



# **AFBR-S50**

## **Evaluation Kit Quick Start Guide**

### **User Guide**

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# Chapter 1: Getting Started

## 1.1 Evaluation Kit Overview

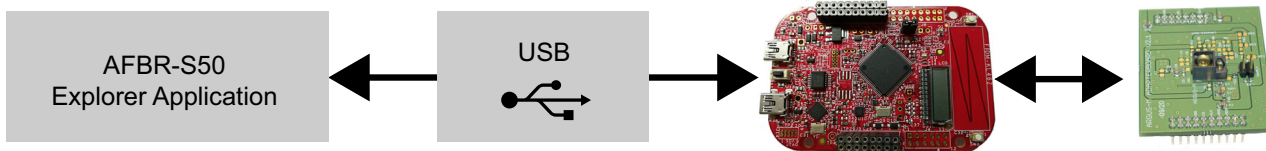
The Broadcom® AFBR-S50 evaluation kit is composed of the following main components:

- NXP FRDM-KL46Z evaluation board: Embedded microcontroller platform (ARM Cortex-M0+) used to read out the AFBR-S50 ToF sensor's data and exchange with the PC.
- AFBR-S50 adapter board: The circuit board on which the AFBR-S50 ToF sensor is mounted. It delivers out-of-box connection between the sensor and a microcontroller board without the need for soldering (just plug and play).
- USB-mini cable: Required to establish a communication between the AFBR-S50 and your system environment (for example, PC, embedded application system).

Download the software development kit (SDK) from the Broadcom website:

<https://www.broadcom.com/products/optical-sensors/time-of-flight-3d-sensors/>

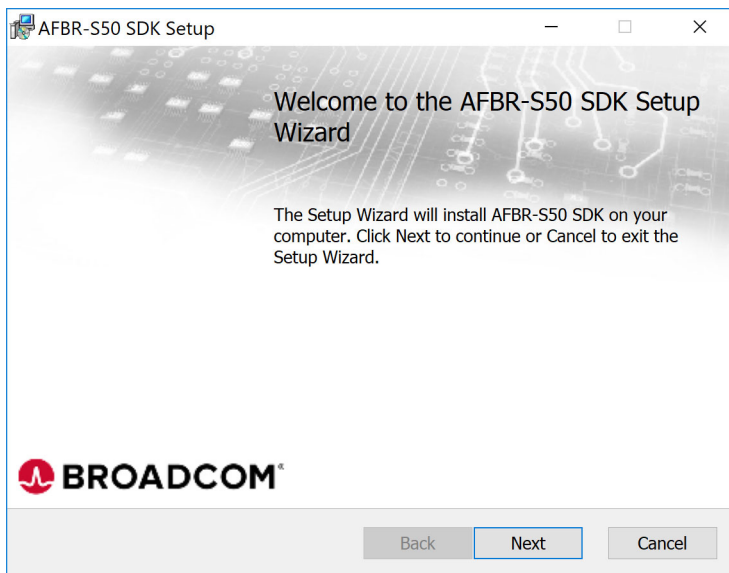
Figure 1: Evaluation Kit Components



## 1.2 Hardware and Software Setup

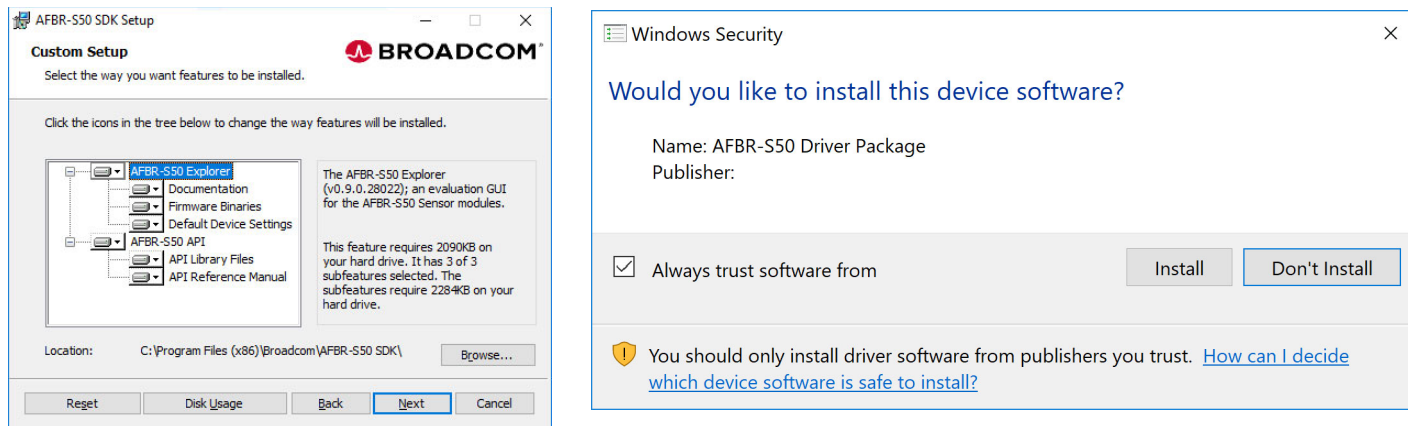
**Step 1:** Install the main application and all necessary drivers by using the AFBR-S50 SDK setup wizard. The initial setup wizard window displays as follows.

