

# Technical Application Note TAN2007001

*Exceeding bandwidth limitations when using Format 7 partial image modes*  
*Revised February 8, 2007*

## 1.1. Subject

Technical Application Note (TAN2007001): *Exceeding bandwidth limitations when using Format 7 partial image modes.*

## 1.2. Applicable Product(s)

- *All Point Grey IEEE-1394 cameras that support Format 7*

## 1.3. Overview

The purpose of this Technical Application Note is to illustrate a mechanism for effectively bypassing IEEE-1394 bus bandwidth negotiation when using cameras in Format 7 partial image mode. This functionality is useful in any situation where the user is trying to host multiple cameras on the same bus in a configuration that would normally exceed the bandwidth allocation, but where the cameras are configured to transmit data in a manner that does not exceed the total bandwidth. An example of this situation is where 3 cameras are on a 1394b bus, each configured to transmit 60MB/sec, running in external trigger mode and being triggered such that no camera was transmitting at the same time.

The method for achieving this functionality is similar to that outlined in the following article:

[KB Article 22: Maximum number of PGR IEEE-1394 cameras on a single 1394 bus.](#)

Bus bandwidth negotiation is done with an initial (negotiated) byte per packet configuration. The byte per packet value is then changed outside of the bandwidth negotiation process to meet the desired bytes per packet.

Please refer to the *PGR IEEE 1394 Register Reference* for more details on accessing and the format of any registers referred to in this document.

## 1.4. Additional References

- *PGR IEEE 1394 Register Reference*
- [KB Article 22: Maximum number of PGR IEEE-1394 cameras on a single 1394 bus](#)
- [KB Article 146: Differences to consider when selecting an IEEE-1394 PCI / PCMCIA host adapter card.](#)
- [KB Article 254: Image divided or chopped into parts and frame rate decreases](#)

## 1.5. Procedure Description

In order to configure the system, the following steps must be executed for all cameras:

- 1) Configure the cameras to operate in Format 7, at the resolution desired, with the original *negotiated* packet size.
- 2) Enable external trigger mode on all cameras.
- 3) Disable isochronous data transmission on all cameras.
- 4) Increase the byte per packet size for all cameras to the *desired* packet size insuring that exactly the same amount of data will be sent as when they were configured to transmit with the minimal packet size.
- 5) Re-enable isochronous data transmission for all cameras.

## 1.6. Additional Details and Limitations

There are a number of very important details that need to be considered when configuring a system to work in this manner.

### 1.6.1. Format 7 configuration limitations

In order for configurations of this nature to work, the user must insure that changing the byte per packet register from the *negotiated* value to the *desired* value does not alter the total amount of data per image transmitted. If the amount of data transmitted changes, image corruption, and/or dropped images, and/or decreased frame rate will be observed. The result of this requirement is that there are a number of restrictions put on:

- a) the image size;
- b) the *negotiated* bytes per packet value; and
- c) the *desired* bytes per packet value.

The restrictions are as follows:

- 1) The amount of data transmitted per image must remain constant in both the original negotiated and desired configurations. This value can be computed as follows:

$$\text{Data\_Sent} = \text{Packet\_Size} * \text{CEIL}(\text{Image\_Size} / \text{Packet\_Size})$$

**Note:** If *Image\_Size* is not a whole number multiple of the *Packet\_Size*, padding data will be transmitted.

- 2) The *negotiated* bytes per packet must be:
  - a. a multiple of the *UnitBytePerPacket* as reported by the *PACKET\_PARA\_INQ* (040h) register; and
  - b. a factor of the *Data\_Sent* as computed above.
- 3) The *desired* bytes per packet must be supported by the camera

As a result of these restrictions, *negotiated* and *desired* byte per packet values are generally determined using a brute force method such as a spreadsheet.

**Note:** Making sure that the total image size is a multiple of the unit packet size generally helps make it easier to find a minimum/maximum bytes/packet combination that will work.

#### 1.6.1.1. Determining possible packet sizes

Given that the camera is configured in Format 7 for a given resolution and pixel format, the possible packet sizes can be determined by reading the *PACKET\_PARA\_INQ* (040h) register for the given mode. The *UnitBytePerPacket* field indicates the unit multiple of the packet size and the *MaxBytePerPacket* indicates the maximum sized packet that can be transmitted by the camera.

