7	•	•	•					1280x960 Y16 (Mono)
SCOR-03SO	0	5	•	•	•	•	•	•		640x480 Y8 (Mono)
	0	6	•	•	•	•	•			640x480 Y16 (Mono)
SCOR-14SO	0	5	•	•	•	•	•			640x480 Y8 (Mono)
	0	6	•	•	•	•	•			640x480 Y16 (Mono)
	2	2	•	•	•	•				1280x960 Y8 (Mono)
	2	6	•	•	•					1280x960 Y16 (Mono)
SCOR-20SO	1	2			•	•	•[1]			800x600 Y8 (Mono)
	1	6		•	•	•	•[2]			800x600 Y16 (Mono)
	2	2	•	•	•	•				1280x960 Y8 (Mono)
	2	5	•	•	•	•				1600x1200 Y8 (Mono)
	2	6	•	•	•					1280x960 Y16 (Mono)
	2	7	•	•	•					1600x1200 Y16 (Mono)
SCOR-03NS	0	5		•	•	•	•			640x480 Y8 (Mono)
	0	6		•	•	•	•			640x480 Y16 (Mono)
SCOR-13SM	0	5		•	•	•	•	•		640x480 Y8 (Mono)
	1	2			•	•	•			800x600 Y8 (Mono)
	1	5	•	•	•	•	•			1024x768 Y8 (Mono)
	2	2	•	•	•	•				1280x960 Y8 (Mono)

Table 4: Supported video formats, modes and frame rates

[1] Actual frame rate: 25Hz
[2] Actual frame rate: 25Hz

8.1.2. Customizable Formats and Modes

The table below outlines the Format_7 custom image modes that are supported by the camera. The implementation of these modes and the frame rates that are possible are not specified by the DCAM.

Format_7 Mode_0 is a region of interest (sub-window) mode that allows the user to only transmit a selected area of the image. Format_7 Mode_1 and Mode_2 are pixel binned (sub-sampled or down-sampled) modes.

Moving the position of region of interest to a different location does not require the camera to be stopped (isochronous transmission disabled) and restarted (iso enabled). However, changing the size of the ROI does require the stop/start procedure.

Camera	Format	Mode	Max Image Size (HxV)	Unit Size (H,V)	Notes
SCOR-03SO	7	0	658x494	2,2	Increased frame rate ▪ 82fps, 320x240 ▪ 97fps, 160x120
	7	1		1,1	2x2 pixel binning mode
	7	2		2,1	1x2 pixel binning mode
SCOR-14SO	7	0	1392x1040	2,2	Region of interest mode ▪ 1024x768: 21fps ▪ 640x480: 25fps ▪ 320x240: 30fps
	7	1	696x520	1,1	2x2 pixel binning mode
	7	2	1392x520	2,1	1x2 pixel binning mode
SCOR-20SO	7	0	1600x1200	4,4	Increased frame rate ▪ 1280x1024: 16fps ▪ 1024x768: 18fps ▪ 640x480: 21fps ▪ 320x240: 24fps ▪ 160x160: 26fps
	7	1		1,1	2x2 pixel binning mode
	7	2		2,1	1x2 pixel binning mode
SCOR-13FF	7	0	1280x1024	4,4	Increased frame rate ▪ 1024x768: 43fps ▪ 640x480: 102fps ▪ 320x240: 333fps ▪ 160x120: 666fps
	7	1		1,1	2x2 pixel binning mode
SCOR-03NS	7	0	648x484	4,4	Increased frame rate ▪ 70fps, 320x240 ▪ 119fps, 160x120
	7	1	-	-	Mode not implemented
SCOR-13SM	7	0	1280x1024	4,4	Increased frame rate ▪ 100fps, 640x480 ▪ 275fps, 320x240
	7	1	-	-	Mode not implemented

Table 5: Supported partial image (Format 7) video formats and modes

8.2. Pixel Binning and Region of Interest Modes

Most *Scorpion* models implement one or more DCAM Format_7 customizable video modes (see the *Customizable Formats and Modes* section for camera-specific information) that allows for faster frame rates based on selecting a specific region of interest (ROI) of the image or by configuring the camera to sub-sample the image using a process known as "pixel binning". See the following knowledge base article for a more detailed description of these modes:

KB Article 163: www.ptgrey.com/support/kb/index.asp?a=4&q=163

8.3. Extended Shutter Times

The maximum shutter time for some *Scorpion* models can be extended beyond the normal shutter range by turning the FRAME_RATE register OFF. To do this, set the *ON_OFF* field of the FRAME_RATE register 83Ch to OFF. Once the FRAME_RATE is turned off, you should see the *Max_Value* of the ABS_VAL_SHUTTER register 910h increase.

