ADQ DIGITIZER

USER'S GUIDE

ADQ 108 – 8-BIT, 7 GSPS DIGITIZER
ADQ 112 – 12-BIT, 1100 MSPS DIGITIZER
ADQ 114 – 14-BIT, 800 MSPS DIGITIZER
ADQ 208 – DUAL-CHANNEL, 8-BIT, 4 GSPS DIGITIZER
ADQ 212 – DUAL-CHANNEL, 12-BIT, 550 MSPS DIGITIZER
ADQ 214 – DUAL-CHANNEL, 14-BIT, 400 MSPS DIGITIZER
ADQ 412 – DUAL/QUAD-CHANNEL, 12-BIT, 3.6/1.8 GSPS DIGITIZER
ADQ1600 – 14-BIT, 1600 MSPS DIGITIZER
SDR14 – DUAL-CHANNEL, 14-BIT, 800 MSPS DIGITIZER, DUAL-CHANNEL 14B,1600 MSPS AWG

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Introduction

The ADQ series digitizers are portable high performance digitizers which incorporate one or more analog inputs, on-board DDR2/DDR3 memory and USB2, USB3, MTCA, PCI Express or PXI Express interface. The analog inputs are sampled with high resolution and at data capture rates of up to several thousand mega samples per second (MSPS), and offers excellent analog input bandwidth.

With its combination of high speed, high resolution and high bandwidth the ADQ digitizers are ideal for broadband applications such as IF sampling of RF signals and high-speed data recording. They come with an easy-to-use API that allows for simple integration into any application. The digitizer connects to a host PC via a high-speed USB 2.0 cable (or super-speed USB 3.0 cable if applicable) or through an optional four or eight-lane PXI Express/PCI Express/MTCA interface. The ADQ digitizer comes equipped with Xilinx FPGAs, and offers significant parts of the FPGA resources available for customized applications.

Specifications

Electrical Characteristics

See datasheet for respective ADQ product.

Front panel

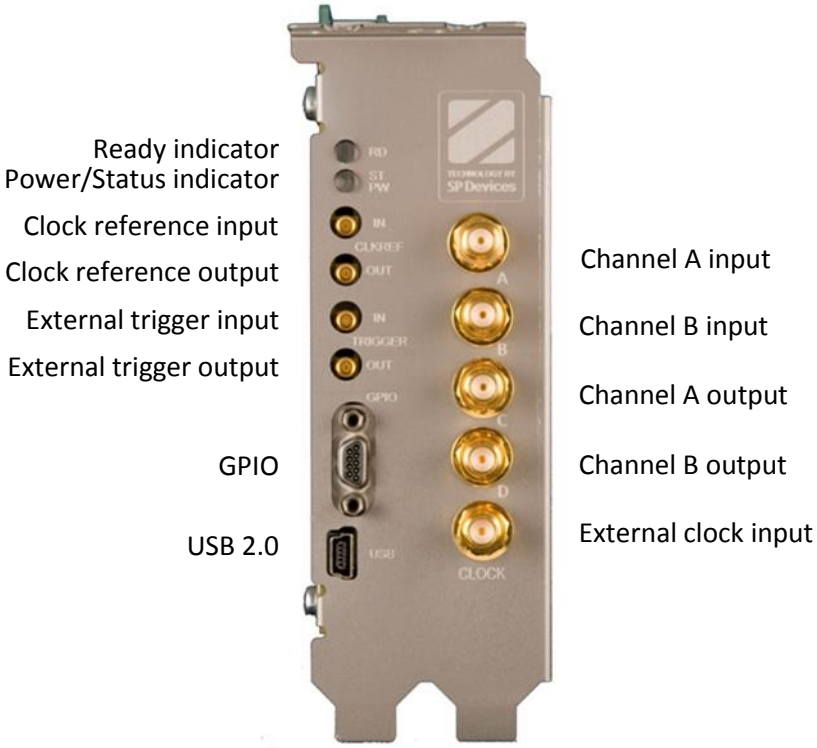
The front of the device features connectors for signal input, external clock input, reference clock I/O, external trigger I/O and GPIO. The function of each connector is described in more detail throughout the user's guide.

The three LED indicators on the front of the device communicate the status of the device when turned on according to the following table.

