

Basler Components



USING A SPECIFIC EXTERNAL TRIGGER SIGNAL WITH OVERLAPPED EXPOSURE APPLICATION NOTES

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1 Introduction

This document provides guidelines for operating Basler cameras when the following two conditions are fulfilled at the same time:

- The exposure time for an image capture overlaps the sensor readout for the previous image capture (overlapped exposure).
- A specific external hardware trigger signal (ExTrig signal) is used, where the start and the length of the exposure will be directly controlled by the ExTrig signal (see [Section 2.2](#)).

This way of operating a Basler camera has the following goals:

- Obtaining a higher frame rate due to overlapped mode, compared to non-overlapped mode.
- Each ExTrig signal triggers one image.
- Each ExTrig signal controls the exposure time of the related image.

To ensure the full control by the ExTrig signal in overlapped mode, you must follow the guidelines given in [Section 3](#).

For more information on overlapped mode and ExTrig signals, see the camera user manuals.

1.1 Applicability

Two different groups of cameras are addressed here. They were designed to different standards and as a result, different terminologies apply.

- Group one includes the A102f, A310f, A600f, A620f, A630f, and A640f cameras. For these cameras the expressions "level control" and "shutter" apply.
- Group two includes the pilot and scout cameras. For these cameras the expressions "trigger width" and "exposure time parameter" apply.

Although the behavior of both groups of cameras is very similar in the context considered here, there are some differences which will be indicated whenever necessary.

2 Image Acquisition Control

2.1 Overlapped Mode

In overlapped mode, the exposure of an image starts before the readout of the previous image is complete. A trigger ready signal (TrigRdy) ensures that two requirements are met in overlapped mode:

- The exposure of a new image does not start while the exposure of the previous image is still in progress.
- The exposure of a new image does not end before the readout of the previous image is complete.

For more information on overlapped mode and the TrigRdy signal, see the camera user manuals.

2.2 ExTrig Signal with Level Controlled/ Trigger Width Exposure

A specific ExTrig signal can be used, where the start and the length of the exposure will be directly controlled by the ExTrig signal:

- If the camera is set for rising edge triggering, the exposure time begins when the ExTrig signal rises and continues until the ExTrig signal falls.
- If the camera is set for falling edge triggering, the exposure time begins when the ExTrig signal falls and continues until the ExTrig signal rises.

The exposure mode, where the ExTrig signal controls the length of the exposure, is referred to as "level controlled exposure mode" for the cameras of group one and as "trigger width exposure mode" for the cameras of group two (see [Section 1.1](#)).

For more information on ExTrig signals and how to apply them, and on level controlled/trigger width exposure mode, see the camera user manuals.

3 Guidelines

When using ExTrig level controlled exposure with overlapped mode, only correct settings will ensure that the ExTrig signal controls the start of exposure and the exposure time.

In this section, you will learn about correct settings and you will find examples illustrating the effects of correct and incorrect settings.

Definitions

This section assumes that the ExTrig signal is set for rising edge triggering. In this case, the rising edge triggers the start of exposure and the exposure proceeds as long as the ExTrig signal is high.

We will distinguish two terms: “set exposure time“ and “desired exposure time“:

- The set exposure time is the exposure time specified by the camera’s shutter settings (cameras of group one) or the exposure time parameter (cameras of group two; see [Section 1.1](#)). For more information on exposure time, see the camera user manuals.
- The desired exposure time is the exposure time specified by the length of time that the ExTrig signal remains high.

Guidelines

To ensure the full control by the ExTrig signal in overlapped mode, you must follow all of these guidelines:

Guideline 1: The rising edge of the ExTrig signal must rise with or after the rise of the TrigRdy signal. Otherwise, the ExTrig signal will not control the start of exposure.

For more information on the TrigRdy signal, see [Section 2.1](#) and the camera user manuals.

Guideline 2: The set exposure time must be equal to or less than the desired exposure time. Otherwise, the ExTrig signal will not control the exposure time.

If the desired exposure time varies, we recommend making the set exposure time equal to the shortest desired exposure time.