#### 1.6.2. Bandwidth limitations

The bandwidth limitations of the IEEE-1394a and IEEE-1394b buses are as follows:

Bus	Maximum Isochronous Bandwidth	Maximum Packet Size
IEEE-1394a	4915 bytes/cycle	4096 bytes/packet
IEEE-1394b	9830 bytes/cycle	8192 bytes/packet

The *Maximum Isochronous Bandwidth* is 80% of the total bus bandwidth. The remaining 20% is reserved for asynchronous data transmission. In some cases it is possible to exceed the 80% limitation the potential issues outlined in 1.6.6 need to be considered.

There are 8000 cycles per second in which data can be transmitted.

The *Maximum Packet Size* is the maximum amount of data that a single node can transmit during any given cycle.

#### 1.6.3. Maximum DMA contexts

Implementations will be limited by the maximum number of DMA contexts supported by the 1394 Host Adapter Card. For more information, please refer to the following knowledge base article:

[KB Article 146: Differences to consider when selecting an IEEE-1394 PCI / PCMCIA adapter card.](#)

#### 1.6.4. Time between triggers

Based on the assumptions that

- a) more than a single camera transmitting data at any one time will exceed the bus bandwidth, and
- b) both cameras are configured to consume the same bandwidth,
- c) both cameras are configured with the same shutter speed,

individual camera triggers will have to be timed such that no two cameras are transmitting at the same time. In the above case, the minimal time between triggers is simply the transmission time where transmission time is computed as follows:

$$\text{Transmission\_Time} = \text{Packets\_Per\_Frame} / 8000 \text{ cycles per second}$$

The number of packets per frame can be calculated using the following formula:

$$\text{Packets Per Frame} = \text{CEIL}(\text{Image Size} / \text{Packet Size})$$

The more desirable method is to read it directly from the *Packet\_Per\_Frame* (048h) register on the camera after the *BytePerPacket* (044h) register has been written.

#### **1.6.5. Using buffer fill mode**

It is important to insure that the driver stack is configured to use *buffer fill* mode rather than *packet per buffer* mode. Configuring the stack to use *packet per buffer* mode adds the requirement that the number and size of packets remains constant.

**pgrcam.sys** - only operates in *buffer fill* mode and as such there are no configuration issues.

**pgr1394b.sys** – by default, this driver operates in *buffer fill* mode. Please refer to the section titled *Switching Between Modes* in the following kb article for confirming that the driver is in the correct mode:

[KB Article 254: Image divided or chopped into parts and frame rate decreases](#)

#### **1.6.6. Attempting to transmit data that will exceed the bus bandwidth**

It is important to note that actually sending data at a rate that exceeds the bus bandwidth can/will result in negative consequences such as torn or corrupt images or bus resets.

## 1.7. Example Configuration

### 1.7.1. Determining Negotiated and Desired Byte Per Packet configurations

As mentioned above, the easiest way to compute *negotiated* and *desired* byte per packet configurations is through the use of a spreadsheet such as that shown below.

<b>MaxBytePerPacket</b>	9792			
<b>UnitBytePerPacket</b>	12			
<b>Image Width</b>	2520 pixels			
<b>Image Height</b>	2060 pixels			
<b>Image Size</b>	5191200 bytes			
	<b>Packet Size</b>	<b>Packets/Image</b>	<b>Data Sent</b>	
<b><i>Desired</i></b>	<b><i>9456</i></b>	<b><i>549</i></b>	<b><i>5191344 bytes</i></b>	
	12	432600	5191200 bytes	-
	24	216300	5191200 bytes	-
	36	144200	5191200 bytes	-
	48	108150	5191200 bytes	-
	60	86520	5191200 bytes	-
	72	72100	5191200 bytes	-
	84	61800	5191200 bytes	-
	96	54075	5191200 bytes	-
	108	48067	5191236 bytes	-
	120	43260	5191200 bytes	-
	132	39328	5191296 bytes	-
	144	36050	5191200 bytes	-
	156	33277	5191212 bytes	-
	168	30900	5191200 bytes	-
	180	28840	5191200 bytes	-
	192	27038	5191296 bytes	-
	204	25448	5191392 bytes	-
<b><i>Negotiated</i></b>	<b><i>216</i></b>	<b><i>24034</i></b>	<b><i>5191344 bytes</i></b>	<b><i>valid</i></b>
	228	22769	5191332 bytes	-
	240	21630	5191200 bytes	-

For the purposes of this document, the *negotiated* byte per packet value should be 216 bytes. The reason for this is that it is the smallest factor of data sent that is a packet size supported by the camera.

