ADVS200x Demo User Guide

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ANALOG DEVICES

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1 Preface

Thank you for purchasing the Analog Devices, Inc. ADIS1700x Vision-Sensing Camera Module. The ADVS200x is a high dynamic range image sensor that can be used for optimal exposure. It supports accurate data extraction in the most demanding light conditions.

Purpose of This Manual

This manual provides instructions for using the ADVS200x demo software.

Intended Audience

The primary audience for this manual is a programmer who is familiar with the Analog Devices Blackfin+ ADSP-BF70x processor and ADVS200x imager.

For additional information about the Analog Devices camera module, see the *ADIS17001/ADIS17002 Low Power, Small Form Factor Vision-Sensing Camera Module Data Sheet*.

Other applicable documentation for the ADIS17001/ADIS17002 includes:

- *ADSP-BF70x Blackfin+ Processor Hardware Reference*
- *ADSP-BF70x Blackfin+ Processor Programming Reference*
- *ADVS200x Demo User Guide*

Technical Support

You can reach Analog Devices processors and Embedded Vision Sensing technical support in the following ways:

- Post your questions in the Embedded Vision Sensing support community at EngineerZone ®:

  http://ez.analog.com/community/embedded-vision-sensing
- Submit your questions to technical support directly at:

  http://www.analog.com/support

- E-mail your questions about processors, DSPs, and tools development software from ***CrossCore Embedded Studio***® or ***VisualDSP++***®.

  If using CrossCore Embedded Studio or VisualDSP++ choose ***Help*** > ***Email Support***. This creates an e-mail to processor.tools.support@analog.com and automatically attaches your CrossCore Embedded Studio or VisualDSP++ version information and `license.dat` file.

- E-mail your questions about processors and processor applications to:

  processor.tools.support@analog.com

  processor.china@analog.com

- Contact your Analog Devices sales office or authorized distributor. Locate one at:

  http://www.analog.com/adi-sales

- Send questions by mail to:

  Analog Devices, Inc.

  One Technology Way

  P.O. Box 9106

  Norwood, MA 02062-9106

  USA

Product Information

Product information can be obtained from the Analog Devices website.

Analog Devices Website

The Analog Devices website, http://www.analog.com, provides information about a broad range of products - analog integrated circuits, amplifiers, converters, and digital signal processors.

To access a complete technical library for each processor family, go to http://www.analog.com/processors/technical_library. The manuals selection opens a list of current manuals related to the product as well as a link to the previous revisions of the manuals. When locating your manual title, note a possible errata check mark next to the title that leads to the current correction report against the manual.

Also note, MyAnalog.com is a free feature of the Analog Devices website that allows customization of a web page to display only the latest information about products you are interested in. You can choose to receive weekly e-mail notifications containing updates to the web pages that meet your interests, including documentation errata against all manuals. MyAnalog.com provides access to books, application notes, data sheets, code examples, and more.

Visit MyAnalog.com to sign up. If you are a registered user, just log on. Your user name is your e-mail address.

EngineerZone

EngineerZone is a technical support forum from Analog Devices, Inc. It allows you direct access to ADI technical support engineers. You can search FAQs and technical information to get quick answers to your embedded processing and DSP design questions.

Use EngineerZone to connect with other DSP developers who face similar design challenges. You can also use this open forum to share knowledge and collaborate with the ADI support team and your peers. Visit http://ez.analog.com to sign up.

Notation Conventions

Text conventions used in this manual are identified and described as follows. Additional conventions, which apply only to specific chapters, may appear throughout this document.

Example	*Description*
File > ***Close***	Titles in bold style indicate the location of an item within the CrossCore Embedded Studio IDE's menu system (for example, the ***Close*** command appears on the ***File*** menu).
`{this | that}`	Alternative required items in syntax descriptions appear within curly brackets and separated by vertical bars; read the example as `this` or `that`. One or the other is required.
`[this | that]`	Optional items in syntax descriptions appear within brackets and separated by vertical bars; read the example as an optional `this` or `that`.
`[this, …]`	Optional item lists in syntax descriptions appear within brackets delimited by commas and terminated with an ellipsis; read the example as an optional comma-separated list of `this`.
`.SECTION`	Commands, directives, keywords, and feature names are in text with `letter gothic` font.
`filename`	Non-keyword placeholders appear in text with `letter gothic` font and italic style format.
NOTE:	**NOTE:** For correct operation, .. A note provides supplementary information on a related topic.
CAUTION:	**CAUTION:** Incorrect device operation may result if ... **CAUTION:** Device damage may result if ... A caution identifies conditions or inappropriate usage of the product that could lead to undesirable results or product damage.
ATTENTION:	**ATTENTION:** Injury to device users may result if ... A warning identifies conditions or inappropriate usage of the product that could lead to conditions that are potentially hazardous for devices users.