Figure 2: Initial Setup Wizard Window



**Step 2:** Install the main driver and all additional modules to enable the full performance of the device:

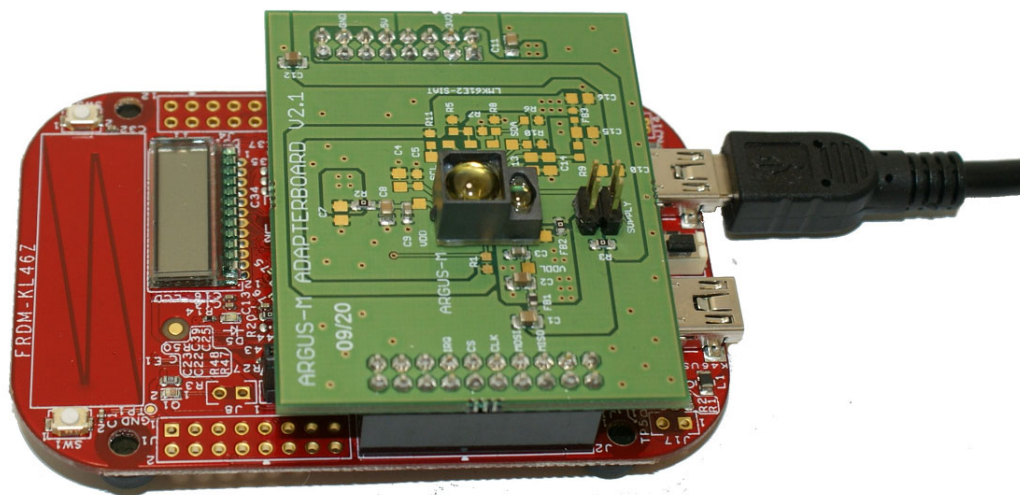
**Figure 3: Installing the Device**



**Step 3:** Plug in the USB cable.

**CAUTION!** The correct USB port for this step is labeled as KL46Z on the bottom side of the NXP board.

**Figure 4: Connecting the USB Cable**



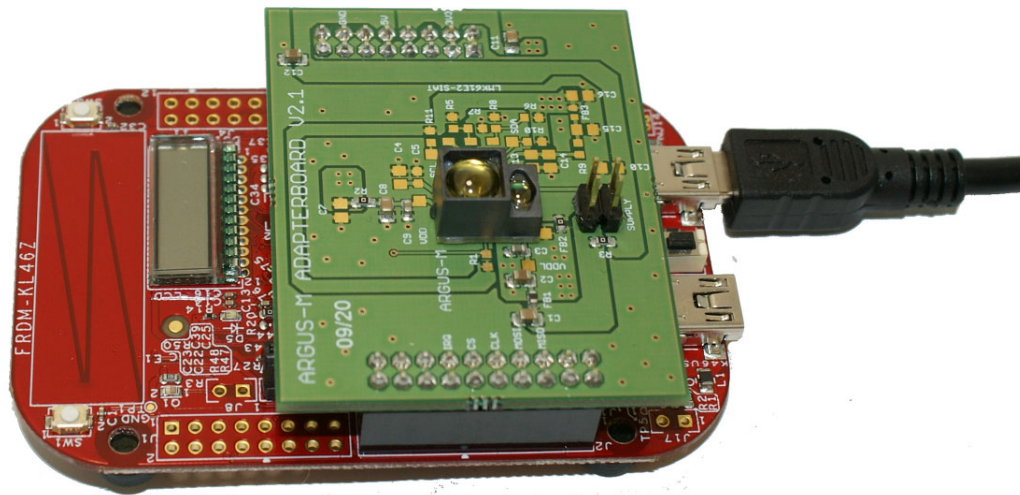
## 1.3 Updating the Device Software

When updating the AFBR-S50 SDK, the software on the evaluation kit must also be updated manually to match with the installed GUI. This is done from the AFBR-S50 Explorer App by performing the following steps:

**Step 1:** Install the desired device software, as described in [Hardware and Software Setup](#), and open the AFBR-S50 Explorer App.

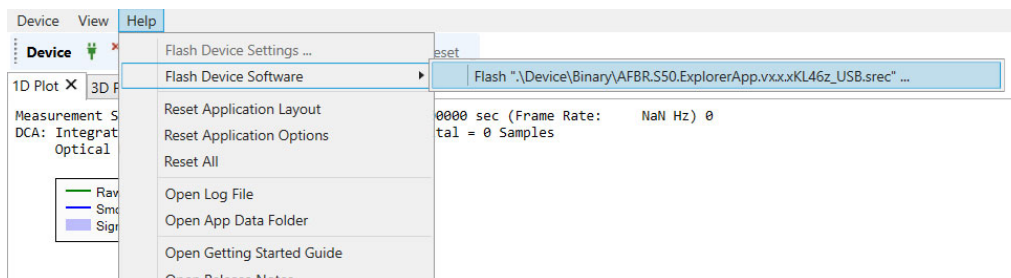
**Step 2:** Connect the red AFBR-S50 evaluation board via the OpenSDA interface to the PC. An additional driver is not required.

**Figure 5: Connecting the Red Evaluation Board with OpenSDA Labeled on the Bottom Side**

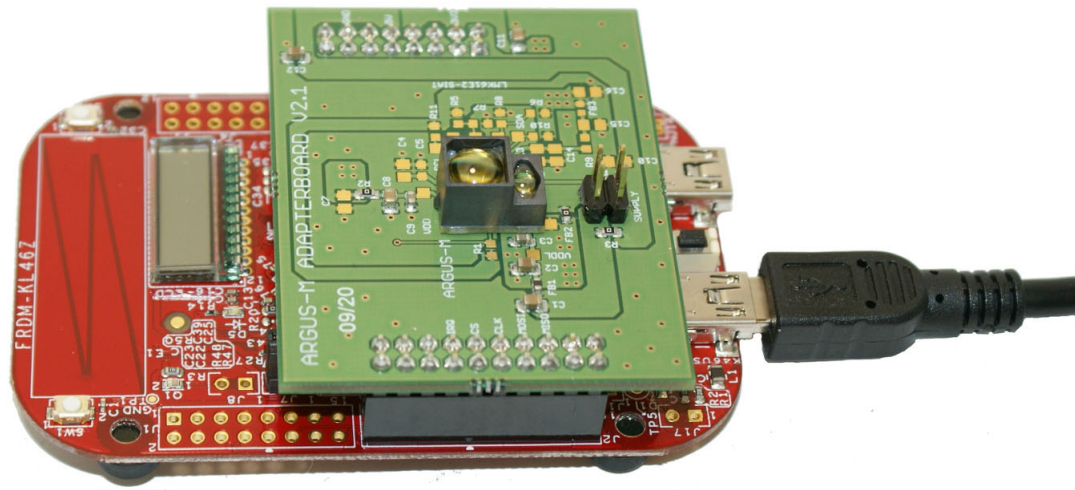


**Step 3:** In the explorer App, go to menu **Help > Flash Device Software > Flash ....** and wait until the device is successfully flashed.

**Figure 6: Flash Device Software Option**



**Step 4:** When flashed successfully, connect the device using the USB port labeled with KL46Z, and run it as described in the following section.

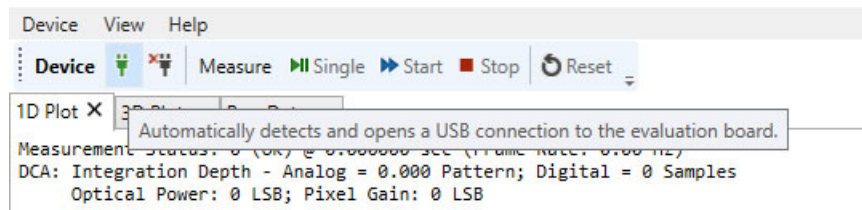
**Figure 7: Connecting the Device Using the USB Port Labeled KL46Z**

## 1.4 Performing a Distance Measurement

**Step 1:** Start the Explorer Application, *AFBR.S50.Explorer.exe*, for example, by clicking **Windows Menu > AFBR-S50 SDK > AFBR S50 Explorer**.

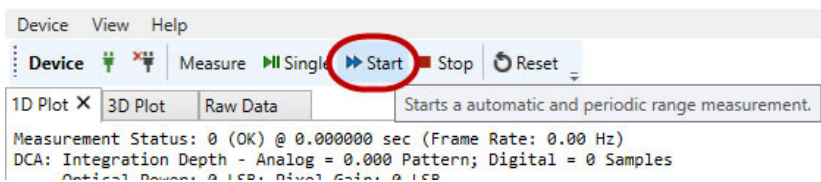
**Step 2:** Open a USB connection by clicking the green plug symbol.