Guideline 3: The following relation must hold between the period of the ExTrig signal and the related image capture. Otherwise, the camera will be overtriggered.

$$\text{ExTrig Period} \geq \text{Exposure} + \text{Readout} - \text{Set Exposure Time}$$



- The exposure is initiated as soon as the TrigRdy signal **and** the ExTrig signal are both high.
 - For the cameras of group one **only**, the set exposure time specifies the absolute minimum exposure. For the cameras of group two, the set exposure time does **not** specify the absolute minimum exposure time. The differences in the behavior of both groups of cameras become apparent from comparing example 5A with example 5B (see below).
 - The set exposure time specifies when the TrigRdy signal will go high and thus specifies the **maximum allowed** overlap between image captures. The higher the set exposure time, the greater the maximum allowed overlap.
- Note:** This causes the seemingly paradoxical situation that decreasing the set exposure time results in a decreased frame rate. Conversely, increasing the set exposure time results in an increased frame rate.

3.1 Examples

The following examples illustrate the effects of correct and incorrect settings:

- Examples one through three illustrate the full control by the ExTrig signal and how to maximize the frame rate. The examples apply to the cameras of groups one and two (see [Section 1.1](#)).
- Examples four through six illustrate adverse affects of incorrect settings. Examples four and six apply to the cameras of groups one and two (see [Section 1.1](#)). Example 5A applies to the cameras of group one only, example 5B applies to the cameras of group two only.

For simplicity, all ExTrig signals are periodic.