2 ADVS200x Demo Application

The `ADVS200x Demo` application is a UI application that demonstrates the capability of the ADVS200x sensor. It provides a user-friendly interface to interact with a device that has an on-board ADVS200x sensor and is running the SNAP Framework (for example, the ADIS1700x). The application has the following features:

- Configures the device, such as adjusting ADVS200x parameters
- Displays live device output such as the luminance image
- Computes and displays motion and occlusion
- Demonstrates conversion between image and world coordinates (camera calibration)
- Records and plays back videos
- Updates the firmware of the device

The `ADVS200x Demo` application communicates with the device using the SNAP Sensor library. A fully documented API of this library for .Net (Windows) and C++ (Windows and Linux) is available.

User Interface

The ***User Interface*** figure shows the different sections of the user interface.

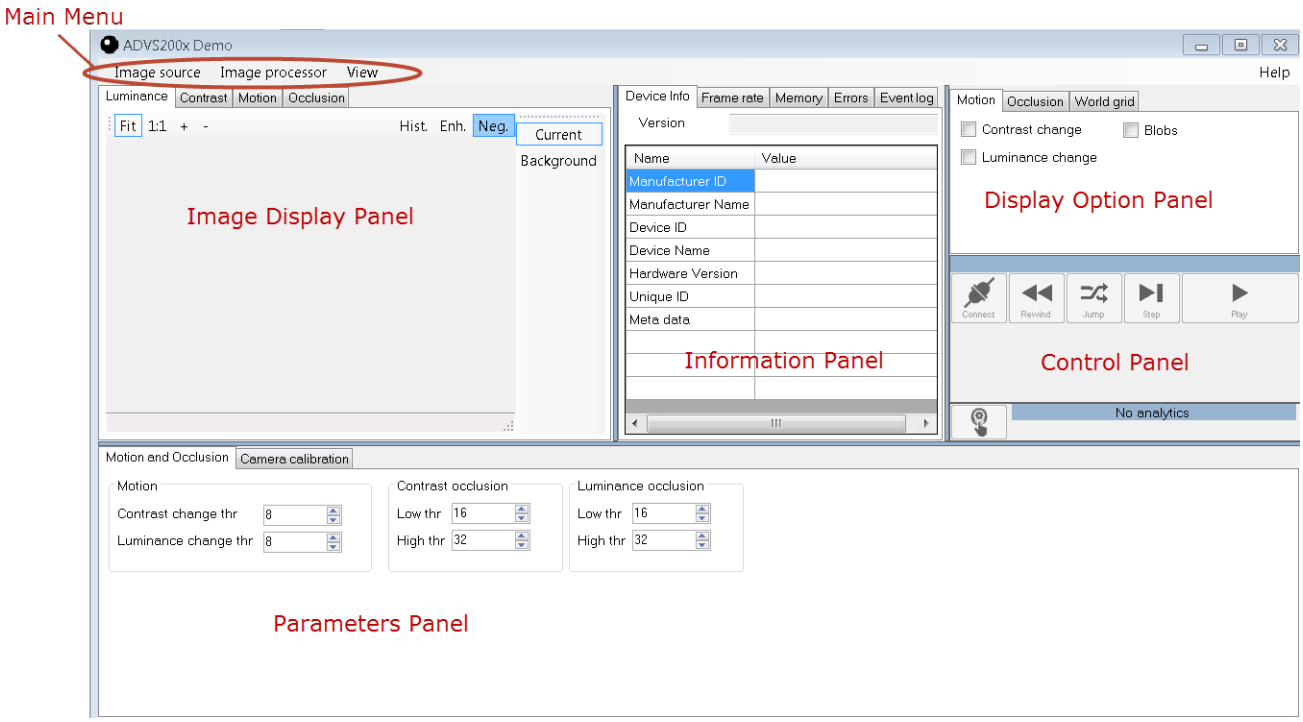


Figure 2-1: User Interface

Connecting to the Device

The following sections describe the steps to connect to the ADVS200x.

- Open a Connection
- Close a Connection

Open a Connection

Complete the following steps to open a connection.

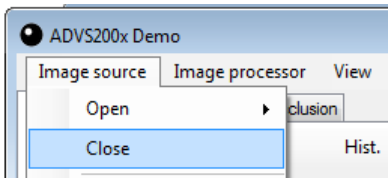
1. Connect the to the PC through the USB port.
2. From the User Interface Main Menu select ***Image source>Open>ADVS200x on USB.***

   The application starts a discovery process to find all the devices connected to the PC. A list of connected devices is displayed.
3. Select the device in the list and click ***Select***.

Close a Connection

Complete the following step to close a connection.

