Basler IP Cameras

Real-Time Trigger

APPLICATION NOTES

Document Number: AW000991
Version: 01 Language: 000 (English)
Release Date: 18 March 2011

BASLER

Contacting Basler Support Worldwide

Europe and the Middle East:

Basler AG
An der Strusbek 60 - 62
22926 Ahrensburg
Germany

Phone: +49-4102-463-303
Fax: +49-4102-463-599
Email: bc.support.ip.emea@baslerweb.com

The Americas:

Basler, Inc.
855 Springdale Drive, Suite 203
Exton, PA 19341
U.S.A.

Phone: +1-610-280-0171
Fax: +1-610-280-7608
Email: bc.support.ip.usa@baslerweb.com

Asia:

Basler Asia Pte. Ltd
8 Boon Lay Way
03 - 03 Tradehub 21
Singapore 609964

Phone: +65-6425-0472
Fax: +65-6425-0473
Email: bc.support.ip.asia@baslerweb.com

www.basler-ipcam.com

Table of Contents

1 Introduction

Basler IP cameras normally capture images without the need for any type of triggering by the user. For instance, if a camera is set for a frame rate of 30 frames (images) per second, it will internally generate all of the required signals needed to initiate the start of an image capture every 1/30th of a second. In this scenario, the user has no control over when the start of any image capture will occur. The camera simple begins each image capture as required to maintain the frame rate.

In many typical surveillance situations, this mode of operation is exactly what the user wants. An automatically captured, continuous stream of images will be perfect, for example, to monitor the actions on a banking floor or a building lobby. In some situations, however, it would be desirable to be able to trigger an image capture at a particular point in time. For example, in a traffic control situation the user might want to trigger an image capture at a particular point in time after a car passes a sensor on a highway.

The real-time trigger feature on the camera guarantees that an image capture will start (i.e., the exposure of an image will start) after a trigger signal is applied to a properly configured I/O port on the camera and an "abort time" period has expired. For example, if the abort time for the camera model you are working with is seven milliseconds, an image capture is guaranteed to start seven milliseconds after a real-time trigger signal is applied to a properly configured port on the camera.

Note that the abort time may vary between camera models. Check the camera user’s manual to determine the abort time for the camera model you are using.

Figure 1, illustrates the normal image capture process used by the camera. In Figure 1, each blue and yellow bar represents an image capture that is triggered by the camera's internal triggering process. The blue portion of each bar represents the time that the sensor is exposed to light during an image capture. The yellow portion of each bar represents the time it takes for the camera to read the image data out of the sensor once exposure is complete. At the end of the readout time, the captured image is transmitted by the camera.

Figure 1 assumes that the camera is set to capture images at a rate of 30 frames per second (fps). This means that the camera will trigger the start of a new capture every 1/30th of a second. Since the camera is triggering these captures internally, a user has no way of knowing exactly when any of the image captures will start.

You may notice in Figure 1 that the exposure time for each image overlaps the readout time for the previous image. This is a normal situation that typically occurs when a camera is operating at near to its maximum allowed frame rate (and for the purposes of this example, we will assume that we are using a camera with a 30 fps maximum allowed rate). Exposure and readout can overlap as shown in the figure as long as the exposure for a new image does not end before the readout of the previous frame is complete. The camera will manage the image capture process to make sure that this rule is not violated.