Example 1

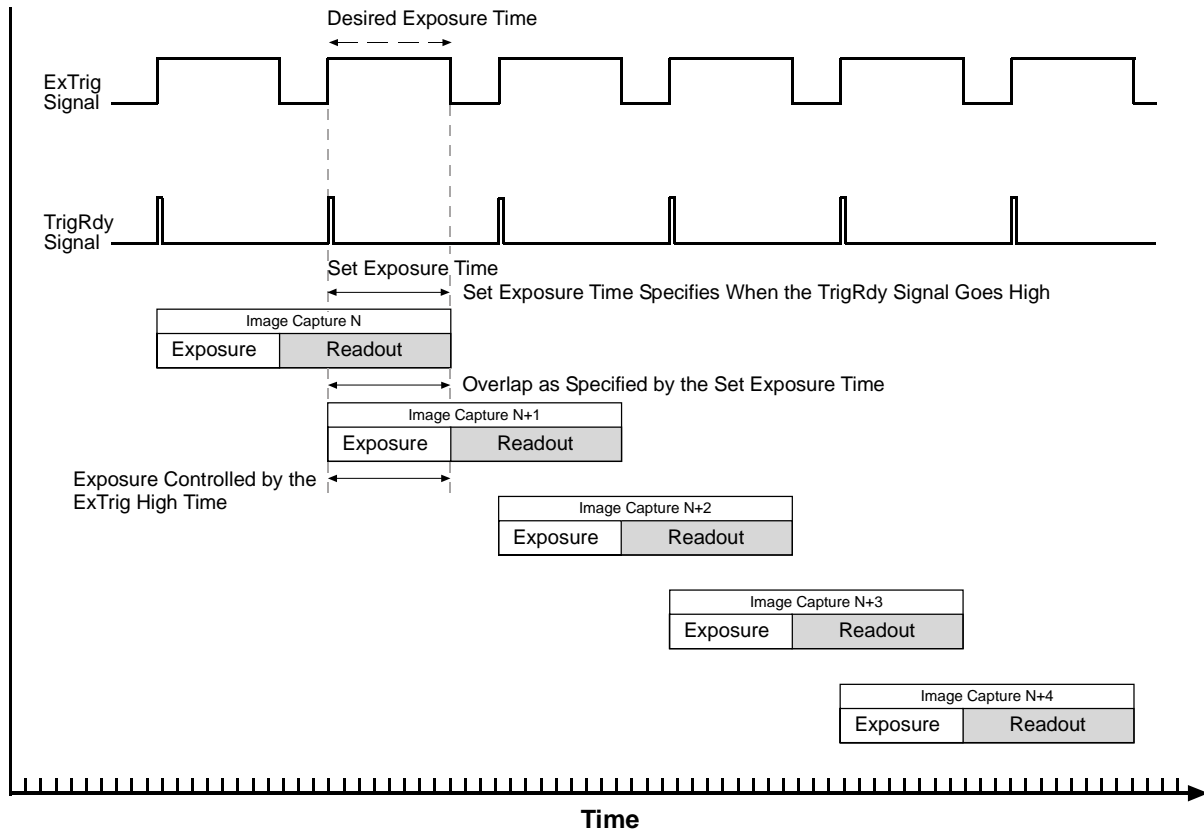


Fig. 1: ExTrig and Level Controlled/Trigger Width Exposure: Maximum Frame Rate

As desired, the ExTrig signal controls exposure start and exposure time. In addition, the maximum frame rate for the desired exposure time is achieved. The optimal performance results from the following settings:

- The ExTrig signal is adjusted to rise at the same time as the TrigRdy signal (guideline one).
- The set exposure time is set to the maximum permitted by guideline two:
 $\text{Set Exposure Time} = \text{Desired Exposure Time}$. Accordingly, there is maximum overlap between image captures, maximizing the frame rate.
- The period of the ExTrig signal is set to the minimum permitted by guideline three:
 $\text{ExTrig Signal Period} = \text{Exposure} + \text{Readout} - \text{Set Exposure Time}$.

Example 2

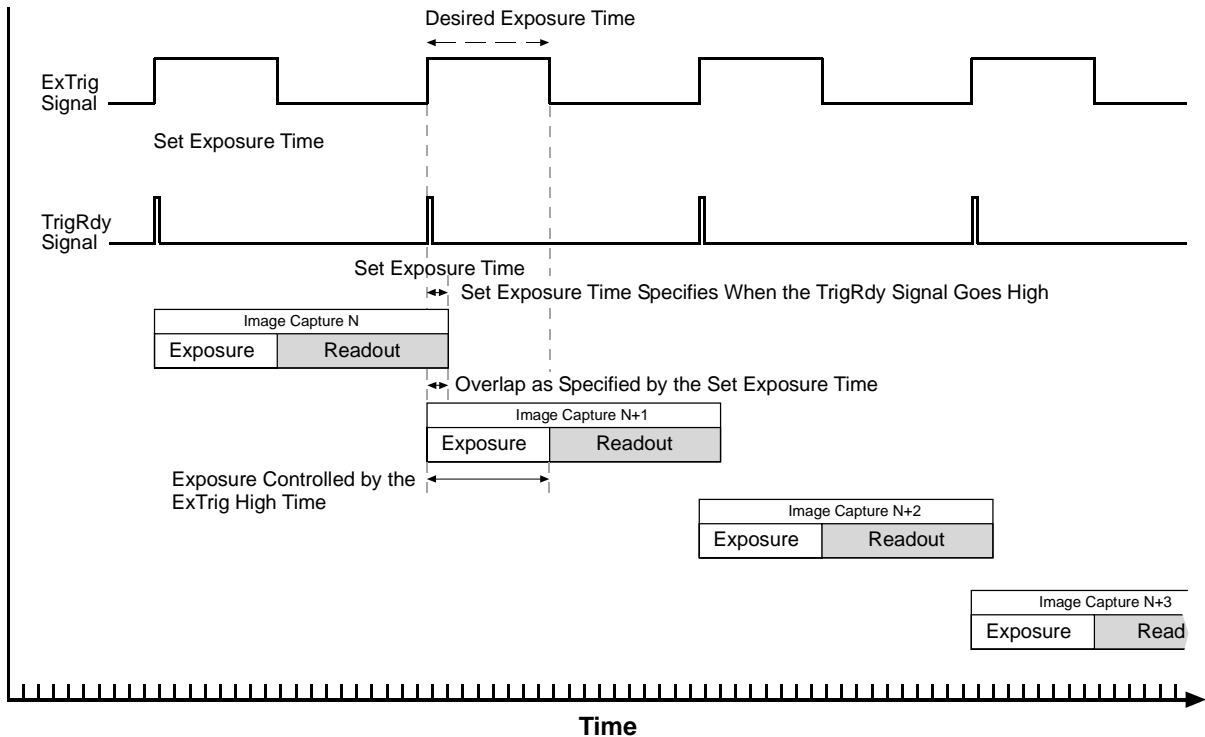


Fig. 2: ExTrig and Level Controlled/Trigger Width Exposure: No Maximum Frame Rate