**Figure 8: Green Plug Symbol**



**Step 3:** Start the measurement by clicking **Start**.

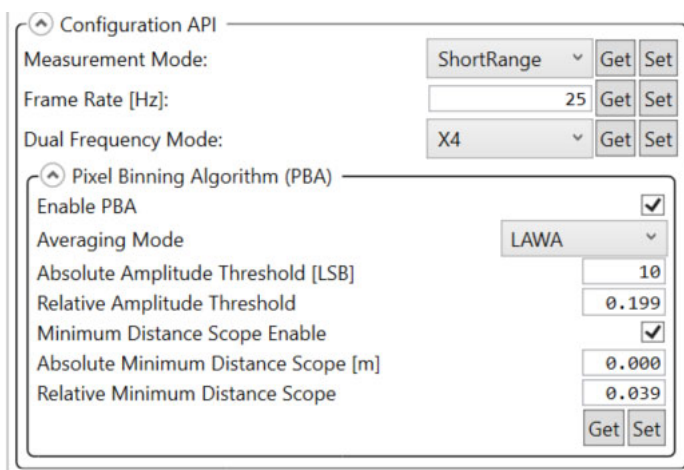
**Figure 9: Starting the Measurement**



**ATTENTION:** To troubleshoot problems with starting the measurement, see [Troubleshooting and FAQs](#).

**Step 4:** Optionally, set up the device to your needs by choosing, for example, a measurement mode and frame rate both before and while measuring.

**Figure 10: Measurement Mode after a USB Connection Has Been Opened**



**NOTE:** Information from the Configuration API section is loaded when a device is successfully connected to the explorer app.



## Chapter 2: AFBR-S50 Explorer

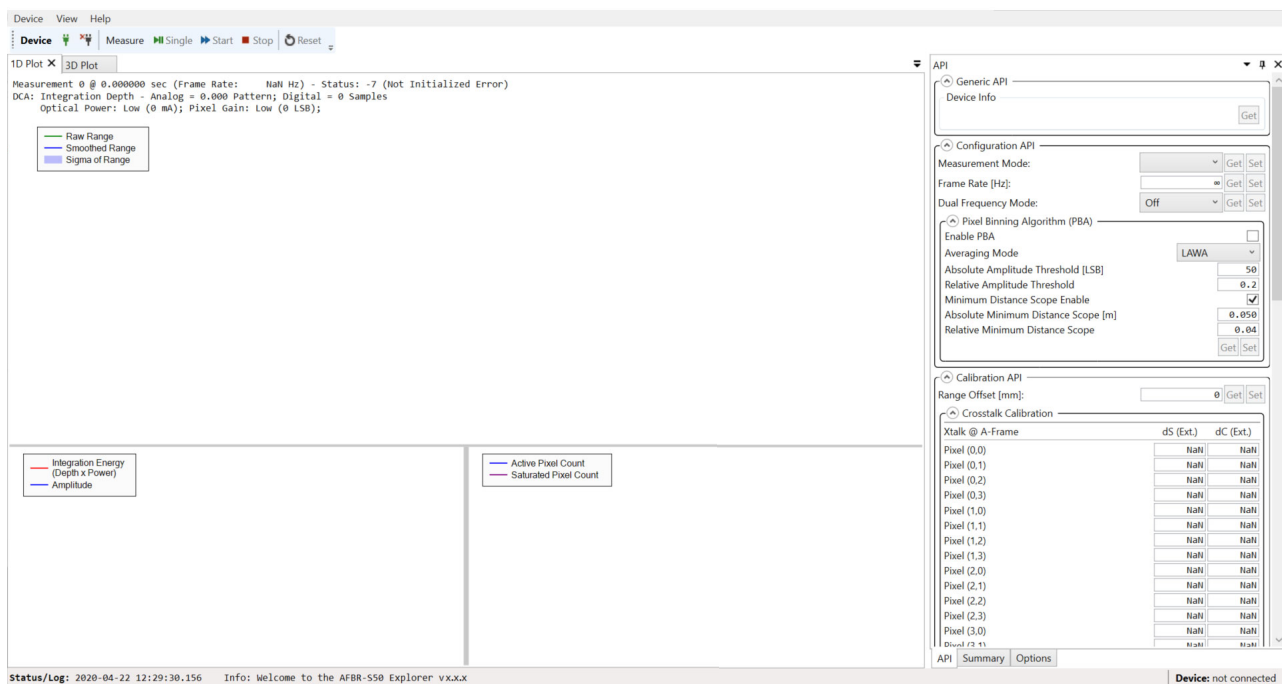
This section is intended to make the user familiar with the graphical user interface (GUI) of the AFBR-S50 Explorer application and support the evaluation of a given ToF sensor device.

The AFBR-S50 Explorer software connects to the AFBR-S50 evaluation board using the USB interface. It receives the measurement data from the device software running on the NXP board's microcontroller and displays it in a convenient way. Furthermore, the ToF sensor device can be configured and calibrated by using the AFBR-S50 Explorer GUI.

### 2.1 AFBR-S50 Explorer Overview

Open the AFBR-S50 Explorer. The following screen displays.

**Figure 11: AFBR-S50 Explorer Display Screen**



The AFBR-S50 Explorer main window consists of the following five basic elements:

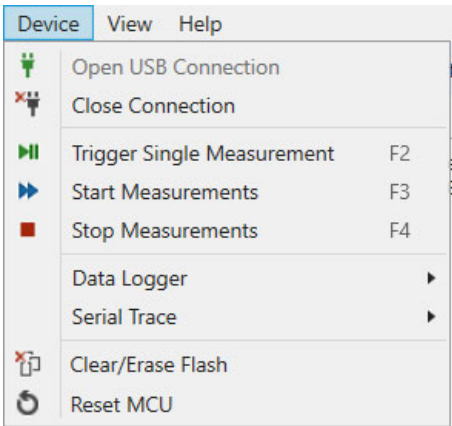
- Menu bar
- Controller tool bar
- Data visualization windows
- Tool windows
- Status bar

## 2.2 Exploring the Menu Bar

The AFBR-S50 Explorer menu bar includes the following three elements:

- Device
- View
- Help

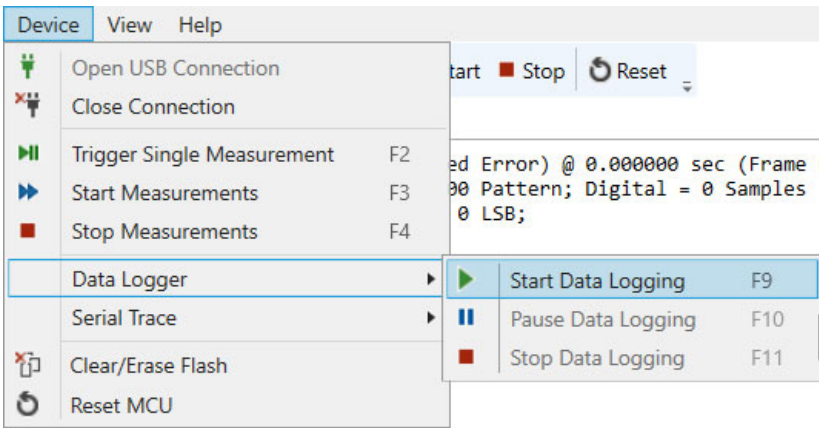
Figure 12: Device Menu



From the Device menu, options are available to open and close the USB connection, trigger measurements, create a log data file over a data logger to store measurement data, monitor and store the communication of the serial interface, and, once connected, reset the microcontroller on demand.