1. From the User Interface Main Menu select *Image source>Close*.



Operating Modes

The User Interface Control Panel allows the user to change modes. The device running the Snap Framework operates in one of four modes: Bootloader (Bootldr), Configuration (Config), Smart Camera (Smart Cam) and Sensor.



Smart Camera Mode

Smart Camera mode is the default mode. In this mode, the device is continuously acquiring luminance images from the ADVS200x. The data is polled by the PC application and displayed.

Configuration Mode

In configuration mode, the device does not collect any image from the ADVS200x. This mode is used by the PC application to allow the user to perform configuration of the device such as setting up the ADVS200x parameters.

Bootloader Mode

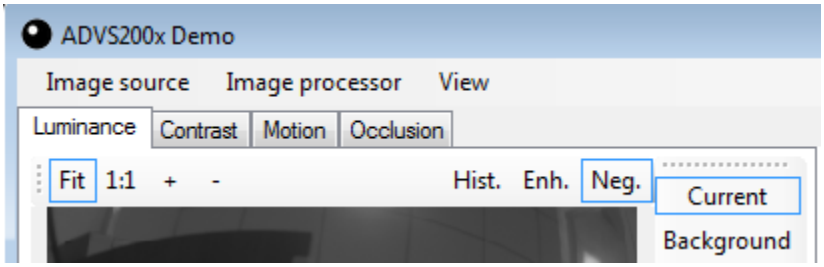
In bootloader mode, a “bootloader” firmware starts running on the device. The ADVS200x is not accessed. This mode is used by the PC application to allow the user to upload new firmware.

ADVS200x Luminance and Contrast Image

A device running the Snap Framework delivers luminance images captured from the on-board ADVS200x sensor. The image has the following properties:

- Image size is QVGA (320 x 240 pixel)
- Each pixel is a 10-bit value (ranging from 0 to 1023), where 0 is the brightest pixel and 1023 is the darkest pixel
- The pixel value is proportional to the log of the light intensity. The value is an indicator of the time the pixel requires to reach a reference voltage

In Smart Camera mode, the ADVS200x Demo application continuously polls for the luminance image. The application displays the image in the User Interface Image Display Panel under the ***Luminance*** tab.



In addition to delivering a luminance image, the ADVS200x sensor can also deliver a contrast image. In a contrast image, each pixel value is an indicator of the difference between the luminance pixel value in the neighborhood of that pixel.

In Smart Camera mode, the ADVS200x Demo application displays the contrast image in the image panel under the ***Contrast*** tab.

The ***Luminance vs. Contrast Image*** figure compares a luminance view of a building with the contrast view of the same building.

Table 2-1: Luminance vs. Contrast Image

Luminance Image	Contrast Image
	

Contrast of a Logarithmic Response Image

The luminance image is a logarithmic response image. (Each pixel value is proportional to the log of the light intensity). A luminance image offers several advantages:

- A high inter-scene dynamic range of up to 130dB
- A contrast that is invariant to the incidence light

Because the ADVS200x sensor can deliver directly, the contrast image offers further advantages:

- Key feature content of the captured scene is pre-computed and delivered
- The processor running image analytics does not need to compute the key feature content. The result is reduced power, memory and cost.

Invariance to Incidence Light Example

Contrast information is independent of the incidence light intensity (for example, ambient light) .

Consider two pixels that lie in the neighborhood of each other: pixel A and pixel B. Pixel A receives light from an object of surface A whose reflectivity is r_A. Pixel B receives light from an object of surface B, whose reflectivity is r_B. Let I be the incidence light falling on the two surfaces.

The light reflected from surface A is $r_A \times I$ and the light reflected from surface B is $r_B \times I$.

The contrast between the two pixel, A and B, for a logarithmic response sensor is proportional to:

Figure 2-2: Logarithmic Response Sensor

$$Contrast_{AB} = \log(r_A I) - \log(r_B I) = \log\left(\frac{r_A I}{r_B I}\right) = \log\left(\frac{r_A}{r_B}\right)$$

As a result, the contrast is dependent only upon the ratio of reflectance between object A and object B. It is independent of the incident light intensity.

Displayed Image Enhancement

In the User Interface Main Menu under the ***Luminance*** tab, select the ***Enh.*** option to display the enhanced image.

The ***Image Enhancement*** figures show the effect of enhancement on an image of a building.

Table 2-2: Image Enhancement

Image Without Enhancement	Image With Enhancement
	

Displayed Image Negation

The luminance image has a value of 0 for the brightest pixel and a value of 1023 for the darkest pixel. Luminance value is an indicator of the time for the pixel to reach a reference voltage. A pixel exposed to a bright light reaches the reference voltage in a shorter period of time and therefore its value is small. A pixel exposed to a dim light reaches the reference voltage in a longer period of time and therefore its value is large.

It is possible to negate the pixel values for displaying. So, a 0 value pixel is displayed bright and a 1023 value pixel is displayed dark.