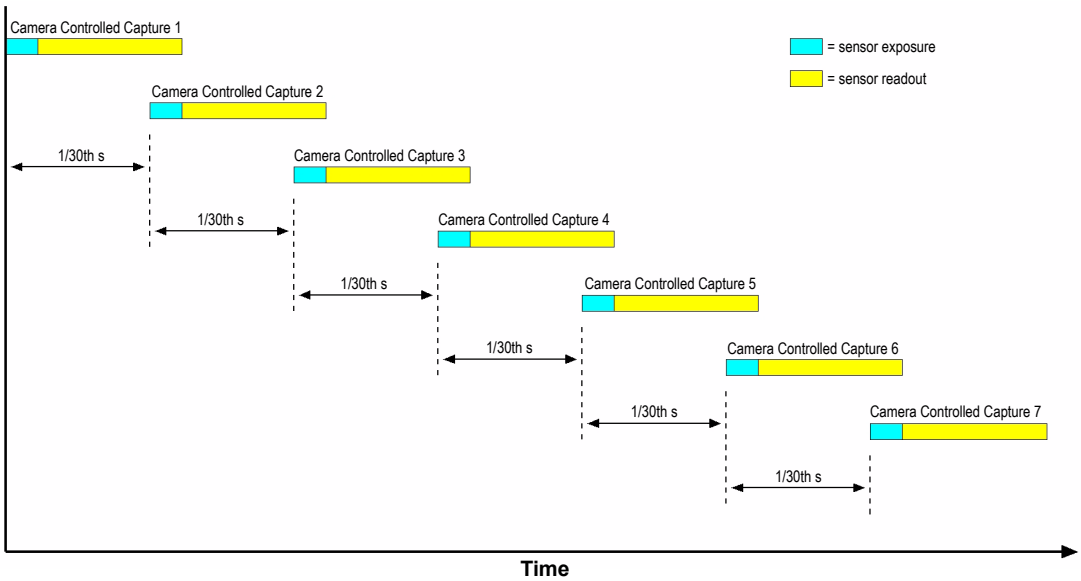


Fig. 1: Normal Image Capture - Near Max Frame Rate

Figure 2 illustrates how the real-time trigger feature works. When the user applies a trigger signal to a properly configured I/O port on the camera, the camera immediately begins to abort any image captures that are currently in progress. The amount of time that the abort process requires is called the "abort time". At the end of the abort time, the camera begins a new image capture (i.e., it starts the exposure for a new image). When the capture process for the real-time triggered image is complete, the image will be transmitted from the camera. The user can be sure that the exposure for this image started exactly "abort time" milliseconds after the real-time trigger signal was received by the camera. For example, if the abort time for the camera model you are working with is seven milliseconds, an image capture will start exactly seven milliseconds after a real-time trigger signal is applied to a properly configured port on the camera.

Note that the abort time may vary from camera model to camera model.You should check the camera user's manual to determine the abort time for the model you are using.

At some point after the abort process ends, the camera will revert to its normal internal method of triggering the start of image capture. In the case of our example, this will happen 1/30th of a second after the end of the abort because we are operating at 30 frames per second.

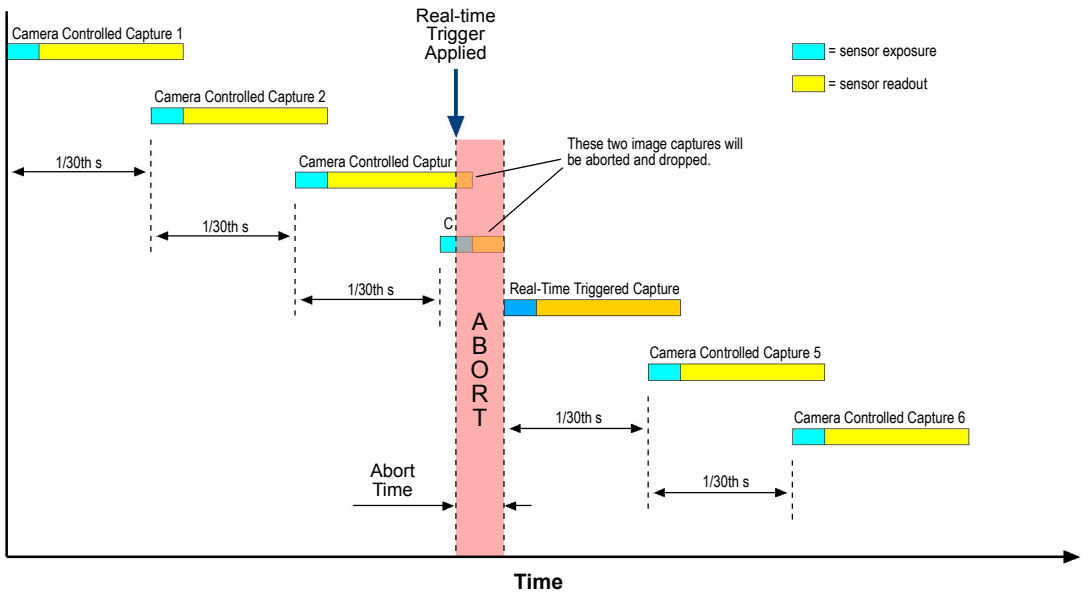


Fig. 2: Real-Time Trigger Image Capture - Two Captures Dropped

	Because the real-time trigger operates at the sensor level, it impacts all enabled streams. So, for example, if you have three streams enabled, each image capture initiated by a real-time trigger signal will be transmitted in all three streams.

If you take a close look at Figure 2, you will notice that two of the image captures triggered by the camera's internal process were aborted. These two partially completed images will be dropped and will not be transmitted from the camera. Note that if you have several streams enabled, the images will dropped from every stream.

In Figure 2, the real-time trigger was received during the period when two images captures were overlapped, so both of these captures were affected by the abort and they were both dropped. But the number of dropped images can actually vary from no images to two images depending on how you are operating the camera.