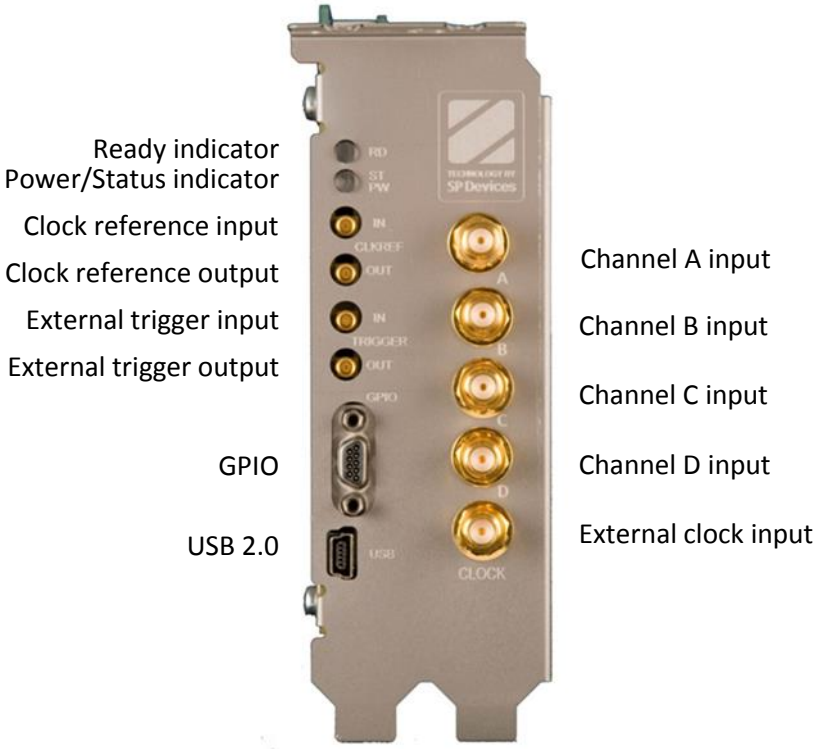
Indicator	Description
Power (Green)	Constant green light indicates power and status OK.
Status (Red)	Constant red light indicates the device is waiting for PLL lock, this is the case until drivers and software has connected to the card. Short flashes of red light indicate the device is calibrating after startup or sample frequency change. Blinking red light in combination with green light off indicates overheat or power error.
Ready (Amber)	Amber light indicates that the trigger has been armed and is waiting to trig the device. Slowly flashing amber light, shows that the current firmware is a bootloader type firmware. Once starting the unit, it will switch to the digitizer firmware.

Front panel for PCIe

The front panel for PCIe board contain these signals



SDR14 PCIe panel connectors



ADQ412 PCIe panel connectors

Front panel for M-TCA

The front panel for M-TCA board contain these signals.

ADQ412 panel connectors

ADQ108 panel connectors

Getting Started

What You Need to Get Started

To set up and use the ADQ digitizer, you must have the following items:

For USB version:

- ☐ Mains power supply, 12 V
- ☐ A host computer with USB 2.0 (also compatible with USB 1.1)
- ☐ USB cable

For PXIe version:

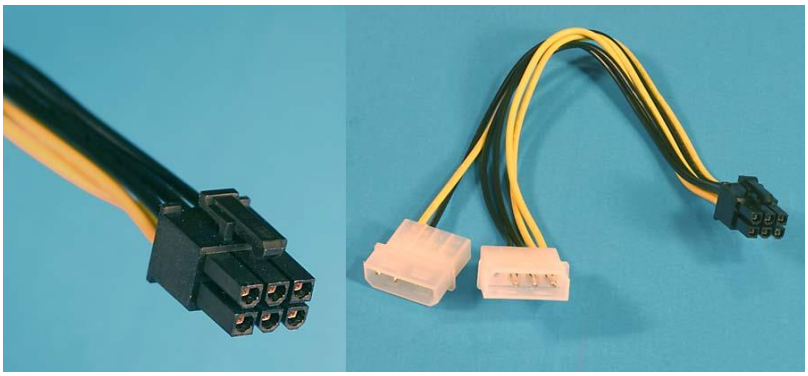
- ☐ A host computer with an available PXI Express or cPCI Express slot

For MTCA version:

- ☐ A host computer with an available MTCA slot

For PCIe version:

- A host computer with an available PCI Express slot and a PCIe Express 6-pin power connector as illustrated below. Please note that an adapter might be required for some systems. The adapter can be purchased from your favorite computer accessory supplier.



PCIe Power cable and adapter

It is also recommended to have:

- Signal generators
- Female SMA Connector Cables

The GPIO connector is Micro D plug 9-way. A suitable socket with lead is for example MOLEX 83421-9044.

- A suitable socket with lead is for example MOLEX 83421-9044.