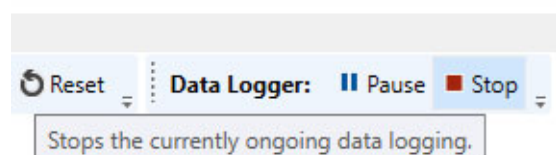
All data measured by the ToF sensor device can be logged to a file for plotting and evaluating the measurement results. The log file is saved to the entered path.

Figure 13: Data Logging Options

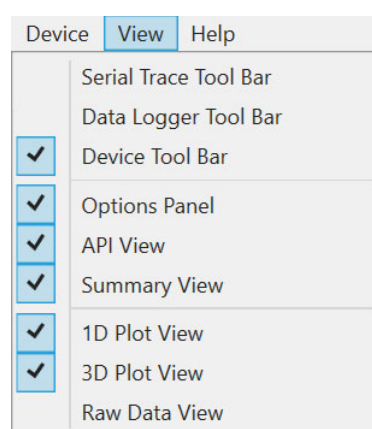


The data logger starts recording once a destination path and file are chosen. In addition, another small menu bar for the data logger is available.

After clicking **Stop**, a message appears in the explorer application with the information and the saved number of samples.

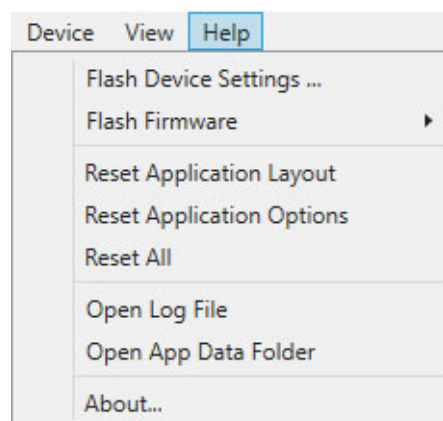
**Figure 14: Data Logger Recording Options**

For formatting reasons, open the created log file either with an advanced text application (for example, Notepad++) or import it directly into a data analysis program. Another helpful debug feature is to perform a Serial Trace of all the bus transfers between the microcontroller and the connected device. After the start of a Serial Trace, the application asks for a path to save the Serial Trace Data. Both the Measurement Log Data and the Serial Trace are saved as .txt files.

**Figure 15: View Menu**

Single view modules can be enabled or disabled in the Explorer app with the **View** menu.

The Help Menu is used to flash the AFBR-S50 device software to the connected microcontroller, open recently logged data, reset the application values to default, and find information on the GUI itself.

**Figure 16: Help Menu**

The AFBR-S50 Controller Tool Bar gives quick access to the most important operation elements regarding measurement and Reset of the microcontroller. On the left it delivers a simple connect and disconnect menu to open up a connection via USB port to the microcontroller on the evaluation kit board.

- Single: Sends a trigger signal to the device to perform a single measurement frame. Afterwards the device goes to idle state.
- Start: Starts a periodic measurement loop.
- Stop: Stops the periodic measurement loop and makes the device go to idle state. Note that this only stops the measurement loop and prevents new measurements to be triggered. However, it does not stop a currently ongoing measurement frame.

**Figure 17: AFBR-S50 Controller Tool Bar**



## 2.3 Measurement Views

Below the AFBR-S50 Controller Tool Bar, all measurement data gathered by the ToF sensor device can be displayed in three different views: 1D Plot, 3D Plot, and Raw Data. Each of the three views are discussed in the next sections and contains information on:

Measurement Status gives information on the timestamp of the measured signal, the corresponding frame rate, the Dynamic Configuration Adaption (DCA, the number of Digital averaging Samples), optical power, and the pixel gain.

**NOTE:** The displayed Frame Rate may differ depending on the characteristics of your serial connection (for example, USB cable length, and so on).

**Figure 18: Measurement Status Example**

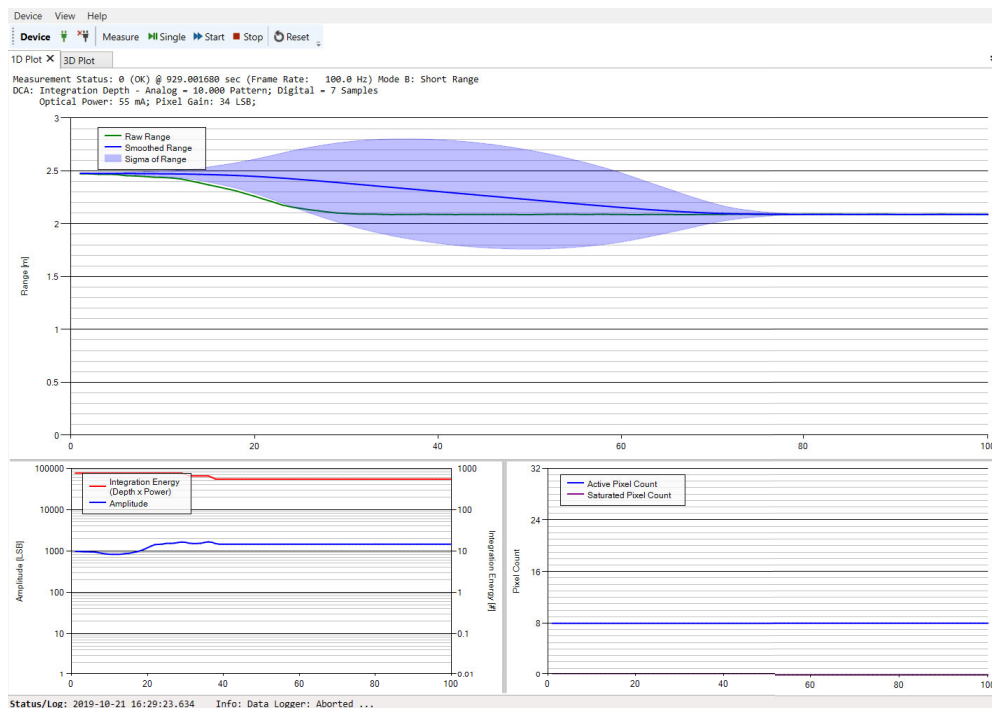
```
Measurement Status: 0 (OK) @ 3552.554128 sec (Frame Rate: 25.00 Hz)
DCA: Integration Depth - Analog = 8.000 Pattern; Digital = 32 Samples
Optical Power: 31 LSB; Pixel Gain: 15 LSB
```

### 2.3.1 1D Plot View

The 1D Plot View consists of three plots and shows the measurement data in real time. It is the standard measurement view displayed after the first start of a measurement. The x-axis for every chart inside the 1D plot View reflects the number of measurement samples.