Figure 3 illustrates a slightly different situation than Figure 2. In this case, the trigger is not received during the time when two image captures are overlapped, but rather when the capture process is only happening for one image. In this case, only one image capture will be aborted and dropped.

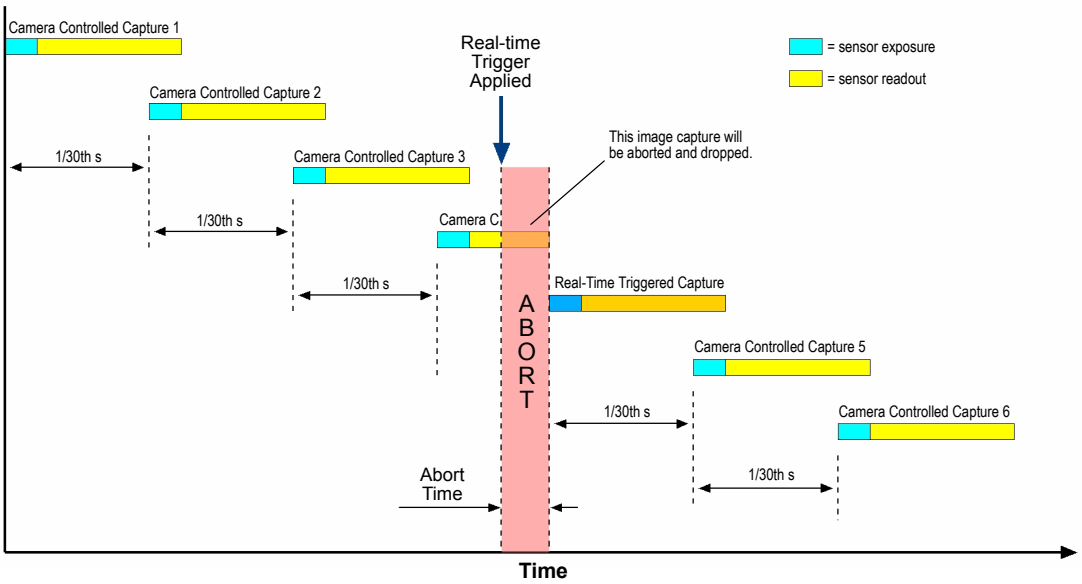


Fig. 3: Real-Time Trigger Image Capture - One Capture Dropped

Figure 4 illustrates a different mode of camera operation. In this case, we will assume that we have set the camera to operate at 15 fps rather than at 30 fps. With the camera set for 15 fps, it will start a new image capture every 1/15th of a second. Because the camera is set to operate at a much lower frame rate, the image capture operations will not overlap as we saw earlier, rather they will be spread out as shown in Figure 4.

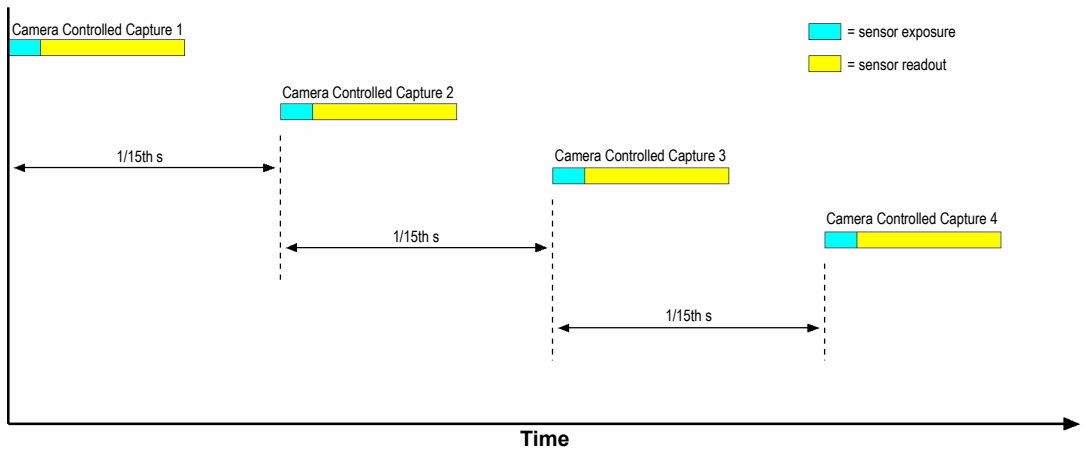


Fig. 4: Normal Image Capture - Lower Frame Rate

Now let's see what can happen if you apply a real-time trigger when the camera is operating this way. Figure 5 shows what will happen if the trigger arrives while an image capture is in progress. In this case, one capture will be aborted, meaning that one image will be lost.