The maximum extended shutter time reported by the SHUTTER_INQ register 51Ch is capped at 4095 (0xFFF), the maximum value allowed by the Max_Value *field of this register. Use the* Max_Value *of the ABS_VAL_SHUTTER register to determine the maximum shutter.*

Model	Format and FPS	Min (ms)	Max (ms)	Notes
SCOR-20SO	1600x1200, 15fps	0.03	3296.99	
	1600x1200, 7.5fps	0.05	5994.53	
	1600x1200, 3.75fps	0.05	5994.53	
	1600x1200, 1.875fps	0.06	23019.00	
SCOR-14SO	1280x960, 15fps	0.02	3335.85	
	1280x960, 7.5fps	0.03	4449.33	
	1280x960, 3.75fps	0.03	8898.66	
	1280x960, 1.875fps	0.11	30650.00	
SCOR-03SO	640x480, 60fps	0.02	1919.74	
	640x480, 30/15/7.5/3.75fps	0.02	3829.50	
	640x480, 1.875fps	0.02	7673.88	
SCOR-13FF	1280x960, 15fps	0.07	276.42	
	1280x960, 7.5	0.14	552.29	
	1280x960, 3.75fps	0.28	1106.45	
	1280x960, 1.875fps	0.55	2212.89	
SCOR-03NS	n/a			
SCOR-13SM	n/a			

Table 6: Extended shutter minimum and maximum times

8.4. Lookup Table and Gamma

All *Scorpion* models (except SCOR-13SM and SCOR-03KD) support lookup table (LUT) and gamma functionality. CCD manufacturers strive to make the transfer characteristics of CCDs

inherently linear, which means that as the number of photons hitting the imaging sensor increases, the resulting image intensity increases will be linear. Gamma is applied after the analog-to-digital conversion. It can be used to apply a non-linear mapping of the resulting 10- or 12-bit image (depending on the type of A/D converter) down to 8 bits. By default, Gamma is OFF and has a value of 1.0, which yields a linear response.

The LUT essentially takes A/D values as inputs and allows users to map these values to 8-bit outputs. For example, the *Scorpion* uses an 11-bit LUT (although it uses a 12-bit A/D converter, the frame buffer is only large enough to accommodate 11-bit images). The LUT allows the user to map the 2^{11}, or 2048, different possible pixel values to any one of 256 (2^8) possible output values. For example, the LUT would allow the user to map any pixel with a value of 2047 (white) to any value between 0 (black) and 255 (white).

Lookup table control is achieved using the LUT_CTRL registers, as outlined in the *PGR IEEE-1394 Digital Camera Register Reference.*

8.5. Automatic Inter-Camera Synchronization

All *Scorpion* models (except SCOR-03KD), when they are on the same IEEE-1394 bus and running at the same frame rate, are automatically synchronized to each other at the hardware level. When using multiple cameras, the timing of one camera to another camera is as follows:

- If the cameras are on the same bus, the cameras are synchronized to within 125µs (microseconds) of each other (note: 125µs is the maximum deviation). However, the 1394 bandwidth limits the maximum number of cameras that can be on one bus. See the section *Maximum Number of Cameras on a Single 1394 Bus* for more information.

- If the cameras are on separate buses, a PGR Sync Unit is needed to synchronize the cameras across buses. The Sync Unit can synchronize cameras on different buses within the same computer or on different buses across multiple computers. This device will ensure that the cameras are synchronized to within 125µs. If there is no sync device, there is no timing correlation between separate cameras on separate buses.