Software Installation

For Linux

Please follow the instructions in the Linux installation archive. The instructions are located in the README file on the top-level of the archive. Please note that ADCaptureLab is not available in a Linux edition.

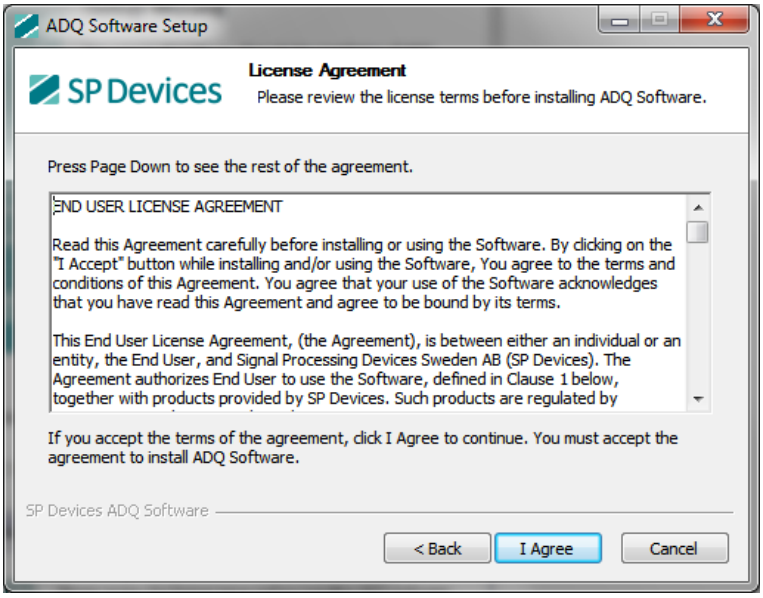
For Windows

To install the software for the ADQ digitizer, run “ADQ-setup.exe” found on the CD (or USB stick) delivered with the digitizer. This will cause all software to be installed and a shortcut to be added to the start menu.

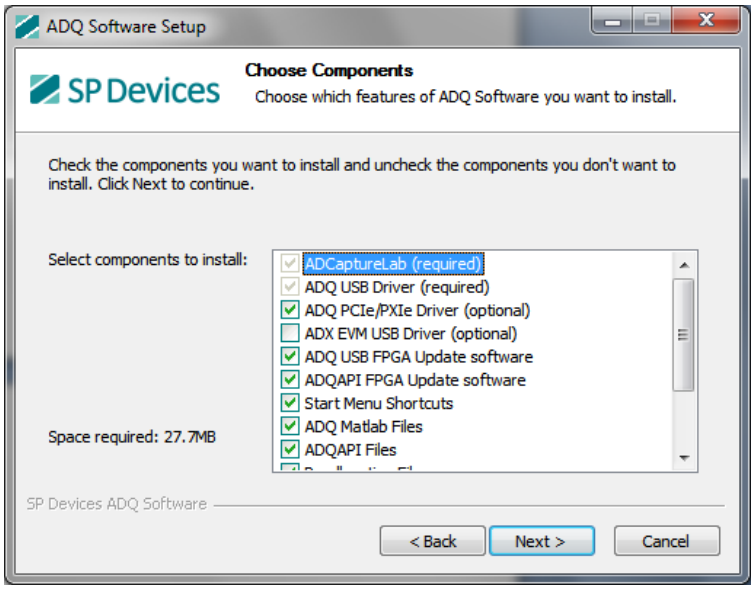
IMPORTANT: Install the software *before* you connect the ADQ digitizer.

1) To install the software, run ADQ-setup.exe which is included on the CD (or USB stick) delivered with your digitizer.
   The window below will be shown.

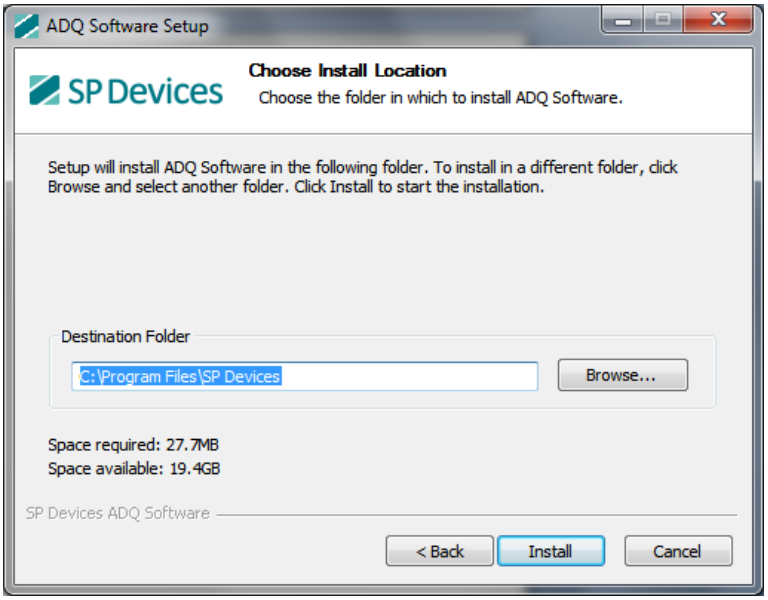
2) Press “Next >”.