- Range Plot
- Amplitude Plot
- Pixel Count Plot

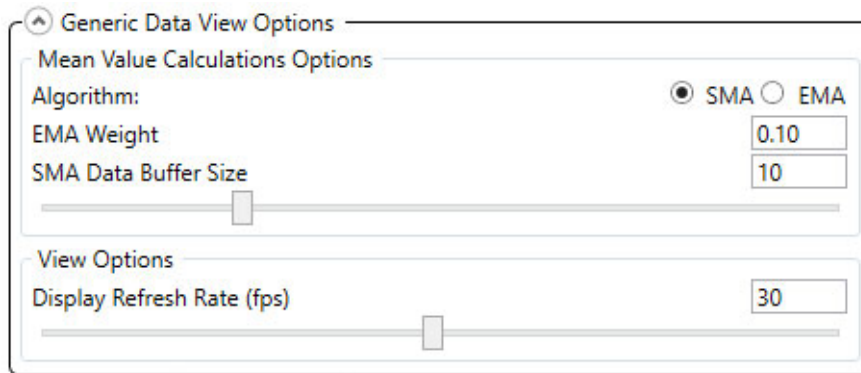
**Figure 19: 1D Plot View GUI**



The Range plot element of the 1D Plot View is able to display up to four different range plots:

- **Binned Range:** Plots the average range over all pixels that are determined by the pixel binning algorithm. This value represents the current range in meters.
- **Smoothed Binned Range:** Plots a time based moving average of the Binned Range. To adjust the algorithm of the time-based moving average, go to the 1D Plot Options View inside the Options tab. A greater SMA data buffer size may result in a slower moving visualization.

**Figure 20: Generic Data View Options**



Choose between two different algorithms used for calculation of the averaged measurement results:

- **Simple Moving Average:** The mean calculated of the previous N data without any weighting. The SMA Data Buffer Size defines the magnitude used for SMA calculations.
- **Exponentially Weighted Moving Average:** A type of an infinite impulse response filter that applies exponentially decreasing weighting factors. The weighting for each older datum decreases exponentially but never reaches zero. EMA Weight implies the quantifier used for the calculation of the EMA. Lower values result in less weighting of past measurement outcome and thus longer averaging times.
- **Sigma of Binned Range:** The blue cloud determines the current time based on moving the standard deviation of the sensor signal; inside the 1D Plot Options, choose between a deviation width of 1 Sigma and 3 Sigma.

**Figure 21: 1D Plot Options**

Options

1D Plot Options

Top Chart

- ☒ Raw Range
- ☒ Smoothed Range
- ☒ Sigma of Range
  - ☐ 1 Sigma
  - ☒ 3 Sigma

Max. Range [m]: 3.00

Min. Range [m]: 0.00

☒ Auto Scaling

Left Chart

- ☒ Amplitude
- ☒ Integration Energy
- ☐ Digital Integration Depth

Center Chart

- ☐ Object Angle X
- ☐ Object Angle Y

Right Chart

- ☒ Active Pixel Count
- ☒ Saturated Pixel Count
- ☐ Plot Valid Data Only

Plot Data Buffer Size 100

The different plots of the Range plot element can be turned either on or off by selecting the respective check boxes inside the Options Panel. It is also possible to change the minimum and maximum displayed range of the respective axis or select the Auto Scaling option.

Figure 22: 1D Plot Options

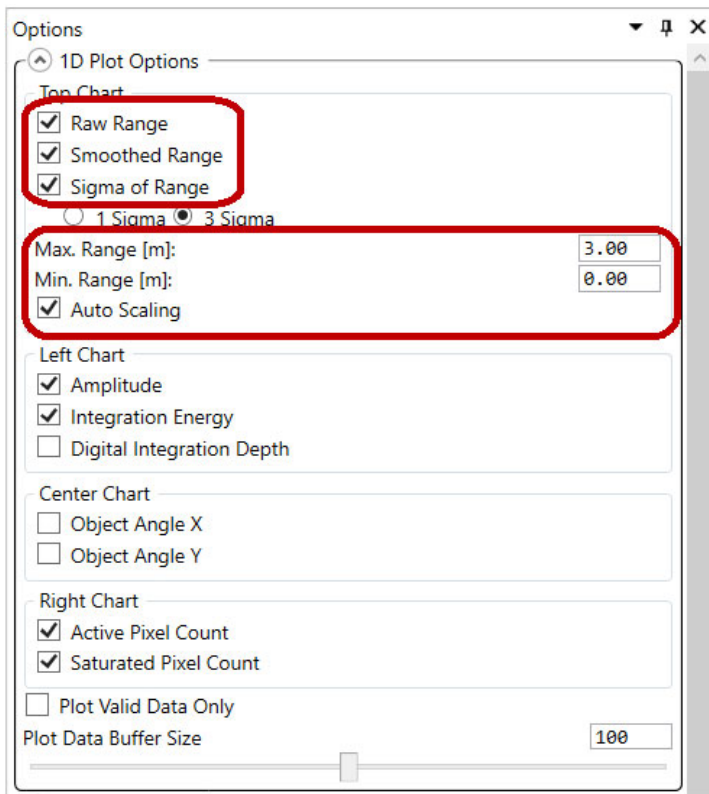
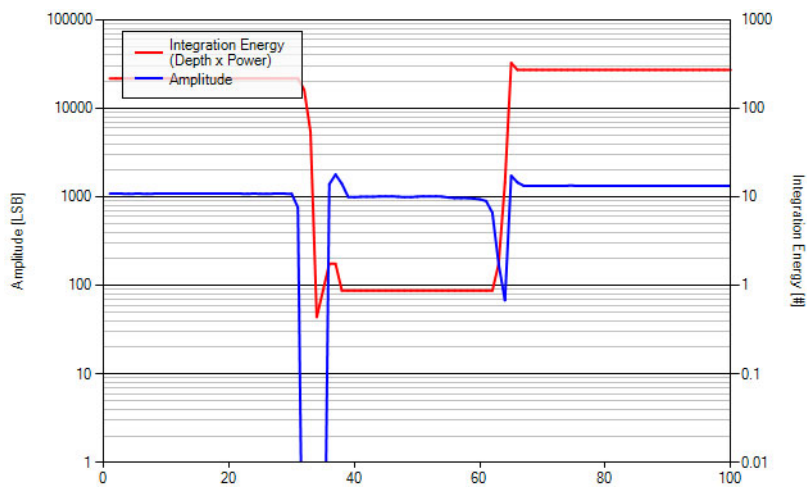
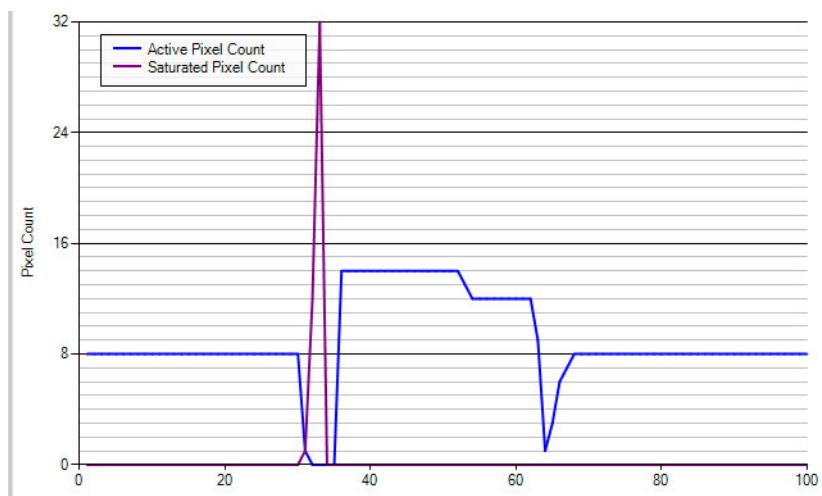