In the User Interface Main Menu under the ***Luminance*** tab, select the ***Neg.*** option to display the negative image. This option is the default setting when the application is launched.

The ***Image Negation*** figures show the effect of negation on an image of a building.

Table 2-3: Image Negation

Image Without Negation	Image With Negation
	

Image Histogram

In the User Interface Main Menu under the ***Luminance*** tab, select the ***Hist.*** option to display a histogram of the image.

A histogram is computed and updated for each new image displayed. The histogram is displayed below the image as shown in the ***Histogram Example*** figure. The horizontal axis shows the pixel values. The vertical axis shows the number of pixels with a value.



Figure 2-3: Histogram Example

Using Spread

It is possible to select a window in the histogram for displaying the image. Edit the *Spread* parameters to modify a window. The width of the window is defined by the *Spread Bits* value. The position of the window in the histogram is defined by the *Spread Min* value.

For example:

- If *Spread Bits* is set to 7, the window width is 2^7 (for example, 128)
- If the *Spread Min* is set to 154, so the window position is at 154

As a result, the histogram window starts at 154 and ends at 281. In the displayed image all pixels below 154 and above 281 are clipped. The ***Histogram Using Spread*** image shows the modified image and histogram.

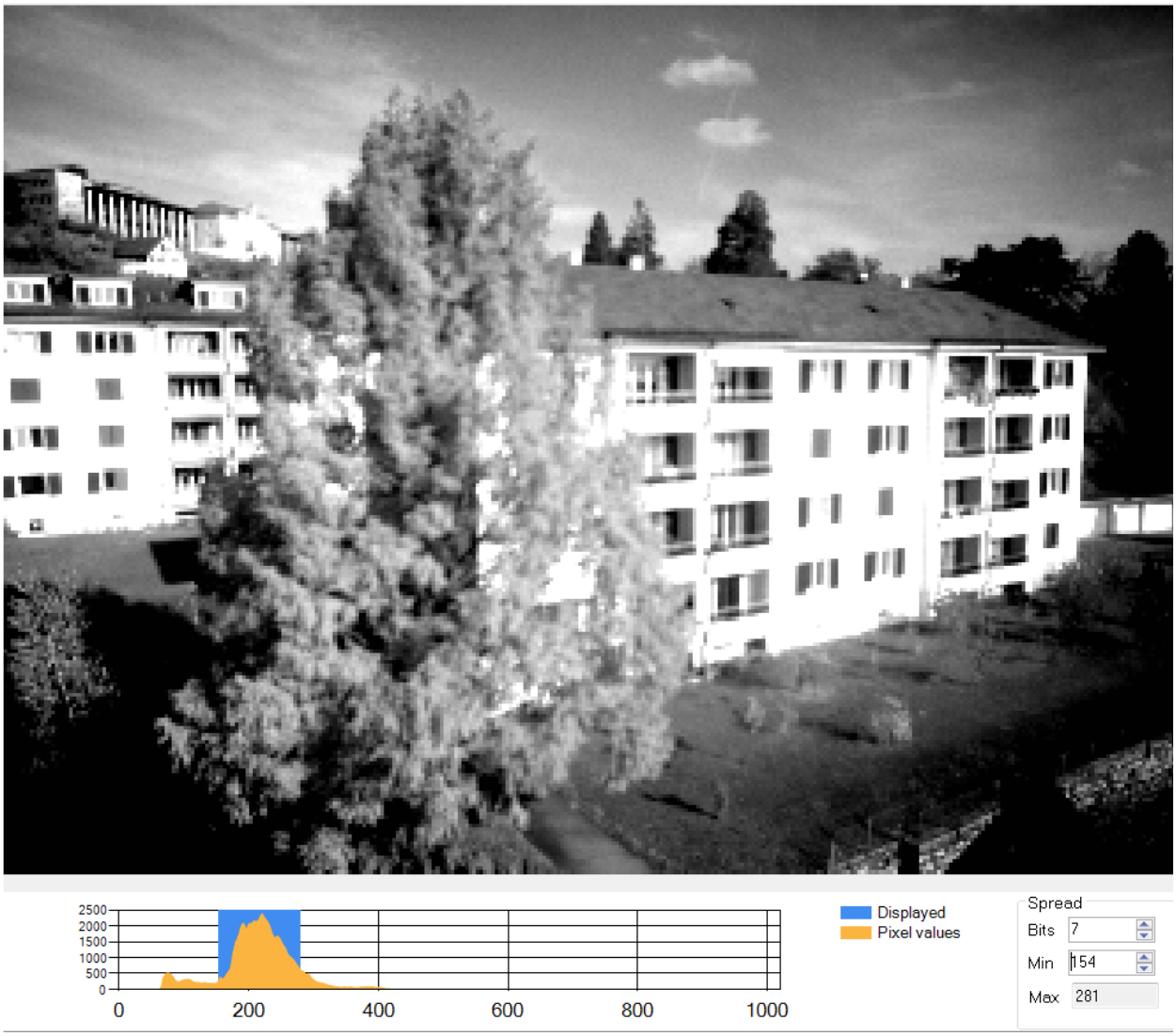


Figure 2-4: Histogram Using Spread

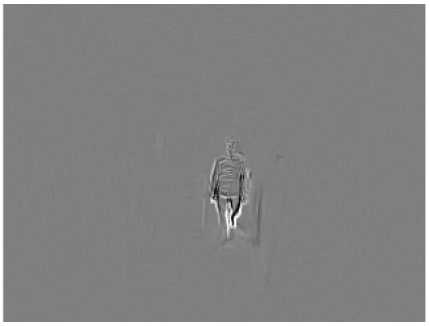
Contrast Change and Motion

The difference between two consecutive contrast images is an indicator of the motion in the scene. Since the contrast pixel values are independent of the incidence light intensity, a change in the contrast would be caused by a change in reflectance (for example, by an object moving).

The ADVS200x Demo application continuously updates the contrast image. For each new contrast image, it computes its difference from the previous one. The contrast change image can be seen in the User Interface Image Display Panel under the ***Motion*** tab.

The ***Image Negation*** table shows the change in contrast for a person walking towards the sensor in an office corridor.

Table 2-4: Image Negation

Image	Luminance	Contrast
First Image		
Second Image		
Difference		

Threshold and Overlay Display

The contrast change pixels can be compared to a user-defined threshold. All pixels that exceed the threshold can be shown as a graphical overlay on the image display.