As desired, the ExTrig signal controls exposure start and exposure time. This results from the following settings:

- The ExTrig signal is adjusted to rise at the same time as the TrigRdy signal (guideline one)
- The set exposure time is shorter than the desired exposure time (guideline two).
- The period of the ExTrig signal is set to the minimum permitted by guideline three:
 $\text{ExTrig Signal Period} = \text{Exposure} + \text{Readout} - \text{Set Exposure Time}$.

The maximum frame rate is, however, not achieved. This is mainly due to the small overlap between image captures. The small overlap results from the short exposure time setting.

You can increase the frame rate by **increasing** the set exposure time (increased overlap) while using an ExTrig signal of shorter period. At the same time, you must ensure the following:

- The set exposure time must not exceed the desired exposure time (guideline two).
- The ExTrig signal period must not be too short (guideline three).

Example 3

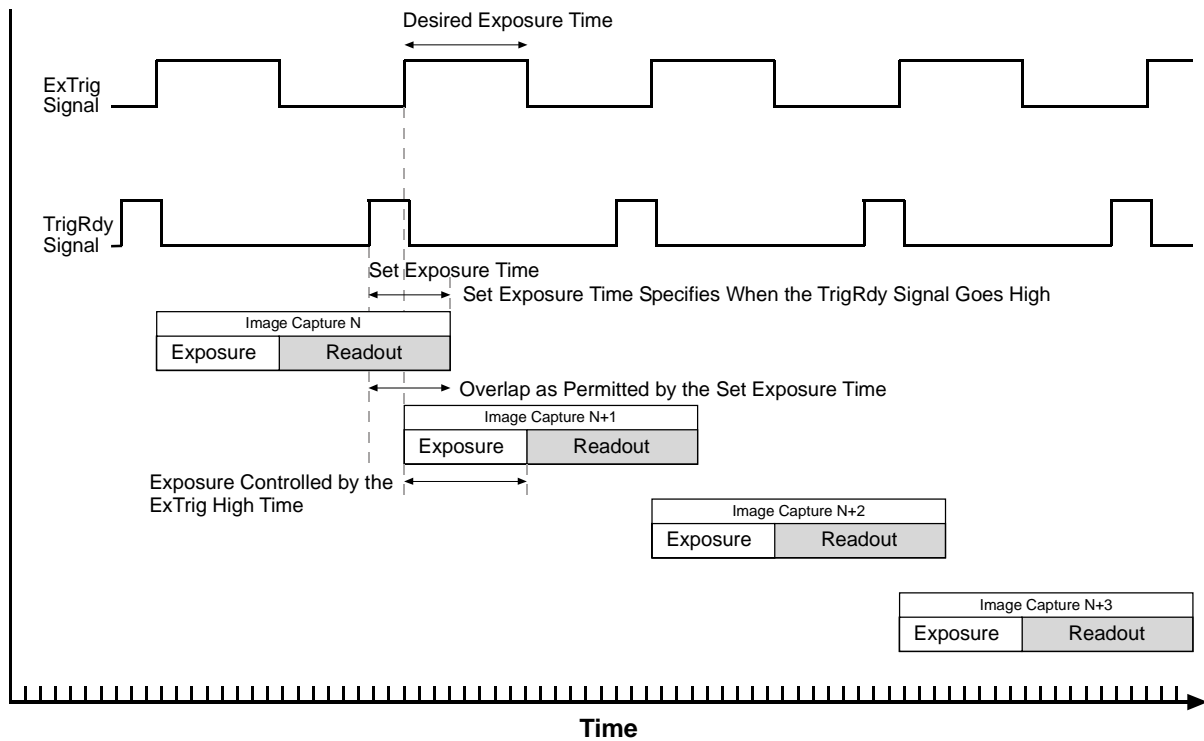


Fig. 3: ExTrig and Level Controlled/Trigger Width Exposure: No Maximum Frame Rate

As desired, the ExTrig signal controls exposure start and exposure time. However, the frame rate is not maximized:

- The ExTrig signal rises after the rise of the TrigRdy signal (guideline one).
- The set exposure time is shorter than the desired exposure time (guideline two).