Figure 23: 1D Plot Example



- Integration Energy: Calculated by the integration depth per sample times the optical output power.
- Amplitude (Maximum) Plot: Shows the current maximum measurement signal amplitude which is determined by averaging all pixels that are selected by the Pixel Binning Algorithm.
- Amplitude (Average) Plot: Shows the current maximum measurement signal amplitude which is determined by averaging all pixels that are selected by the Pixel Binning Algorithm.



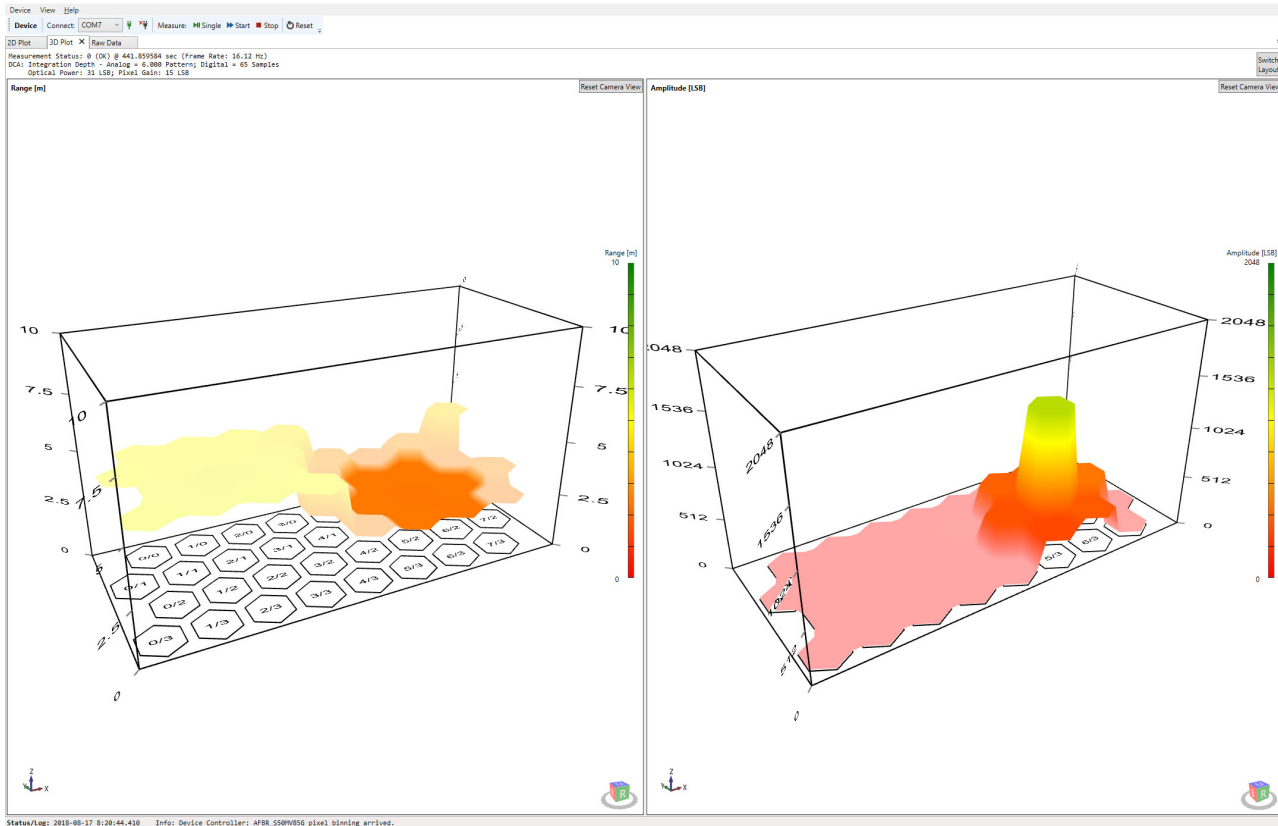
**Figure 24: Active Pixel Count vs. Saturated Pixel Count**

- **Active Pixel Count:** The value of Active Pixel Count reveals the number of pixels that are used for calculating range and amplitude with respect to the current Pixel Binning Algorithm.
- **Saturated Pixel Count:** The value of Saturated Pixel Count reveals the number of pixels being in saturation state due to too much optical power received.

## 2.3.2 3D Plot View

The second tab of the Data Visualization Window opens the 3D Plot View revealing more pixel-specific information on the measured range and amplitude in real time:

**Figure 25: 3D Plot View**



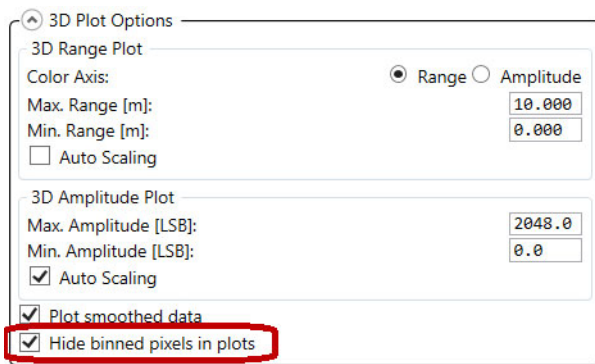
This 3D Plot View shows the retrieved measurement signal of every single pixel of the sensor's pixel matrix.

- **3D Range:** The left plot shows the time based average range values for each available pixel.
- **3D Amplitude:** The right plot inside the 3D plot view shows the time based average amplitude values for each available pixel.

There is also a Color axis for each of the two 3D plots that highlights the corresponding signal magnitude.