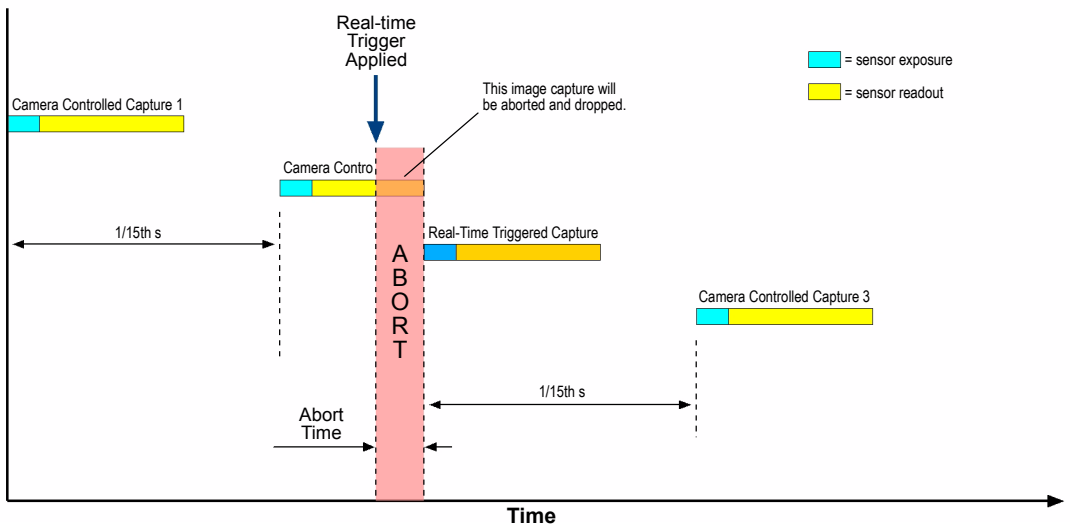


Fig. 5: Real-Time Trigger Image Capture - One Capture Dropped

Figure 6 shows what will happen if the trigger arrives during the time between the end of one capture and the start of the next. In this case, the abort will not affect any image captures and therefore no captures will be lost.

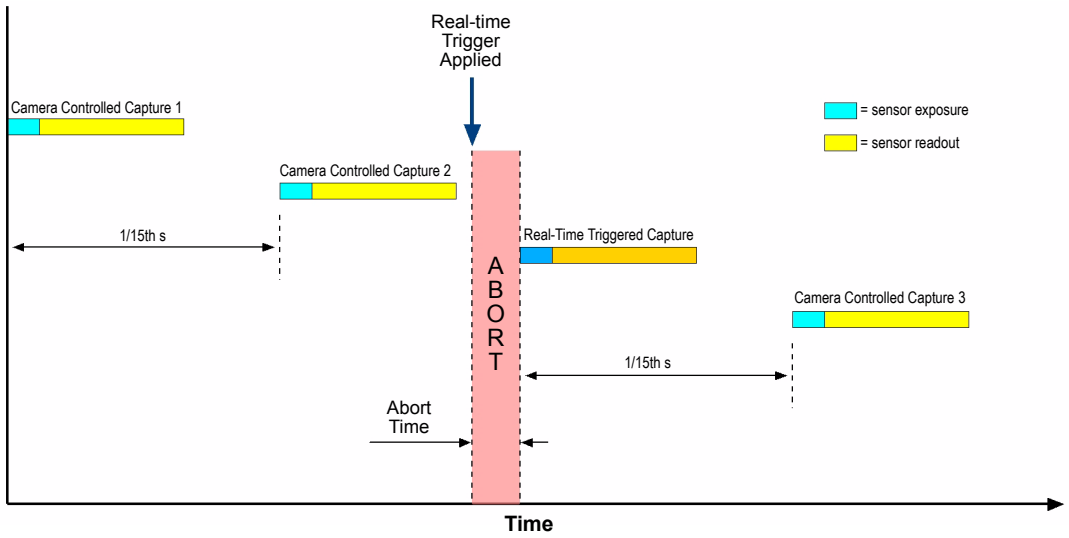


Fig. 6: Real-Time Trigger Image Capture - No Captures Dropped

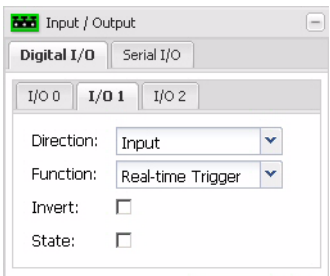
So in summation, the number of image captures that will be aborted and lost can vary between zero and two depending on how you are operating the camera and on when the real-time trigger signal arrives at the camera. If you are operating the camera near to its maximum frame rate, you will lose one or two image captures depending on when the trigger signal arrives. If you are operating the camera well below its maximum allowed frame rate, you will lose zero or one image capture depending on when the trigger signal arrives.