8.6. Embedded Image Information

All *Scorpion* models have a feature that allows image timing and camera settings information to be embedded in the first several pixels of each image. The first byte of embedded image data starts at pixel 0,0 (column 0, row 0) and continues in the first row of the image data i.e. (1,0), (2,0), etc. This feature is enabled via the FRAME_INFO register 12F8h. Insertion of each quadlet is controlled by a bit in the FRAME_INFO register. Timestamp is bit 31, Gain bit 30, etc.

Users using color cameras and doing Bayer color processing on the PC must extract the value from the non-color processed image in order for the data to be valid.

Model	Data Size (quadlets)	Data Description (starting at quadlet 1)
SCOR-13FF SCOR-20SO SCOR-14SO	Variable up to 9 quadlets	1. Timestamp 2. Gain 3. Shutter

SCOR-03SO		4. Brightness 5. Exposure 6. White Balance 7. Frame Counter 8. Strobe Pattern Counter (see *TAN2005003*) 9. GPIO Pin State (at end of shutter)
SCOR-03KD	8 quadlets (not variable)	1. Timestamp 2. Gain 3. Shutter 4. Brightness 5. Exposure 6. CMOS sensor registers [0x1D, 0x1E, 0x1F, 0x20] 7. CMOS sensor registers [0x21, 0x25, 0x26, 0x15] 8. CMOS sensor registers [0x16] and 3 zero bytes
SCOR-13SM	Variable up to 5 quadlets	Implements the same first five quadlets as the SCOR-13FF, etc., described above.

Table 7: Types of embedded image information

8.7. Frame Rate Control

All *Scorpion* models (except SCOR-03KD and SCOR-13SM) allow users to fine-tune the frame rates of their cameras using the FRAME_RATE register 0x83C, which is described in the *PGR IEEE-1394 Digital Camera Register Reference*. This is particularly useful for capturing an image stream at a different frame rate than those outlined in the *Supported Data Formats and Modes* section. For example, users may wish to play an image stream back on a PAL-based system that displays at 25FPS. This is also useful for synchronizing to 50Hz light sources, which can cause image intensity fluctuations due to the light source oscillations being out of sync with the frame rate.

8.8. Programmable Strobe Output

All *Scorpion* models (except SCOR-03KD and SCOR-13SM) are capable of outputting a strobe pulse off one or all of their GPIO pins. By default, a pin that is configured to be a strobe output will output a pulse each time the camera begins integration of an image. However, some models can also be configured to output a variable strobe pulse pattern. The strobe pattern functionality allows users to define the frames for which the camera will output a strobe. For example, this is useful in situations where a strobe should only fire:

- Every Nth frame (e.g. odd frames from one camera and even frames from another); or
- N frames in a row out of T (e.g. the last 3 frames in a set of 6); or
- Specific frames within a defined period (e.g. frames 1, 5 and 7 in a set of 8).

To determine which *Scorpion* models support this and how to configure the variable strobe pattern, download Technical Application Note TAN2005003 from:

KB Article 207: www.ptgrey.com/support/kb/index.asp?a=4&q=207

8.9. RS-232 Serial Port

All *Scorpion* models (except SCOR-03KD) are capable of serial communications via the on-board RS232 serial port built into the camera's GPIO connector. For information on how to configure the camera's serial port, download Technical Application Note TAN2004001 from:

KB Article 151: www.ptgrey.com/support/kb/index.asp?a=4&q=151

8.10. Camera Upgrades

The firmware on all *Scorpion* models can be upgraded / downgraded to later / earlier versions using the **UpdatorGUI** program that is bundled with every firmware version available from www.ptgrey.com/support/downloads/. The latest firmware versions often include significant bug fixes and feature enhancements that may benefit some users. To determine the changes made in a specific firmware version, consult the Release Notes. For more information on updating camera firmware, consult the *UpdatorGUI User Manual* available in the downloads section.

9 Application Notes

This section is recommended for advanced users only, and is not meant to address all possible applications of the *Scorpion* camera.