The contrast change threshold can be modified in the User Interface Parameters Panel under the ***Motion and Occlusion*** tab.

Contrast change pixels that exceed this threshold can be drawn as graphical overlay by checking the ***Contrast change*** option in the Display Option Panel.

The ***Motion Contrast*** figures show the effect of enhancement on an image of a person moving. The red areas of the overlay indicate a change in contrast where the contrast occlusion is rising. The blue areas of the overlay indicate a change in contrast where the contrast occlusion is falling. In effect, the red areas indicate where the object is moving to and blue areas indicate where the object is moving from.

Table 2-5: Motion Contrast

Contrast Without Overlay	Contrast With Overlay
	

Motion Blob Detection

Areas that contain contiguous pixels of contrast change that exceed the contrast threshold are called contrast change blobs (or motion blobs). The analytics can find these areas and compute a bounding eight-sided box (octobox) around these areas.



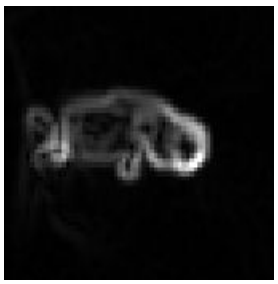
Figure 2-5: Motion Blob Example

In the ***Motion Blob Example*** three people are moving around in a room. The motion of each person is captured as a blob. The blob overlay can be enabled by checking the ***Blobs*** option in the User Interface Display Option Panel.

Contrast Occlusion

The difference between the current contrast image and a “background” contrast image is an indicator or the presence of an object in the scene. The ***Occlusion Image Comparisons*** table shows the differences.

Table 2-6: Occlusion Image Comparisons

	Luminance	Contrast
Current image (with person)		
Background image (without person)		
Difference (occlusion person only)		

The ADVS200x Demo application continuously updates the contrast occlusion image. This image can be seen in the User Interface Image Display Panel under the *Occlusion* tab.

Threshold and Overlay Display

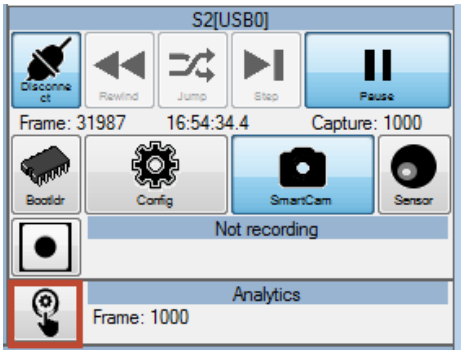
The contrast occlusion pixels can be compared to a user-defined threshold. Typically two thresholds are used (low and high) for hysteresis. All pixels that exceed the high threshold are latched as occluding pixels. They maintain the state as occluding pixels until the occlusion drops below the low threshold.

The contrast occlusion thresholds can be modified in the User Interface Parameters Panel under the *Motion and Occlusion* tab.

Contrast occlusion pixels that are latched as occluding pixels can be drawn as graphical overlay by checking the *Contrast occlusion* option in the User Interface Display Option Panel.