3) Read the license agreement, and then press “I Agree”.



4) Choose the components to be installed and press “Next >”.
SP Devices recommend installation of all suggested components.



5) If the suggested default installation location is not satisfactory, press “Browse” to choose another location.
Then press “Install”.

6) When all components have been installed the software is ready for use.
Press “Finish” to complete the installation.

Installed Components

ADCaptureLab

ADCaptureLab is an easy-to-use standalone program which allows for configuration and operation of all ADQ series digitizers from SP Devices. It displays the collected data and calculates key performance metrics such as SNR and SFDR. Collected data can be stored on disk for later use so that

comparison with previous measurements can be done. For more information on how to use ADCaptureLab, please refer to section “Using ADCaptureLab” on page 28. ADCaptureLab is only available for Windows.

MATLAB Interface

The MATLAB interface consists of a dynamic link library and a MATLAB function that together provide easy-to-use communication with your ADQ device. Example code included on the CD shows how to interact with the device.

ADQ API (C/C++ SDK)

The ADQ ADI consists of a number of C++ classes that can easily be integrated with existing source code. It comes with source code and example files. For more information about the ADQ API, please refer to the separate user’s guide for the API.

Additional Software

There are several other software interfaces available. They include, but are not limited to, LabVIEW and a Dynamic Link Library (DLL) that can be used when not programming in C++, for example with Delphi or CVI. For further information please contact SP Devices.

Testing Your Device

After installing the relevant software according to the instructions in the previous section, the ADQ digitizer has to be configured when connected to the host PC for the first time. Once this has been done, the device will be ready for operation. An initial test as described in section “Data Acquisition using ADCaptureLab” will get you started with exploring the capabilities of your new device.

Connecting the device for the first time

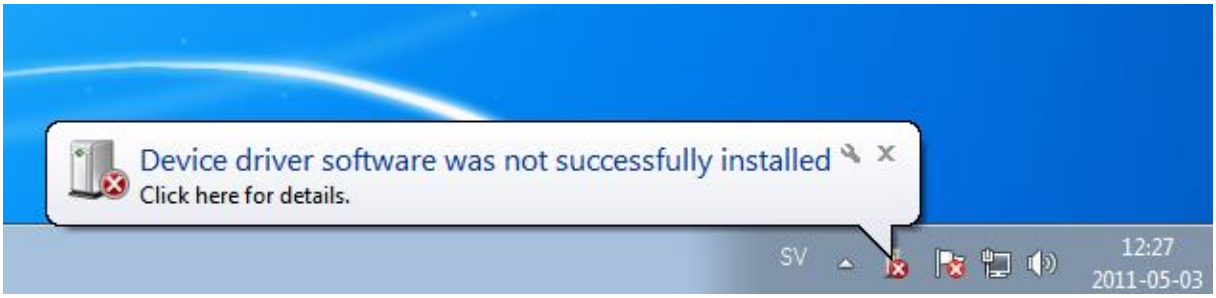
IMPORTANT: Install the software *before* you connect the ADQ digitizer.

Perform the following steps before moving on to acquiring the signal using any of the methods described in later sections.