2 Using Real-Time Triggering

2.1 Enabling Real-Time Triggering

Enabling Triggering Using the Web Client

To enable real-time triggering via the Basler Surveillance Web Client, use the **Digital I/O** tab in the **Input/Output** parameters group to properly configure one of the I/O ports. The port should be configured with the **Direction** parameter set as an "Input" and the **Function** parameter set as "Real-time Trigger" as shown to the right.



If the invert function for the port is not enabled (i.e., the **Invert** check box is not checked), an image capture will be triggered whenever the electrical signal applied to the port causes the port to transition from the inactive to the active condition.

If the invert function for the port is enabled (i.e., the **Invert** check box is checked), an image capture will be triggered whenever the electrical signal applied to the port causes the port to transition from the active to the inactive condition.

The **State** check box indicates the state of the port. The box will be checked when the state is active and unchecked when the state is inactive.

Enabling Triggering Using the Camera API

To enable real-time triggering via the camera API, use the following parameters in the IO group:

- Use *IOSelector* to select a port.
- Use *Direction* to set the selected port's direction to "Input".
- Use *Function* to set the selected port's function to "RealtimeTrigger".

With these settings, an image capture will be triggered whenever the electrical signal applied to the port causes the port to transition from the inactive to the active condition.

- If desired, use *Invert* to set the selected port to invert:

When the invert function for the port is enabled, an image capture will be triggered whenever the electrical signal applied to the port causes the port to transition from the active to the inactive condition.

- If desired, use *State* to check the current state of the selected port.

	Note that you can configure more than one port to act as an input with the function set to real-time trigger. In this situation, an image capture will be triggered anytime the proper electrical signal is applied to one of the ports. For information about wiring the ports and about the electrical requirements for the ports, see the "Terminal Connector" section of the camera user's manual.

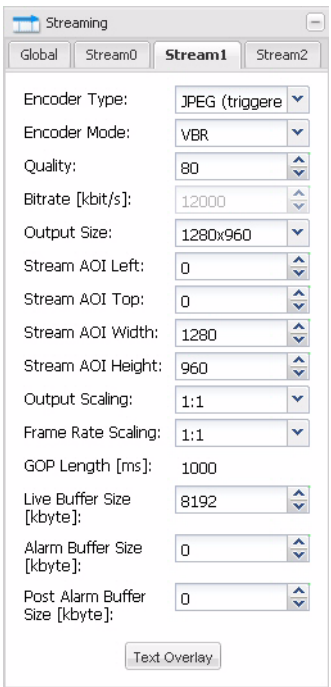
2.2 Real-Time Triggering's Impact on Streams

Considerations When Using the Web Client

When you are setting the Streaming group parameters on the camera, remember that because the real-time trigger operates at the sensor level, it impacts all enabled streams. So, for example, if you enable three streams, each image capture initiated by a real-time trigger signal will be transmitted in all three streams.

If the **Encoder Type** parameter for a stream is set to "JPEG", "MPEG4", "H.264 Base Profile" or "H.264 High Profile", the images captured as a result of the real-time trigger will be transmitted from the camera as part of the normal image stream as illustrated in Figure 2 on page 3.

If the **Encoder Type** parameter for a stream is set to "JPEG (triggered)" as shown to the right, the stream will only include images captured as a result of using the real-time trigger. The images in the stream will be motion JPEG encoded.



Considerations When Using the Camera API

When you are using the API to set the values in the Stream parameters group, remember that because the real-time trigger operates at the sensor level, it impacts all enabled streams. So, for example, if you enable three streams, each image capture initiated by a real-time trigger signal will be transmitted in all three streams.

If the *EncoderType* parameter for a stream is set to "JPEG", "MPEG4", "H_264" or "H_264_High", the images captured as a result of the real-time trigger will be transmitted from the camera as part of the normal image stream as illustrated in Figure 2 on page 3.

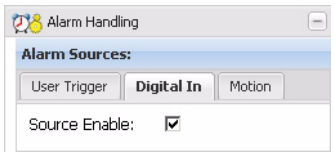
If the *EncoderType* parameter for a stream is set to "JPEG_TRIGGERED", the stream will only include images captured as a result of using the real-time trigger. The images in the stream will be motion JPEG encoded.