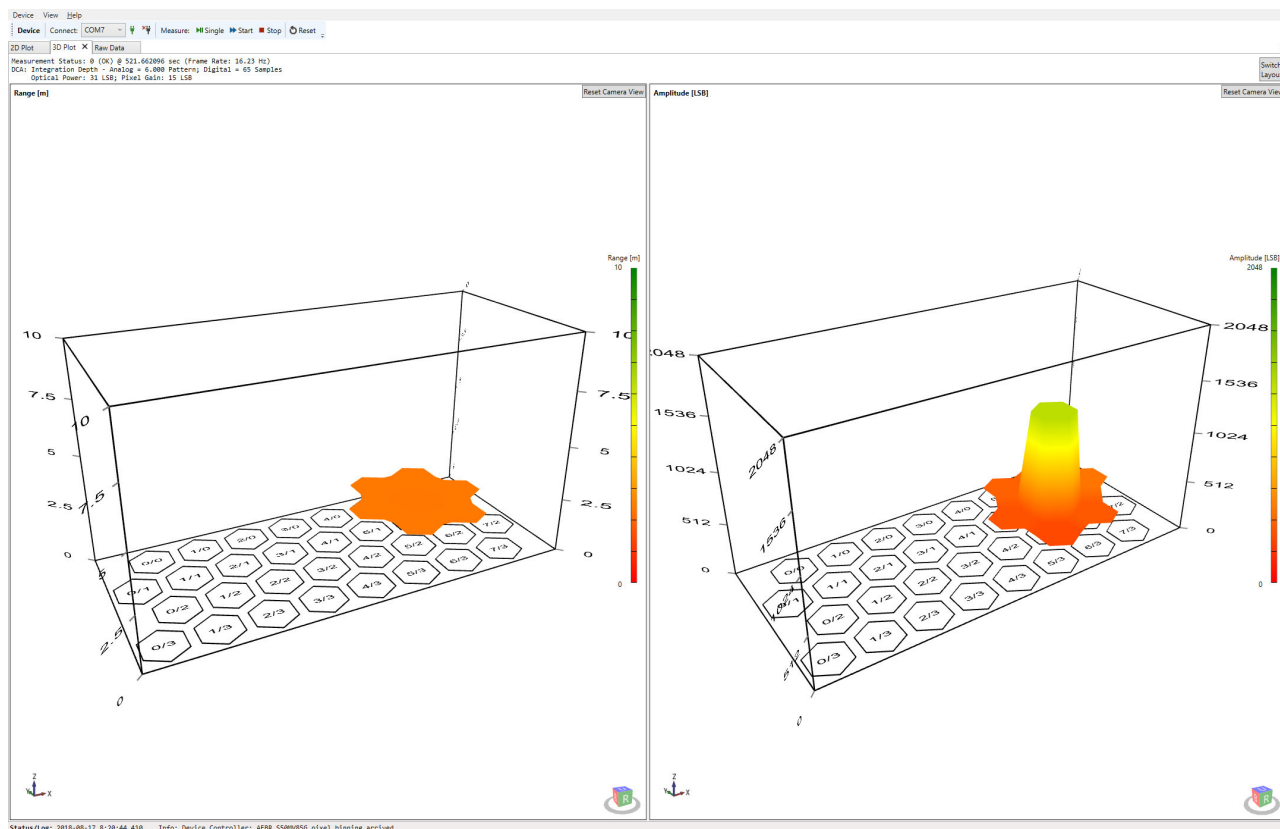
Hide binned pixels to see only pixels considered valid for the measurement by enabling the **Hide Binned Pixels in Plots** option in the 3D Plot options tab.

Figure 26: Hide Binned Pixels Option



Invalid pixels that do not satisfy the binning criteria will disappear from the plot.

Figure 27: Hidden Binned Pixels



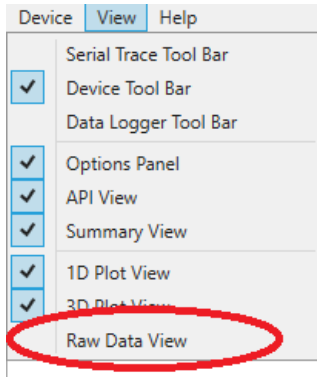
For a closer look at each pixel, zoom and rotate the 3D plots using the mouse.

- To move a plot, click and hold the scroll wheel.
- Rotate the plots by clicking and holding the right mouse button.
- Use the scroll wheel to zoom in and out.
- Double-click the scroll wheel to reset a plot to its default point of view.

## 2.3.3 Raw Data View

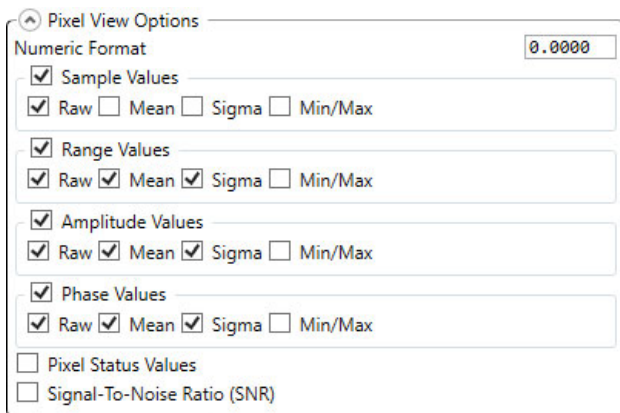
The raw data view is not visible by default, it has to be enabled in the help menu first.

**Figure 28: Enabling the Raw Data View**



Raw Data view gives additional details about each pixel's measured range and amplitude results including the corresponding mean values and signal deviations (referred to as sigma). Furthermore, Mean and Sigma of both Raw Range and Raw Amplitude can be displayed as either SMA or EMA weighted (Mean(s), Mean(e), Sigma(s), Sigma(e)). The above screenshot shows not all Pixels for reason of better overview. Keep in mind that the choice of SMA and EMA affect the displayed values of Sigma and Mean in different ways.

**Figure 29: Raw Data View**



By enabling the **Pixel Status Values** check box, the Raw data view displays several status flags for each pixel.

**Figure 30: Single Pixel Status**

```
Pixel (5,2)
Status: 0b00000000
- Saturated: False
- 1D Binned: True
- Ampl. Min: False
- Ampl. Max: False
- No Signal: False
- OutOfSync: False
- Stalled: False
Range:
Raw:      2.4267
Mean(s):  2.4224
Sigma(s):  0.0025
Amplitudes:
Raw:      989.4375
Mean(s):  987.7613
Sigma(s):  2.2184
```

For a detailed description of the single statuses, open the API reference manual and type `argus_px_status_t` in the search field.

Choose which of the results to keep visible or hidden by selecting the associated Pixel View Options from the Options Panel. In addition, the Numeric Format of the displayed results can be adapted.