9.1. Maximum Number of Cameras on a Single 1394 Bus

There are four elements that limit the number of cameras that can be used on the same 1394 bus:

1. Although the 1394a standard limits the maximum number of simultaneous isochronous channels to 16, there is currently no host adapter that is capable of supporting 16 channels. Host adapters based on the TI chipset can support at most 4 simultaneous DMA channels (also known as DMA contexts). Similar adapters based on the Lucent/Agere chipset support up to 8 DMA contexts. There are no known 1394b chipsets that allow more than 4 simultaneous DMA contexts. See Knowledge Base Article 146 for more information.
2. The maximum bandwidth of the 1394a bus is 400Mbits/sec (5120Bytes/packet). The usable bandwidth as defined by the 1394a Trade Association and enforced by the Microsoft Windows 1394 driver stack (1394bus.sys, ohci1394.sys, etc.) is approximately 80% or 40MBytes/sec (4096Bytes/packet). The remaining 20% of the bandwidth is allocated for asynchronous communication (e.g. register reads/writes). The same general rules apply for 1394b buses, except that the maximum bandwidth increases to 800Mbps (10240Bpp) when 1394b devices are connected.
3. The 1394a standard limits the maximum number of devices on a single bus to 63.
4. An inadequate power supply. Consult the voltage and power requirements in the General Specifications section of your PGR camera's Technical Reference or Getting Started manual to determine the amount of power required to operate the cameras effectively.

9.1.1. Calculating Maximum Possible Frame Rate

The maximum frame rate allowable for each of the cameras on the bus depends on the resolution of the cameras and the frame rate, and can be roughly approximated using the following general formula (assuming all cameras are at the same resolution):

*Frames_per_second = (Bandwidth / (Pixels_per_frame * Bytes_per_pixel)) / Num_cameras*

Example:
To calculate the frames per second available to three 1024x768 *Scorpions* that are in 8-bit mode, you would calculate:

Frames_per_second = (40MB/s / (1024*768*1byte/pixel)) / 3
= (40MB/s / 0.75MB/total_frames) / 3
= 53.33fps / 3
= 17.8fps

You can perform a more exact calculation using the number of pixels or bytes per packet (Bpp) that each camera is required to send when in a particular video format/mode/frame rate. The Bpp can be derived using the "Isochronous Bandwidth Requirements" table in Section 3 of the *PGR IEEE-1394 Digital Camera Register Reference*.

For example, a single PGR *Scorpion* SCOR-03SO in 640x480 Y16 mode running at 15fps is sending 640 pixels per packet. Each pixel consists of 16 bits, or 2 bytes, of data. Therefore, the camera is sending 640*2 = 1280Bpp of data. The maximum bandwidth of the 1394a bus as discussed above is 4096Bpp, so it would be possible for 4096/1280 = 3 (rounded down) PGR *Scorpion*'s to run in 640x480 Y16 mode at 15fps on the same 1394a bus.

9.1.2. Problems Maximizing Frame Rates

In some circumstances, due to 1394 bus bandwidth limitations set by Microsoft Windows, some cameras may not be able to achieve the maximum calculated frame rate.

Example:
According to the formula in the section *Calculating Maximum Possible Frame Rate* it is possible to run four 640x480 cameras in Y8 (8-bit) mode at 30Hz. However, when attempting to do this via the PGR software *Format and Frame Rate* controls, starting the fourth camera at 30Hz often results in a "bandwidth exceeded" error.

The workaround to this problem is to circumvent the Windows bandwidth restrictions by directly manipulating the camera's CURRENT_FRAME_RATE register 600h. In the example above, start three instances of the PGR FlyCapture demo program, FlyCap, with each camera running at 30Hz. Start the fourth camera up at 15Hz, then access register 600h and set the register to 0x80000000 (FrameRate_4: 30Hz).

9.2. Using the Camera in Single-Shot and Multi-Shot Modes

It is possible to put the camera into a mode where it will grab only a single image (single-shot) or a set number of images (multi-shot).

In order to have the camera capture a single image, the user must do the following:

1. Put the software system into a mode where it is ready to accept images from the camera. If you are using the PGR FlyCapture software, this will require calls to flycaptureInitialize() and flycaptureStart().
2. Ensure that isochronous data transfer is turned off by doing the following:

   set 614h to 00 00 00 00

3. For a single shot, poke the first bit of the MULTI_SHOT register as follows:

   set 61Ch to 80 00 00 00

   For multiple shots (in this example 175, or 0xAF), poke the first bit of the MULTI_SHOT register as follows:

set 61Ch to 40 00 00 AF

This will cause the camera to produce the desired number of images before resuming a wait state. Standard image transmission can be resumed by poking the 614h register again as follows:

set 614h to 80 00 00 00

9.3. Interacting with External Devices

The Point Grey Research *Scorpion* is a versatile IEEE-1394 digital camera that is capable of interacting with external devices. It can be configured to trigger on an external electrical signal or produce a similar signal that allows devices external to the camera to be synchronized to the camera. Input and output of these signals is achieved via the *Scorpion's* general-purpose IO pins described in section 7.5: *General Purpose Input/Output (GPIO)*.