2.3 Real-Time Triggering and Alarms

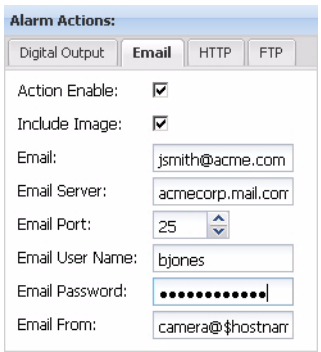
Setting the Alarm Functionality Using the Web Client

If you have enabled real-time triggering as described in Section 2.1 on page 7, then you can set the camera so that an alarm condition will be declared whenever a real-time trigger is applied.

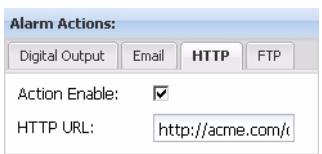
If the **Source Enable** check box on the **Digital In** tab in the **Alarm Sources** section of the **Alarm Handling** parameters group is checked as shown to the right, the camera will declare an alarm condition whenever a real-time trigger signal is applied to the camera.



If you want the camera to send an email with attached images when an alarm condition is declared, set the parameters on the **Email** tab in the **Alarm Actions** section of the **Alarm Handling** parameters group as shown to the right. For each JPEG encoded stream, the email will include an attached image that was captured when the real-time trigger signal caused the alarm condition. The size of each image will be determined by the AOI settings for the stream in which the image was included.



If you want the camera to send an HTTP request when an alarm condition is declared, set the parameters on the **HTTP** tab in the **Alarm Actions** section of the **Alarm Handling** parameters group as shown to the right.



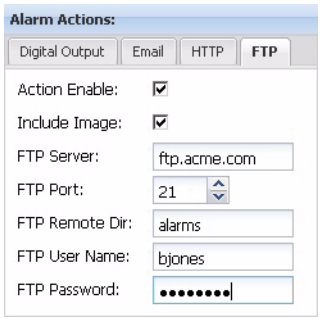
You must enter a valid URL request in the **HTTP URL** line. You could, for example, enter this request:
http://MyServer/cgi-bin/alarm.cgi

You should be aware that the camera will automatically add the following two parameters to the end of the request:

?host=<hostname>&date=<date/time>

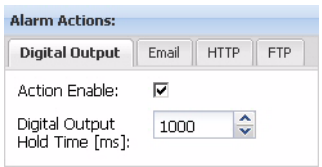
where "hostname" is the camera's host name and "date/time" is the current date and time.

If you want the camera to upload a text file and image files to an FTP server when an alarm condition is declared, set the parameters on the **FTP** tab in the **Alarm Actions** section of the **Alarm Handling** parameters group as shown to the right. When an alarm condition is declared, a text file containing information about the alarm will be uploaded to the FTP server. Along with the text file, an image file will be uploaded from each JPEG encoded stream. The image from each stream will be the one that was captured when the real-time trigger signal caused the alarm condition. The size of each image will be determined by the AOI settings for the stream in which it was included.



If you want the camera to make an I/O port change state when an alarm condition is declared, you must do two things:

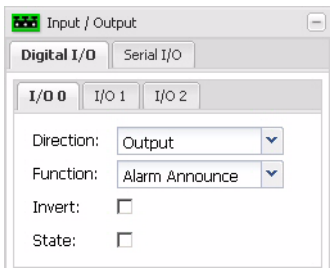
- Set the parameters on the **Digital Output** tab in the **Alarm Actions** section of the **Alarm Handling** parameters group as shown to the right. When the **Action Enable** box checked, the camera will change the state of a properly configured I/O port when an alarm condition is declared. The camera will hold the I/O port in the changed state for a time period determined by the **Digital Output Hold Time [ms]** parameter setting.



- Properly configure the I/O port.

  On the **Digital I/O** tab in the **Input/Output** parameter group, select the tab for the I/O port you want to use (I/O 0 is used for this example). Set the **Direction** parameter to **Output** and the **Function** parameter to **Alarm Announce**.

  If the invert function for the port is not enabled (i.e., the **Invert** check box is not checked), the port to transition from the inactive to the active state when an alarm is declared. It will remain in that state for a time period equal to the Digital Output Hold Time setting and then will return to the inactive state.



  If the invert function for the port is enabled (i.e., the **Invert** check box is checked), the port will transition from the active to the inactive state when an alarm is declared. It will remain in that state for a time period equal to the Digital Output Hold Time setting and then will return to the active state.

  The **State** check box indicates the state of the port. The box will be checked when the state is active and unchecked when the state is inactive.