Resetting the Background Image

The first image that is captured from a video file or the ADVS200x is automatically set as the background image. The background image can be reset any time to the current image by clicking ***Reset Analytics***.



Configuring the ADVS200x

The following tasks are associated with configuring the ADVS200x:

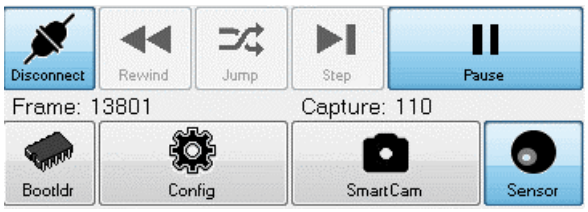
- Modifying ADVS200x Parameters
- Saving and Loading ADVS200x Parameters

Modifying ADVS200x Parameters

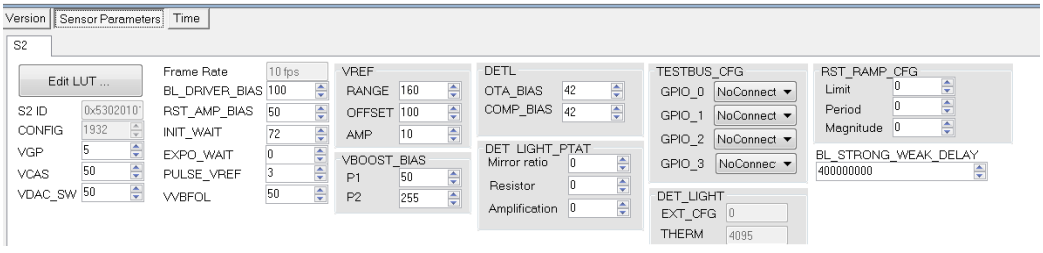
The following steps describe how to edit the ADVS200x parameters.

1. Select Configuration mode.

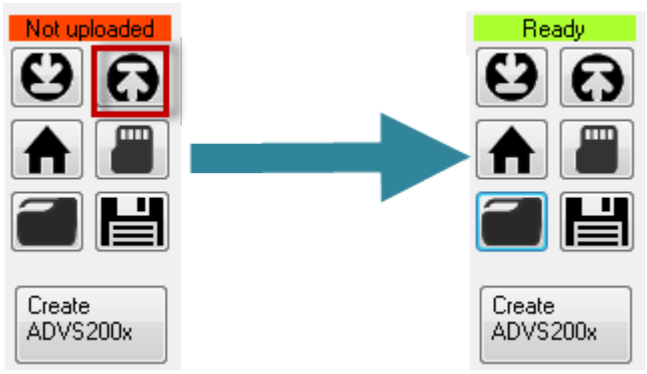
   NOTE: Switching modes can take a few seconds.



2. In the configuration panel select the ***Sensor Parameters*** tab.



3. Modify the parameters, as required.
4. Click ***Upload*** icon to upload the ADVS200x parameters to the device.



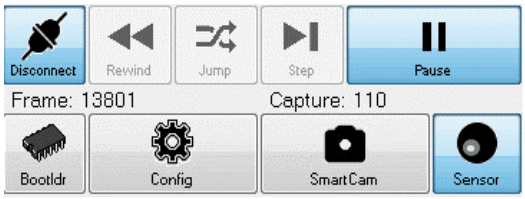
5. Click ***Yes*** when requested to save the data on the device flash.
6. Select Smart Camera mode

Setting the Pre-defined ADVS200x Parameters

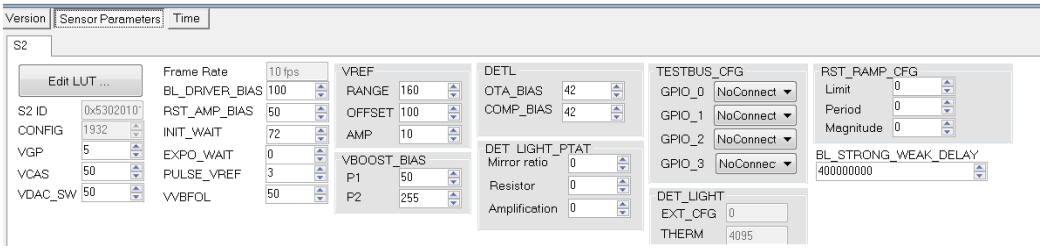
The following steps describe how to set the default ADVS200x parameters.

1. Select Configuration mode.

NOTE: Switching modes can take a few seconds.