- The ***Packet Size*** column is computed by starting with the UnitBytePerPacket value and simply incrementing by same
- The ***Packets/Image*** column is computed by computing the ceiling of Image Size divided by Packet Size.
- The ***Data Sent*** column is computed by multiplying *Packets/Image* by *Packet Size*.

The *negotiated* bytes per packet is the lowest packet size that results in the same amount of Data Sent as the *desired* value.

### 1.7.2. Camera configuration

Given the *desired* and *negotiated* settings determined above, the following example illustrates a configuration that will work.

Hardware	
<b>1394 card</b>	SIIG FireWire 800 3-port PCIe
<b>Camera</b>	5MP
Software	
<b>FlyCapture SDK</b>	1.6 Release 19
<b>Device Driver</b>	pgrcam.sys or pgr1394b.sys (in <i>buffer fill</i> mode)
<b>Image Capture</b>	FlyCap
Camera Parameters	
<b>Image Size</b>	2520 x 2060
<b>Format 7 Mode</b>	Mode 0
<b>Pixel Format</b>	Mono8
<b>Minimum Packet Size</b>	12 bytes per packet
<b>Maximum Packet Size</b>	9792 bytes per packet
<b>Negotiated Packet Size</b>	216 bytes per packet (D8h)
<b>Desired Packet Size</b>	9456 bytes per packet (24F0h)
<b>Data transmitted per Frame</b>	5191344 bytes
<b>Padding</b>	144 bytes

Using FlyCap with both cameras plugged into the same bus.

#### 1) Initialize each camera:

- a. Start FlyCap and select the camera
- b. Before initializing, click *Configure Selected*
- c. Select the *Custom Image* tab
- d. Configure the following values:
  - *Mode*: Mode 0
  - *Pixel Format*: Mono8
  - *Image Left*: 0
  - *Image Right*: 0
  - *Width*: 2520
  - *Height*: 2060
  - *Packet Size* -> *Current* 216
- e. Click the *Set* button in the *Custom Image* tab, close the dialog and hit *OK* to start the camera.

#### 2) Put each camera into trigger mode:

- a. Open the *Camera Control Dialog*
- b. Access the *GPIO/Trigger* tab
- c. Enable the *Trigger On/Off* button

### 3) Increase the bandwidth requirements:

For each camera, with the *Register* tab on the *Camera Control Dialog* open:

- a. Disable ISO Transmission by setting bit 0 of register 614h to 0

read	614h	0x80000000
write	614h	0x00000000

- b. Adjust the bytes per packet register by setting the first 16 bits of register A44h to 9456 (24F0h)

read	A44h	0x00D82640
write	A44h	0x24F02640

- c. Re-enable ISO data transmission by reading the value

read	614h	0x00000000
write	614h	0x80000000

- 4) **Determine minimum time between triggers** by reading the *Packets\_Per\_Frame* register at A48h and dividing it by 8000 packets/sec.

read	614h	0x00000214
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$$\begin{aligned}
 &214h \text{ packets per frame} = 532 \text{ packets per frame} \\
 &532 \text{ packets/frame} / 8000 \text{ cycles/second} = \mathbf{66.5ms/frame}
 \end{aligned}$$

- 5) **Fire trigger for each camera** individually by hitting the *Fire Software Trigger* button on the *GPIO/Trigger* tab of the *Camera Control Dialog*.

## 1.8. Additional Downloads and Support

Access more Technical Application Notes on the web at [www.ptgrey.com/support/downloads](http://www.ptgrey.com/support/downloads).

Point Grey Research Inc. endeavors 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](http://www.ptgrey.com/support).

### 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/](http://www.ptgrey.com/support/downloads/).

### Knowledge Base

Our on-line knowledge base at [www.ptgrey.com/support/kb/](http://www.ptgrey.com/support/kb/) contains answers to some of the most common support questions. It is constantly updated, expanded, and refined to ensure that our customers have access to the latest information.

### 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](http://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.

### 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 at [www.ptgrey.com/support/contact/](http://www.ptgrey.com/support/contact/).