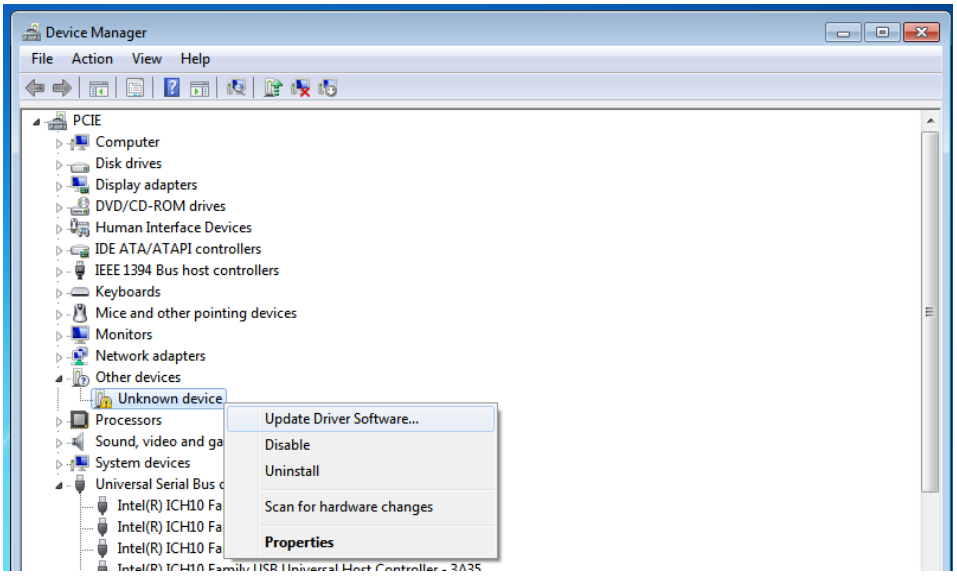
Windows 7

Note that the examples in this section are based on installation and operation of an ADQ 412 minor differences will occur when using other digitizers.

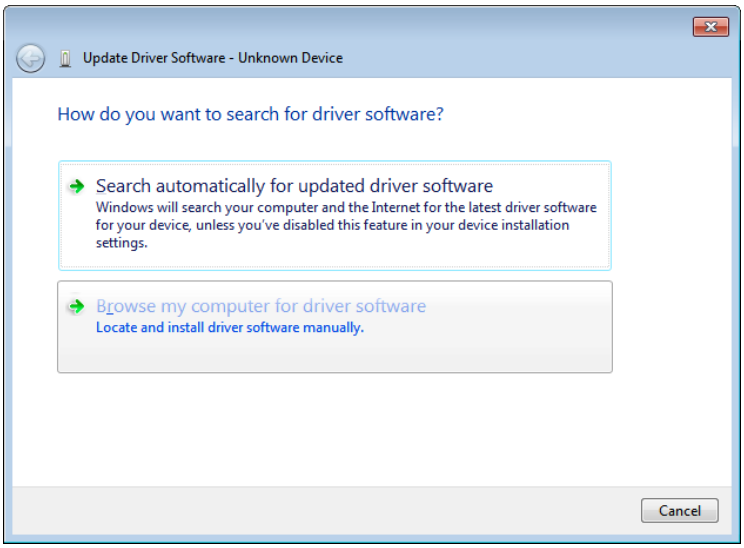
1) Switch on the ADQ digitizer and connect it to the host PC using the USB cable. The message below will be shown.



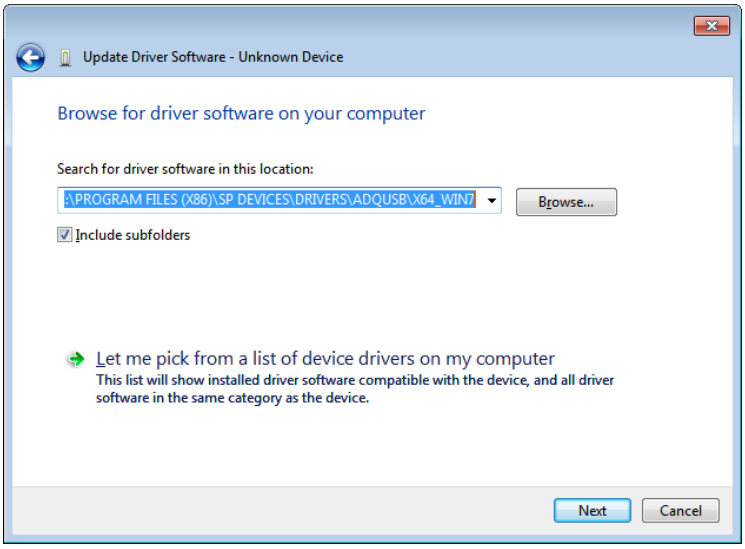
2) Open the Device Manager by typing “devices manager” in the search field of the start menu.