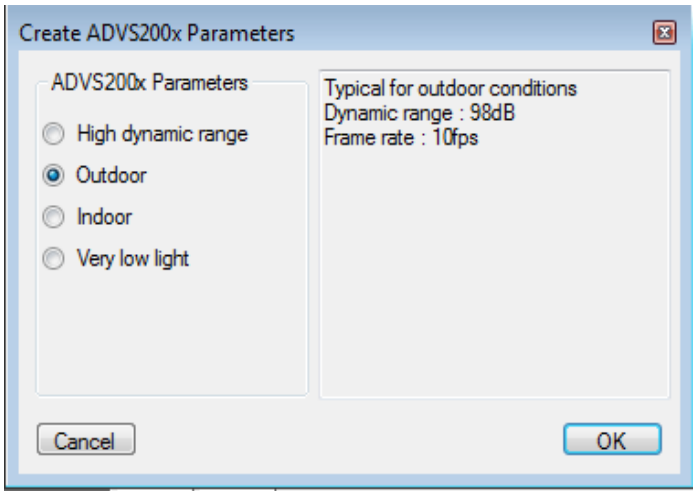
2. In the configuration panel select the ***Sensor Parameters*** tab.



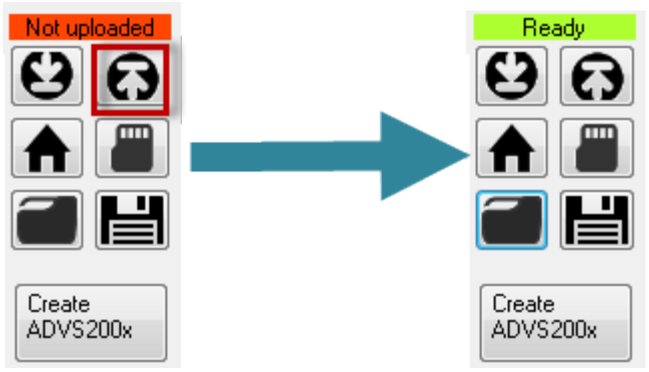
3. Click ***Create ADVS200x***.



4. In the *Create ADVS200x Parameters* window, select the desired pre-defined parameters (high dynamic range, outdoor, indoor or very low light).



5. Click *Upload* to upload the ADVS200x parameters to the device.



6. Click *Yes* when requested to save the data on the device flash.
7. Select Smart Camera mode.

Saving and Loading ADVS200x Parameters

Complete the following steps to save the ADVS200x parameters to a file:

1. Load the ADVS200x Parameters from a file
2. Save the ADVS200x Parameters to a file

Load the ADVS200x Parameters

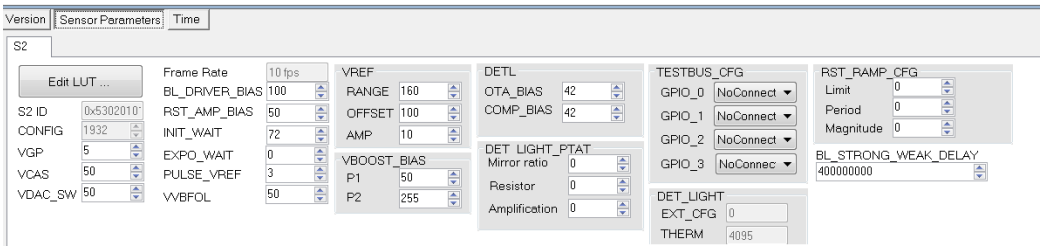
Complete the following steps to load the ADVS200x parameters to a file:

1. Select Configuration mode.

   NOTE: Switching modes can take a few seconds.



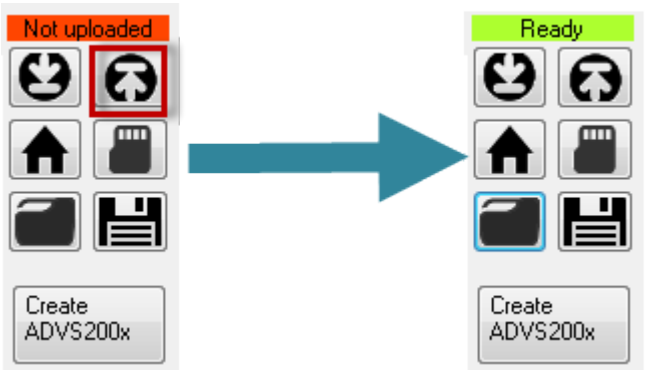
2. In the configuration panel select the ***Sensor Parameters*** tab.