Setting the Alarm Functionality Using the Camera API

If you have enabled real-time triggering as described in Section 2.1 on page 7, then you can set the camera so that an alarm condition will be declared whenever a real-time trigger is applied. Use the API to set the following parameters in the Alarm parameters group:

- Use *SourceSelector* to select "PIO" as the alarm source.
- Use *SourceEnable* to enable the selected source.

If desired, you can set the camera to send an email with attached images when an alarm condition is declared. For each JPEG encoded stream, the email will include an attached image that was captured when the real-time trigger signal caused the alarm condition. The size of each image will be determined by the AOI settings for the stream in which the image was included.

To set the camera to send an email with images when an alarm condition is declared, use the following parameters in the Alarm parameters group:

- Use *ActionSelector* to select "Email" as the alarm action.
- Use *ActionEnable* to enable the selected action.
- Use *ActionIncludeImage* to enable the sending of images attached to the email.
- Use *Email* to enter a recipient address.
- Use *EmailFrom* to enter a sender's address.
- Use *EmailServer* to enter an SMTP server to use to send the mail.
- Use *EmailPort* to set the port to use on the target email server.
- Use *EmailUserName* to specify a user name for authentication on the SMTP server.
- Use *EmailPassword* to specify a password for authentication on the SMTP server.

If desired, you can set the camera to send an HTTP request when an alarm condition is declared. You could, for example, set the camera to send this request: http://MyServer/cgi-bin/alarm.cgi

You should be aware that the camera will automatically add the following two parameters to the end of the request:

?host=<hostname>&date=<date/time>

where "hostname" is the camera's host name and "date/time" is the current date and time.

To set the camera to send an HTTP request, use the following parameters in the Alarm parameters group:

- Use *ActionSelector* to select "HTTP" as the alarm action.
- Use *ActionEnable* to enable the selected action.
- Use the *HTTPURL* parameter to enter the request.

If desired, you can set the camera to upload a text file and image files to an FTP server when an alarm condition is declared. The text file will contain information about the alarm condition. An image file will be uploaded from each JPEG encoded stream. The image included from each stream will be the one that was captured when the real-time trigger signal caused the alarm condition. The size of each image will be determined by the AOI settings for the stream in which it was included.

To set the camera to upload a text file and images, use the following parameters in the Alarm parameters group:

- Use *ActionSelector* to select "FTP" as the alarm action.
- Use *ActionEnable* to enable the selected action.
- Use *ActionIncludeImage* to enable the sending of images along with the text file.
- Use *FTPServer* parameter enter an FTP server to receive the upload.
- Use *FTPRemoteDir* to set a path to a target subdirectory for upload.
- Use *FTPPort* to set the port to use on the target FTP server.
- Use *FTPUserName* to specify a user name for authentication on the FTP server.
- Use *FTPPassword* to specify a password for authentication on the FTP server.

If desired, you can set the camera to change the state of a properly configured I/O port when an alarm condition is declared. Begin by setting the following parameters in the Alarm parameters group:

- Use *ActionSelector* to select "PIO" as the alarm action.
- Use *ActionEnable* to enable the selected action.
- Use *PIOHoldTime* to set a time in milliseconds that the port will be held in the changed state after an alarm condition is declared.

Next, use the following parameters in the IO group to configure the port:

- Use *IOSelector* to select a port to configure.
- Use *Direction* to set the selected port to act as an "Output".
- Use *Function* to set the function of the selected port to "AlarmAnnounce".

With these settings, the port to transition from the inactive to the active state when an alarm is declared. It will remain in the active state for a time period equal to the Digital Output Hold Time setting and then will return to the inactive state.

- If desired, use *Invert* to set the selected port to invert:

When the invert function for the port is enabled, the port will transition from the active to the inactive state when an alarm is declared. It will remain in the inactive state for a time period equal to the Digital Output Hold Time setting and then will return to the active state.

- If desired, use *State* to check the current state of the selected port.

2.4 Minimum Time Between Trigger Signals

As described in Section 1 on page 1, when a real-time trigger signal is applied to a properly parameterized camera, the camera will immediately begin an abort process and it will start an image capture as soon as the abort time has expired. Once a trigger signal has been applied to the camera and an abort process has started, the camera cannot react to a new real-time trigger signal until a certain minimum amount of time has passed. If a new real-time trigger signal is applied to the camera before the minimum time has passed, the camera will simply ignore the new trigger signal.

To determine the minimum required time between real-time trigger signals, you must know two values: the camera's current Frame Rate Mode parameter setting and its current Exposure Time Limit parameter setting.