9.3.1. External Trigger Timing Information

For most *Scorpion* models the time from the external trigger going low to the integration time is shown below:

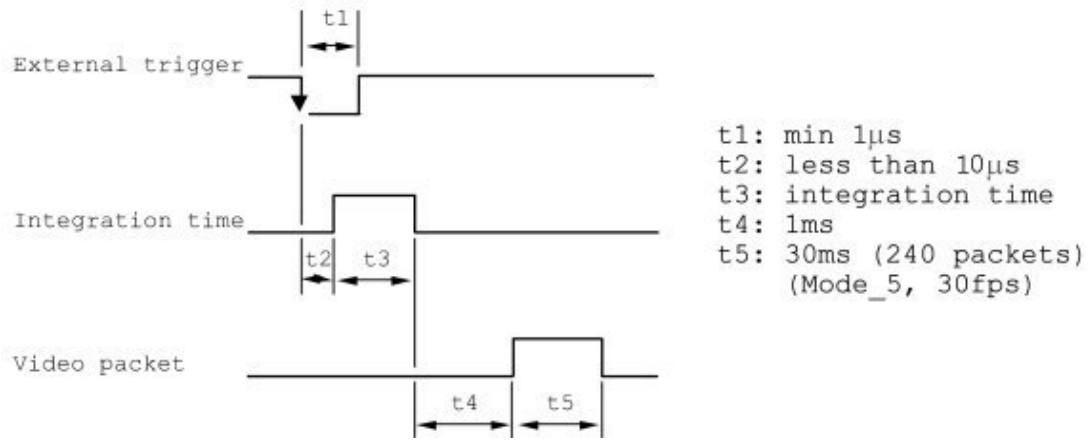

Figure 10: Scorpion external trigger timing characteristics

9.3.2. Synchronizing to an External Device Using External Trigger Mode

Refer to www.ptgrey.com/support/kb/index.asp?a=4&q=177 to determine the maximum possible frame rate possible in external trigger mode.

All *Scorpion* models support Trigger Mode_0, which is described in greater detail in the *PGR IEEE-1394 Digital Camera Register Reference*. For more information on synchronizing to an external device using the Trigger Mode_0, download Technical Application Note TAN2004004 from the downloads section. This functionality is also demonstrated in the AsyncTriggerEx example program that is included with the PGR FlyCapture SDK.

9.3.3. Broadcasting a Strobe Pulse to an External Device

For more information on how to configure a GPIO pin to output a signal of user-defined delay and duration using the DCAM v1.31 strobe output functionality, download Technical Application Note TAN2005001 from:

KB Article 179: www.ptgrey.com/support/kb/index.asp?a=4&q=179

9.3.4. Control Shutter Time with Trigger_Mode_1 (Bulb Trigger Mode)

To see the effects of using Trigger_Mode_1 to control the camera shutter time:

1. Attach a function generator to the camera - negative to GND pin, positive to IO2.
2. Attach an oscilloscope to the camera (just to observe the signal and duty cycle) - ground the GND and signal lead to IO2.
3. Open the PGR FlyCapture SDK example program, FlyCap, and start the camera
4. Open the Camera Control Dialog box and go to the Extended tab
5. Enable External Trigger mode - the function generator's pulses should now be driving the external trigger
6. Enable Trigger_Mode_1 by writing 82 01 00 00 to register 830h
7. Use the function generator to increase and decrease the duty cycle. Decreasing the duty cycle increases the integration (shutter) time, and vice versa.

9.4. Software Triggering an Image Acquisition

All *Scorpion* models support the ability to be software triggered when in Trigger Mode_0 to begin integration of a new image. The user initiates a trigger by writing specific registers on the camera to first put the camera into trigger mode then generate a software asynchronous trigger.