The maximum frame rate is, however, not achieved. This is mainly due to a long ExTrig signal period.

You can increase the frame rate by **increasing** the set exposure time (increased overlap) while using an ExTrig signal of shorter period. At the same time, you must ensure the following:

- The set exposure time must not exceed the desired exposure time (guideline two)
- The ExTrig signal period must not be too short (guideline three)

Example 4

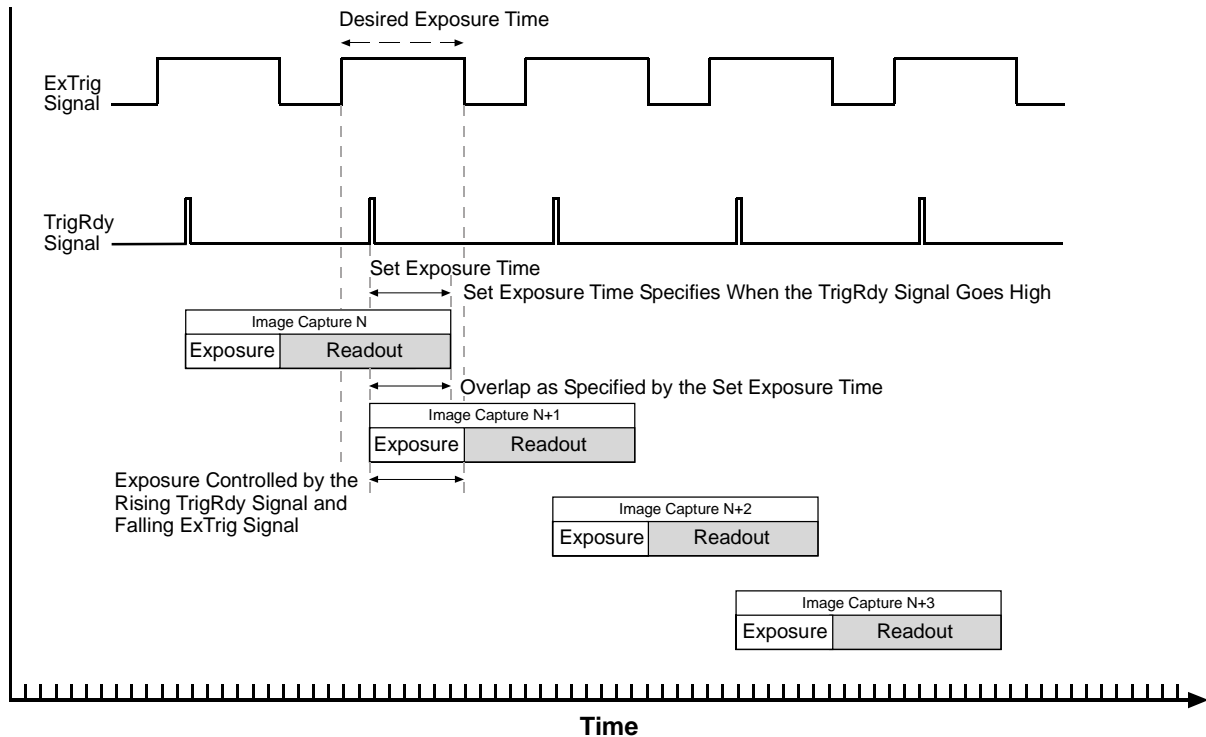


Fig. 4: ExTrig and Level Controlled/Trigger Width Exposure: Premature Rise of the ExTrig Signal

The ExTrig signal does not control exposure start and exposure time:

- The ExTrig signal rises before the TrigRdy signal rises (guideline one is violated). The exposure start is controlled by the TrigRdy signal.
 Note that the period of the ExTrig signal is not too short by the definition of guideline three: In the example shown, $\text{ExTrig Signal Period} = \text{Exposure} + \text{Readout} - \text{Set Exposure Time}$, and therefore guideline three is not violated.
- With the exposure start being controlled by the TrigRdy signal and the end of exposure being controlled by the ExTrig signal, the exposure is shorter than desired.
 Note for the cameras of group one, where the set exposure time specifies the absolute minimum exposure: The set exposure time is shorter than the interval between the rise of the TrigRdy signal and the next fall of the ExpTrig signal. Therefore, the set exposure time does not control exposure.

Solution: Make sure the ExTrig signal rises with or after the rise of the TrigRdy signal (guideline one).

Example 5A (Applies to the Cameras of Group One Only)

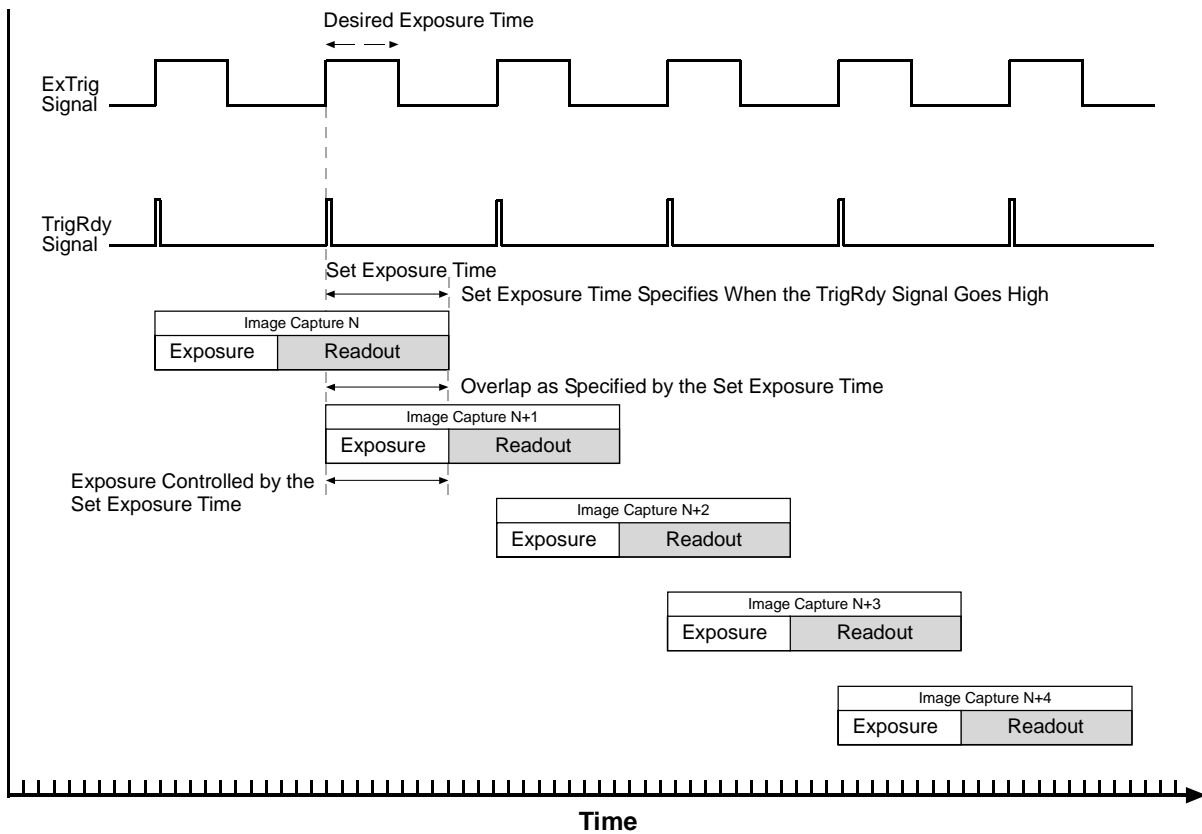


Fig. 5: ExTrig and Level Controlled Exposure: Control by Set Exposure Time

The ExTrig signal does not control exposure time:

- The desired exposure time is shorter than the set exposure time (guideline two is violated). The set exposure time, however, sets the absolute minimum exposure time and therefore controls exposure. The set exposure time also specifies the maximum allowed overlap between image captures.