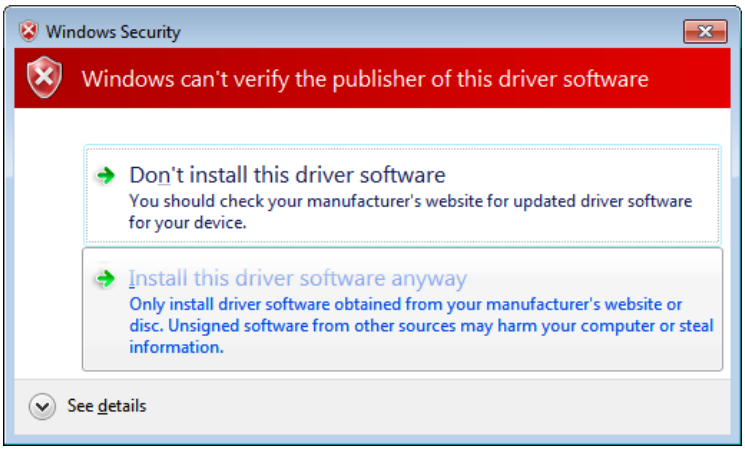
3) Locate “Unknown device” and right click. Select “Update Driver Software”.



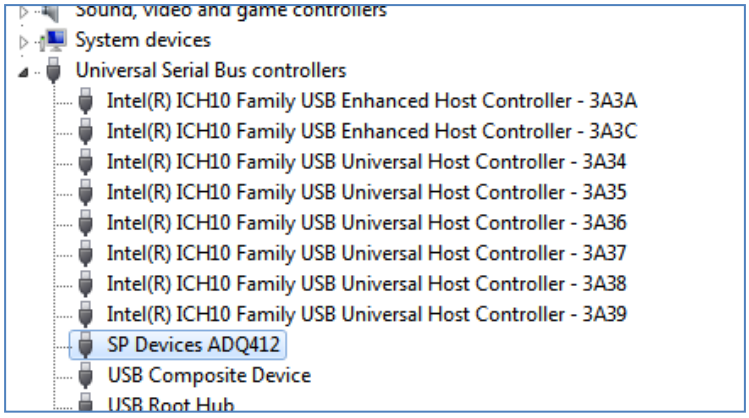
4) Select “Browse my computer for driver software”.



5) Press “Browse” and select “Drivers\ADQUSB\X64_WIN7” in the installation directory , then press “Next >”. NOTE: If you are running 32-bit version select “Drivers\ADQUSB\x86_win7”.



6) Press “Install this driver software anyway”.



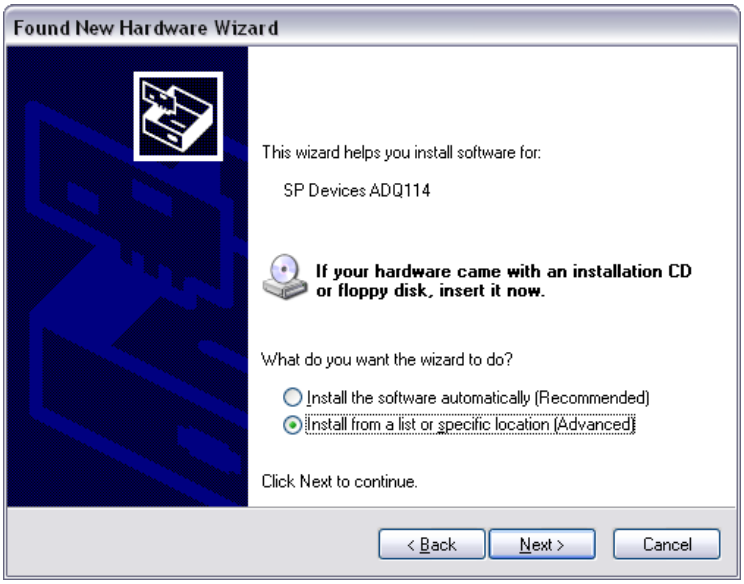
7) Your ADQ unit shall now appear under USB devices in the device manager.

Windows XP and Vista

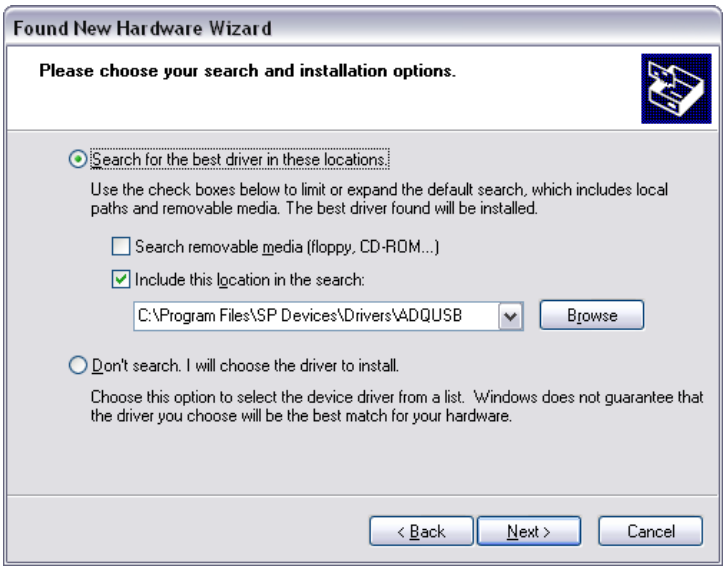
Note that the examples in this section are based on installation and operation of an ADQ 114, minor differences will occur when using other digitizers.