Scorpion's that implement DCAM v1.31 triggering functionality (see the *Individual Model Specifications* section) are triggered using the DCAM v1.31 SOFTWARE_TRIGGER register 0x62Ch and by setting the *Trigger_Source* to be the SOFTWARE_TRIGGER. All *Scorpion*'s can also be software triggered using the PGR-specific SOFT_ASYNC_TRIGGER register 0x102C.

Consult the *PGR IEEE-1394 Digital Camera Register Reference* for camera register information.

The time between a software asynchronous trigger and the start of integration is discussed in the following knowledge base article: www.ptgrey.com/support/kb/index.asp?a=4&q=169

9.5. Working with Y16 (16-bit Mono) Images

Most *Scorpion* models can output Y16 (16 bits per pixel) mono images. However, not all 16 bits of data are useable. Models that use a 12-bit A/D converter (see *Individual Model Specifications* and *Analog-to-Digital Converter* sections) output 12 bits of data. Models that use a 10-bit A/D converter output 10 bits of data.

To determine the number of bits of useable image data that is actually being produced by the A/D converter, consult the following knowledge base article:

www.ptgrey.com/support/kb/index.asp?a=4&q=170

9.5.1. Y16 Data Format

The data format for Y16 images is DCAM-compliant.

Description	Data Format	
Actual bit depth: 10bpp	0-7	8-15
Bit alignment: MSB Byte alignment: Big-endian	High Byte	Low Byte

Table 8: Y16 (16-bit Mono) data format

9.5.2. Saving Y16 Images

The PGM file format can be used to correctly save 16-bit images. Following is some sample code that can be used in conjunction with the PGR FlyCapture SDK:

```
FILE* fileImage = fopen( "image16.pgm", "wb" );
fprintf( fileImage, "P5\n" ); // PGM magic id value
fprintf( fileImage, "%d %d\n", image.iCols, image.iRows );
fprintf( fileImage, "%d\n", 0xFFFF ); // max value of a 16bit pixel

unsigned short* pPixel = (unsigned short*)image.pData;
for( int iPixel = 0; iPixel < image.iRows * image.iCols; iPixel++ )
{
       fwrite( pPixel, 1, 2, fileImage );
       pPixel++;
}
```

There are very few photo manipulation/display applications that can correctly display true 16-bit images. XV in Linux and Adobe Photoshop are two possibilities.

10 Glossary

Term	Definition
Absolute Values	Real-world values, such as milliseconds (ms), decibels (dB) or percent (%). Using the absolute values is easier and more efficient than applying complex conversion formulas to integer values.
Analog-to-Digital Converter	Often abbreviated as ADC or A/D converted, it is a device that converts a voltage to a digital number.
API	Application Programming Interface. Essentially a library of software functions.
Auto Exposure (EV)	This is the average intensity of the image. It will use other available (non-manually adjustable) controls to adjust the image.
Brightness (%)	This is essentially the level of black in an image. A high brightness will result in a low amount of black in the image. In the absence of noise, the minimum pixel value in an image acquired with a brightness setting of 1% should be 1% of the A/D converter's minimum value.
DCAM	Abbreviation for the *IIDC 1394-based Digital Camera (DCAM) Specification*, which is the standard used for building FireWire-based cameras.
Firmware	Programming that is inserted into programmable read-only memory, thus becoming a permanent part of a computing device. Firmware is created and tested like software and can be loaded onto the camera.
Format_7	Encompasses partial or custom image video formats and modes, such as region of interest of pixel binned modes. Format_7 modes and frame rates are defined by the camera manufacturer, as opposed to the DCAM specification.
FPS	Frames Per Second.
Frame Rate	Often defined in terms of number of frames per second (FPS) or frequency (Hz). This is the speed at which the camera is streaming images to the host system. It basically defines the interval between consecutive image transfers.
Gain (dB)	The amount of amplification that is applied to a pixel by the A/D converter. An increase in gain can result in a brighter image and an increase in noise.
Gamma	Gamma defines the function between incoming light level and output picture level. Gamma can also be useful in emphasizing details in the darkest and/or brightest regions of the image.
GPIO	General Purpose Input/Output.
Saturation	This is how far a color is from a gray image of the same intensity. For example, red is highly saturated, whereas a pale pink is not.
Sharpness	This works by filtering the image to reduce blurred edges in an image.
Shutter (ms)	This is the amount of time that the camera's electronic shutter stays open for; also known as the integration time. The shutter time defines the start and end point of when light falls on the imaging sensor. At the end of the integration period, all charges are simultaneously transferred to light-shielded areas of the sensor. The charges are then shifted out of the light shielded areas of the sensor and read out.