Solution: Set the exposure time to equal or shorter than the desired exposure time (guideline two) and adjust the ExTrig signal to meet guideline one.

Example 5B (Applies to the Cameras of Group Two Only)

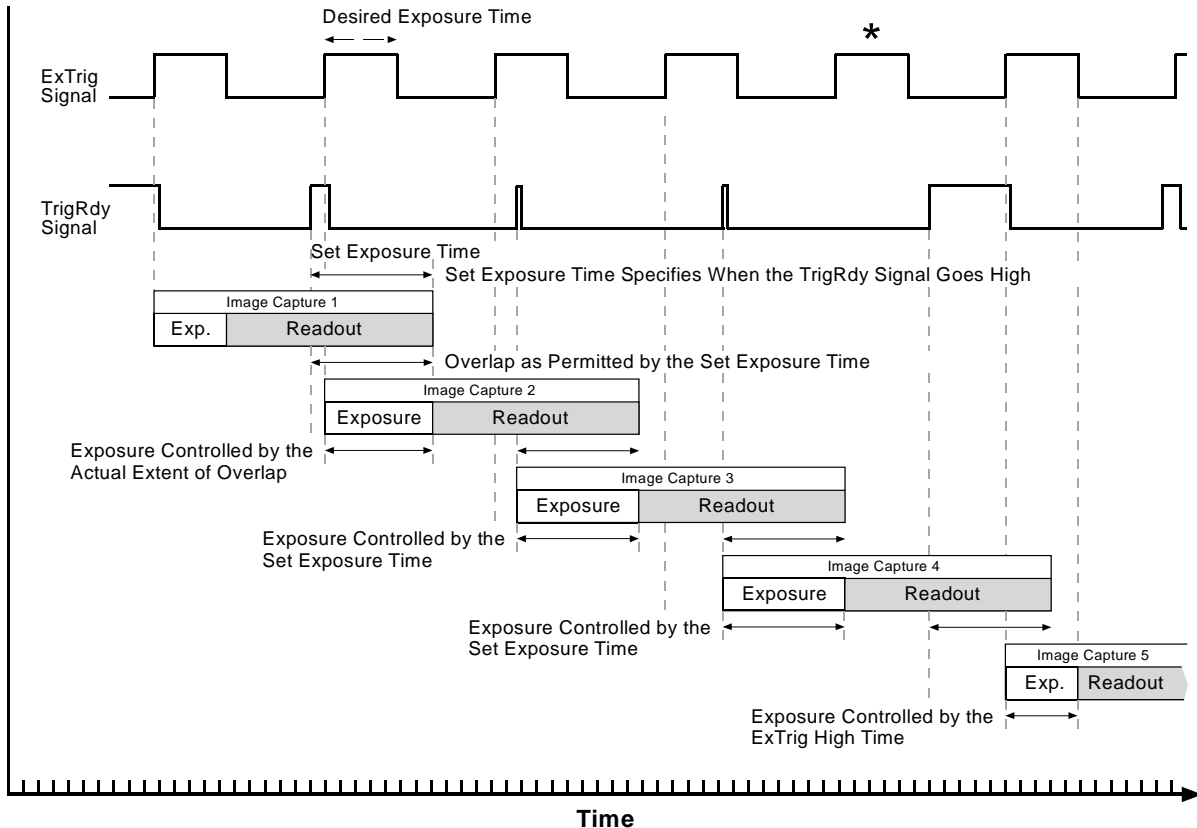


Fig. 6: ExTrig and Trigger Width Exposure: Irregular Behavior

The ExTrig signal does not always trigger one exposure. This situation is marked by the asterisk where the ExTrig signal goes high while exposure for the previous image capture is still in progress. The ExTrig signal only occasionally controls exposure start and exposure time and the overlap between image captures varies:

- The desired exposure time is shorter than the exposure time parameter setting (guideline two is violated).
The exposure time parameter setting does not set the absolute minimum exposure but specifies the maximum allowed overlap between image captures.
- For image captures two, three, and four, guideline three is violated.