3. Click the ***Load from file*** icon.



4. Click ***Upload*** to upload the ADVS200x parameters to the device.



5. Click *Yes* when requested to save the data on the device flash.
6. Select Smart Camera mode.

Save the ADVS200x Parameters

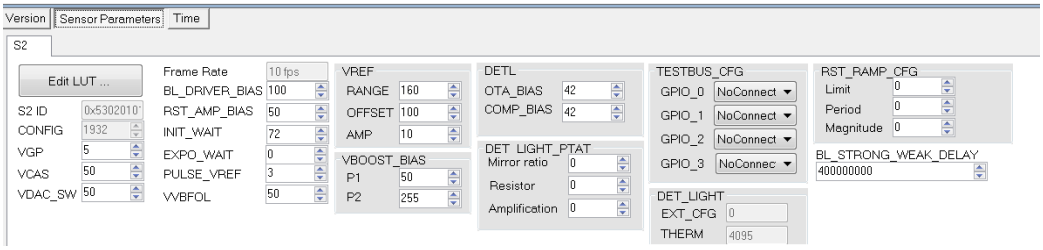
Complete the following steps to save the ADVS200x parameters to a file:

1. Select Configuration mode.

   NOTE: Switching modes can take a few seconds.



2. In the configuration panel select the *Sensor Parameters* tab.



3. Click the *Save to file* icon.



4. Select Smart Camera mode.

Updating Firmware

There are two tasks associated with updating the firmware stored in the device flash storage:

- Update Bootloader Firmware
- Update Application Firmware

When the device powers up, the bootloader firmware is loaded into memory and starts running. The bootloader firmware then looks for the application firmware in the flash storage. It loads it into memory and starts running it.

When the bootloader firmware is running, the application mode is Bootloader.

When the application firmware is running, the application mode is Configuration, Sensor or Smart Camera.

To update the bootloader or application firmware, switch to the Bootloader mode (the bootloader firmware is running).

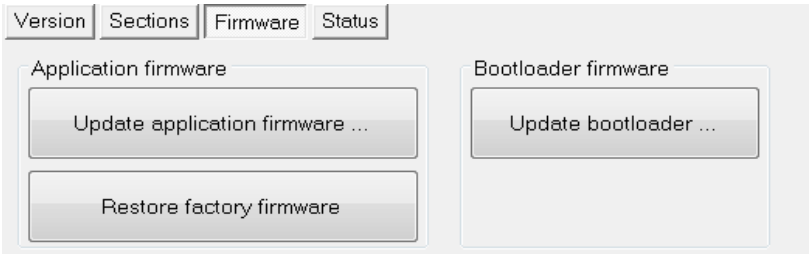
Update Bootloader Firmware

The following steps describe how to update the bootloader firmware.

1. Select Bootloader mode.



2. Select the ***Firmware*** tab.



3. Click ***Update bootloader***.
4. Select the firmware file (for example, *ADIS1700x_Bootloader_vXX.ldr* for ADIS1700x).

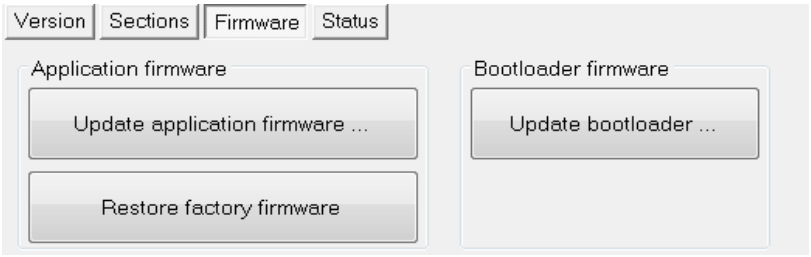
Update Application Firmware

The following steps describe how to update the application firmware.

1. Select Bootloader mode.



2. Select the ***Firmware*** tab.

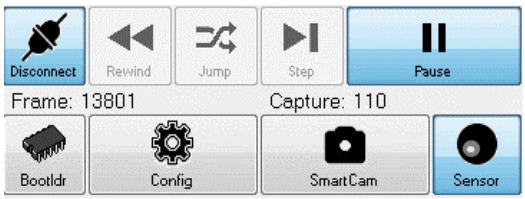


3. Click ***Update application firmware***.
4. Select the firmware file (for example, *ADIS1700x_application_vxx.ldr* for ADIS1700x).

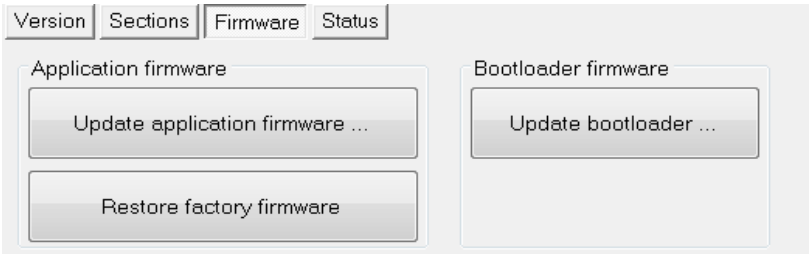
Recovering from a Restore Point

Complete the following steps to recover the original firmware application and its associated data.

1. Select Bootloader mode.



2. Select the ***Firmware*** tab.



3. Click ***Restore factory firmware***.