1) Switch on the ADQ digitizer and connect it to the host PC using the USB cable. The window below will be shown.

2) Select “No, not at this time” and press “Next >”.



3) Select “Install from a list or specific location (Advanced)” and press “Next >”.



4) Select “Search for the best drivers in these locations”. Check “Include this location in the search”. Press “Browse” and select “Drivers\ADQUSB” in the installation directory, then press “Next >”

5) Press “Continue Anyway”.

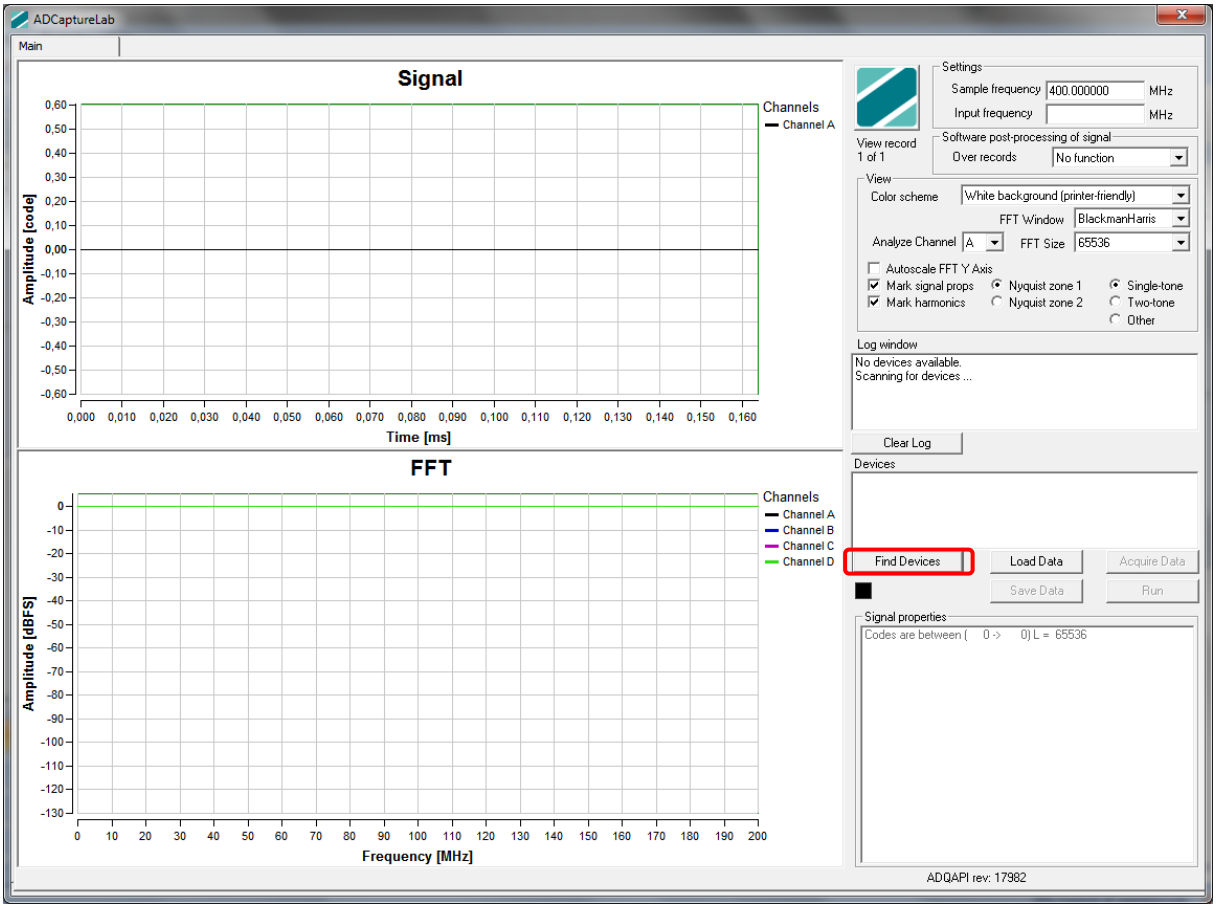
6) Press “Finish”.