Solution: Set the exposure time parameter to be less than or equal to the desired exposure time (guideline two) and adjust the ExTrig signal to meet guideline one.

Example 6

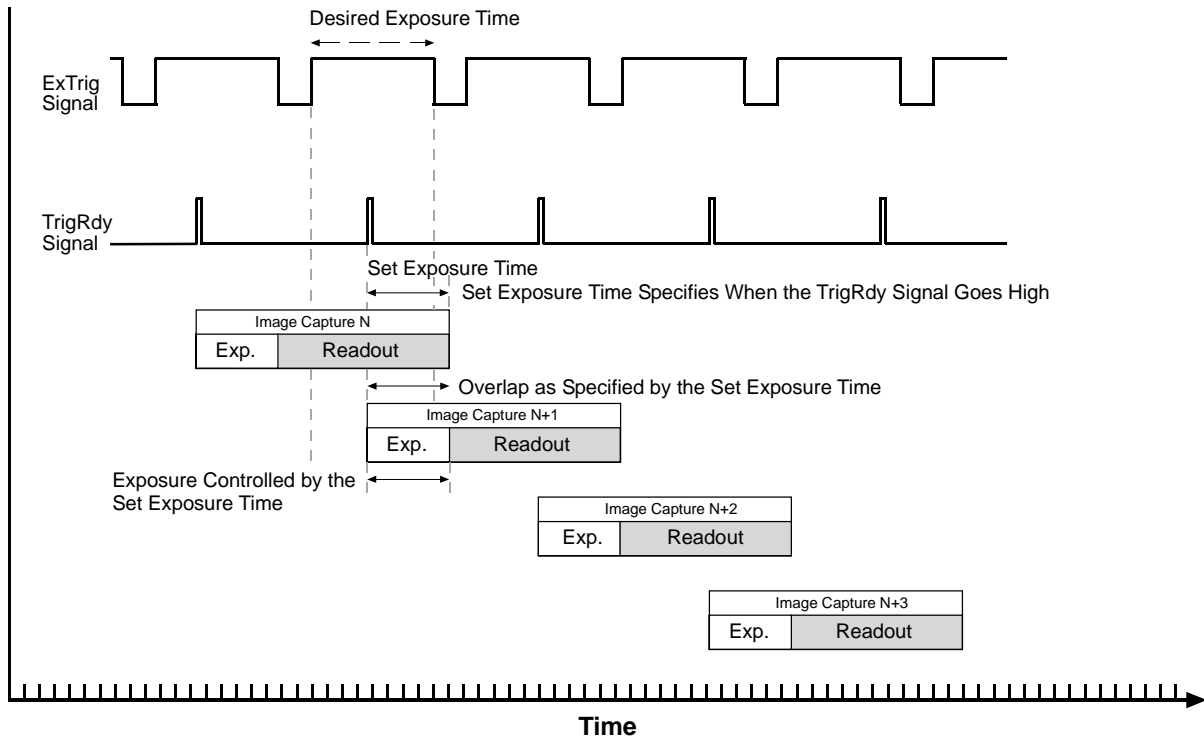


Fig. 7: ExTrig and Level Controlled Exposure: Overtriggering

The ExTrig signal does not control exposure start and exposure time:

- The ExTrig signal rises before the TrigRdy signal rises (guideline one is violated). Accordingly, the exposure start is controlled by the TrigRdy signal.
- The exposure time is controlled by the extent of overlap which is specified by the set exposure time.
- The period of the ExTrig signal is too short (guideline three is violated).

Solution: Make sure the ExTrig signal rises with or after the rise of the TrigRdy signal (guideline one). Increase the period of the ExTrig signal to meet guideline three.

Revision History

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AW00056501000	20 Feb 2008	Initial version.
AW00056502000	30 Jul 2008	Updated contact addresses and phone numbers.