**Figure 31: Pixel View Options**

Pixel View Options

Numeric Format: 0.0000

☒ Sample Values

☒ Raw ☐ Mean ☐ Sigma ☐ Min/Max

☒ Range Values

☒ Raw ☒ Mean ☒ Sigma ☐ Min/Max

☒ Amplitude Values

☒ Raw ☒ Mean ☒ Sigma ☐ Min/Max

☐ Phase Values

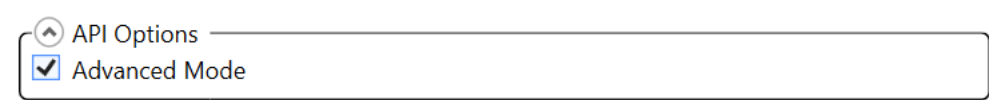
☒ Raw ☒ Mean ☒ Sigma ☐ Min/Max

☐ Signal-To-Noise Ratio (SNR)

## 2.4 API Advanced Options

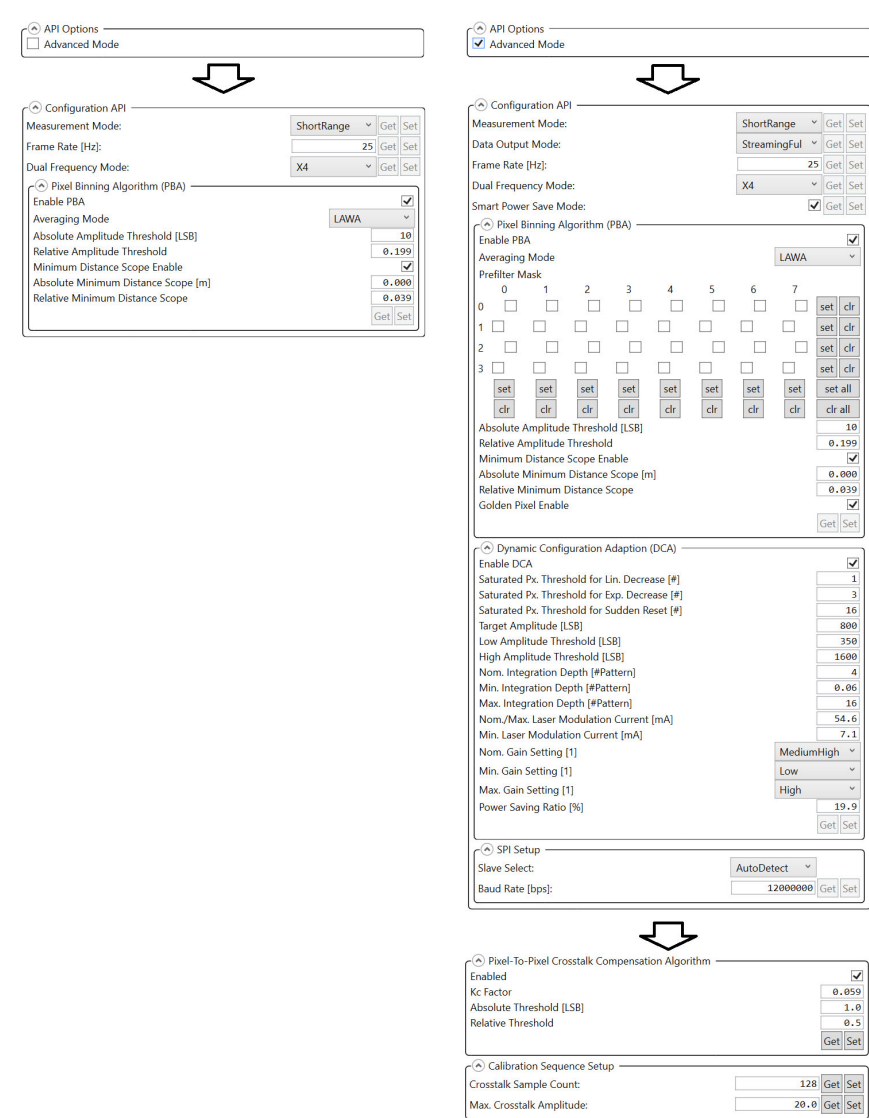
Advanced users may want to further modify the PBA or DCA settings, which can be unlocked by selecting the **Advanced Mode** check box in the **Options** tab.

Figure 32: Enabled Advanced Mode Check Box from the API Tab



More options now appear in the **API** tab, enabling the user to refine PBA and DCA settings. Use the tooltips to get more information about each parameter.

Figure 33: Overview – Advanced API Options



# Appendix A: Troubleshooting and FAQs

## A.1 Related Documents

- *AFBR-S50xxxxx Data Sheet*
- *AFBR-S50 Software Release Notes*

## A.2 Different Versions of Explorer and Controller Board

If an error message indicates that the software versions of the AFBR-S50 Explorer and microcontroller device software do not match, you may have an older or incompatible FW running on the evaluation board.

**Figure 34: Error Message**

```
Device Software Version (0.9.5) do not fit to the Explorer Version (1.x.x)!
The systems communication interface is probably incompatible.
Please update your software.

SCI: Deserialization error on received frame! Command: Configuration (configuration);
SCI: Rx Frame too short.

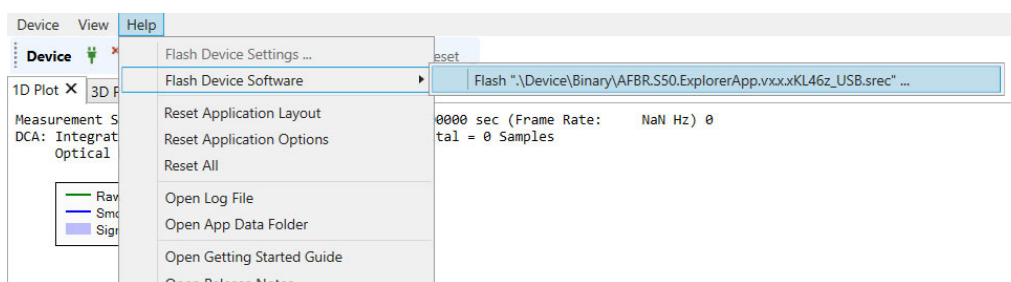
SCI: Deserialization error on received frame! Command: Calibration (calibration);
SCI: Rx Frame too short.
```



When upgrading to v1.x, the USB driver version is updated automatically. When downgrading manually to versions older than v1.x, you might need to install the older USB driver as well.

Flash the appropriate device software version onto the NXP microcontroller board by following the procedures in [Updating the Device Software](#).

**Figure 35: Flashing the Device Software**



## A.3 SCI Error – No Communication to Sensor

Figure 36: SCI Error

SCI: Failed to open an USB connection!

If the issue persists, try the following steps:

- reset your device (push the reset button on the board or reconnect the USB cable)
- verify that the device is connected correctly to the "KL46Z" USB port (not the "OpenSDA" USB port)
- verify that the device is running the current device software version (i.e. re-flash the software via "Menu->Help->Flash Device Software...")

Ok

In principle, this message can have multiple reasons. Most likely, the USB cable was plugged into the openSDA (see [Figure 7](#)) instead of the KL46Z USB port. Another reason can be that the device software is corrupted and must be flashed again (see [Section A.2, Different Versions of Explorer and Controller Board](#)). Because this error indicates a serial communication issue, it is also possible that your sensor is defective or the USB cable might need to be replaced.



## Revision History

### **AFBR-S50-EK-UG101; April 29, 2020**

- Updated for new release.

### **AFBR-S50-EK-UG100; December 6, 2019**

- Initial release.