Using the current Frame Rate Mode setting, you can calculate the camera's current frame period with this formula:

Frame Period = 1 / Current Frame Rate Mode parameter setting

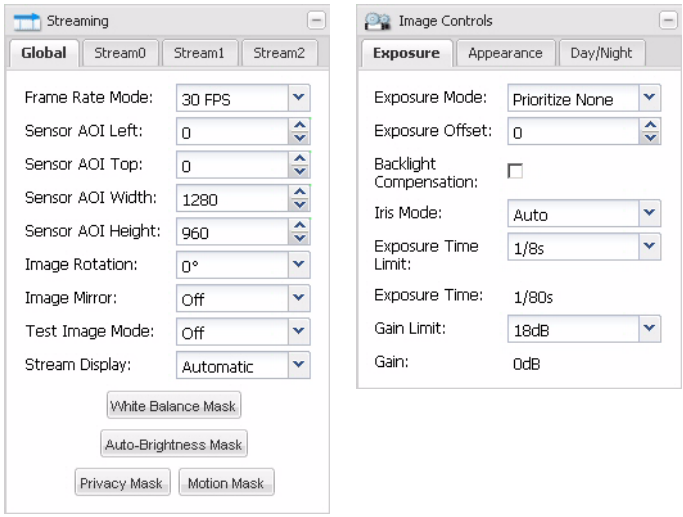
And now you can determine the minimum time between triggers:

- If the Exposure Time Limit parameter setting is > the frame period:
  Min Time Between Triggers = (2 x Exposure Time Limit) + Abort Time
- If the Exposure Time Limit parameter setting is ≤ the frame period:
  Min Time Between Triggers = (2 x Frame Period) + Abort Time

Note that the abort time may vary from camera model to camera model.You should check the camera user's manual to determine the abort time for the model you are using.

	When you have applied a real-time trigger signal to the camera, the "min time between triggers" represents the smallest amount of time that you must wait before the camera is guaranteed to be able to react to a new real-time trigger signal. In some cases, the camera may be able to react to a new trigger signal sooner, but this is not guaranteed. If a real-time trigger signal is received too early, the camera will ignore the trigger signal. The camera will never abort an image capture that was initiated by the application of a real-time trigger signal.

If you are parameterizing the camera using the Basler Surveillance Web Client, you can find the **Frame Rate Mode** parameter setting on the **Global** tab in the **Streaming** parameters group and you can find the **Exposure Time Limit** parameter setting on the **Exposure** tab in the **Image Controls** group as shown at right.



If you are using the API to set camera parameters, you can read the value of the *FrameRateMode* parameter in the Sensor parameters group and the value of the *ExposureTimeLimit* parameter in the ImageControls parameter group to obtain the required information for the calculations.

2.5 Accessing a Stream Set for "JPEG (triggered)" Encoding

For normal streams (i.e., streams set for JPEG, MPEG-4, or H.264 encoding), the TCP connection to the host will be closed by the camera if the camera does not have any new images to send for a period of 10 seconds. Since a stream using "JPEG (triggered)" encoding will not be continuous and may have periods longer than 10 seconds with no images available for transmission, a new mode was required for use with requests to access a "JPEG (triggered)" encoded stream. The new "triggered" mode was added for use when accessing streams encoded as "JPEG (triggered)".

Example 1 Using the Stream Oriented Approach for Stream Access

Assume that you are using a camera with the host name set to IPCam_1. Also assume that you have stream 1 set for the "JPEG (triggered)" encoder type (and therefore stream 1 is only encoding and streaming images that were triggered by the camera's real-time trigger function). To access the images from stream 1, you would issue this request:

```
http://IPCam_1/cgi-bin/mjpeg?stream=1&mode=triggered
```

Example 2 Using the Buffer Oriented Approach for Stream Access

Assume that you are using a camera with the host name set to IPCam_1 and that stream 0 is set for the "JPEG" encoder type. Also assume that stream 1 is set for the "JPEG (triggered)" encoder type (and therefore stream 1 is only encoding and streaming images that were triggered by the camera's real-time trigger function). You would access the images from stream 1, in this manner:

Begin the process by requesting a list of available streams:

```
http://IPCam_1/cgi-bin/stream?list
```

Assume that you receive the following return

```
buffer_0=(0,"stream 0",image/jpeg,LIVE,1280x960)
buffer_1=(0,"stream 0",image/jpeg,ALARM,1280x960)
buffer_2=(1,"stream 1",image/jpeg,TRIGGERED,1280x960)
```

To access the images from stream 1, you would issue this request:

```
http://IPCam_1/cgi-bin/mjpeg?buffer=2&mode=triggered
```

Revision History

Doc. ID Number	Date	Changes
AW00099101000	18 Mar 2011	Initial release of this document.