11 Errata and Change Notifications

This errata section lists significant changes to the *Scorpion* hardware and electrical components that have been implemented since the last release of the *Scorpion Technical Reference*. For a summary of all firmware changes, please consult the Scorpion Firmware Release Notes.

11.1. Case and Adapter Revisions

The following revisions pertain to the aluminum case enclosure that houses the Scorpion stacked PCBs and the tripod mounting adapter that can be screwed to the bottom of the case.

Sticker Cutout Added - May 27, 2003

- A 0.5mm deep cutout was added to the bottom of the case to allow for a sticker containing camera information (part number, serial number, etc.).

Two Mounting Holes Added - September 12, 2003

- Two (2) M2.5 tapped holes 5mm deep were added to the top of the case. This modification was integrated into standard product design.

Multiple Mounting Holes Added – December 15, 2003

- Four (4) M3 tapped holes 5mm deep added to the front of the case.

Sticker Cutout Modified – Jan 12, 2004

- Size of the cutout modified.

Adapter Modified – July 2, 2004

- Size of the screw holes changed to M4.

Adapter Modified – August 20, 2004

- Size of the screw holes changed to M3.

Glass System Added (SCOR-14SO only) – November 14, 2004

- The design of the case was modified to prevent dust from falling directly onto the CCD's protective glass surface. This is achieved by placing a piece of glass that is 2.5mm above the surface of the CCD's glass. By increasing the distance between the imaging surface and the location of the potential dust particles, the likelihood of interference from the dust is reduced (assuming non-collimated light).

12 Technical Support Resources

Point Grey Research Inc. endeavours to provide the highest level of technical support possible to our customers. Most support resources can be accessed through the Product Support section of our website: www.ptgrey.com/support.

12.1. Creating a Customer Login Account

The first step in accessing our technical support resources is to obtain a Customer Login Account. This requires a valid name, e-mail address, and camera serial number. To apply for a Customer Login Account go to: www.ptgrey.com/support/downloads/user_request.html.

12.2. Knowledge Base

Our on-line knowledge base contains answers to some of the most common support questions. It has information about all PGR products and was developed to help customers resolve product issues. It is constantly updated, expanded, and refined to ensure that our customers have access to the latest information. To access the knowledge base, go to: www.ptgrey.com/support/kb/.

12.3. Product Downloads

Customers with a Customer Login Account can access the latest software and firmware for their cameras from our downloads site at www.ptgrey.com/support/downloads. We encourage our customers to keep their software and firmware up-to-date by downloading and installing the latest versions. These versions include the latest bug fixes and feature enhancements.

12.4. Contacting Technical Support

Before contacting Technical Support, have you:

1. *Read the product documentation and user manual?*
2. *Searched the Knowledge Base?*
3. *Downloaded and installed the latest version of software and/or firmware?*

If you have done all the above and still can't find an answer to your question, contact our Technical Support team using our on-line web form: www.ptgrey.com/support/contact/. This will create a ticket in our Request Tracker support system, and a Technical Support representative will contact you by e-mail within one (1) business day.

13 Contacting Point Grey Research Inc.

For any questions, concerns or comments please contact us via the following methods:

Email:

For all general questions about Point Grey Research please contact us at info@ptgrey.com.

For specific product questions, quotes or product pricing contact sales@ptgrey.com.

For technical support (existing customers only) contact us at http://www.ptgrey.com/support/contact/.

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Knowledge Base:

Find answers to commonly asked questions in our knowledge base at http://www.ptgrey.com/support/kb/.

Downloads:

Users can download the latest manuals and software from http://www.ptgrey.com/support/downloads/

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