Data Acquisition using ADCaptureLab[1]

This section describes how to acquire a signal and save it to disk using ADCaptureLab. For a more detailed description of ADCaptureLab, please refer to section “Using ADCaptureLab”. Follow these steps to acquire a signal:

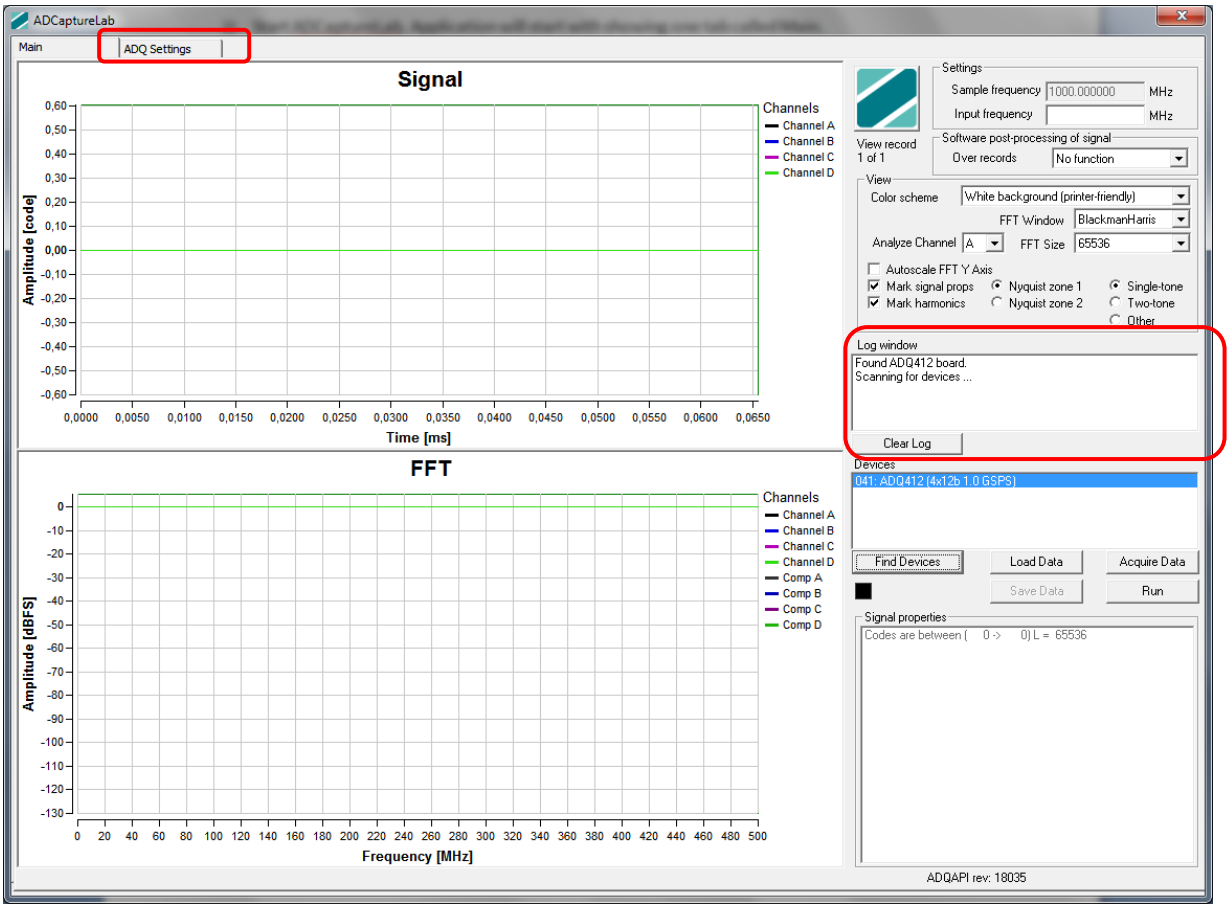
1) Make sure that the ADQ digitizer is switched on and connected to the host PC through USB.

2) Start ADCaptureLab. Application will start with showing one tab called Main.



3) In ADCaptureLab, press “Find Devices”. All connected ADQ devices (connected to the host PC over USB2/USB3/PXIe/PCIe/MTCA) will be identified and initialized. On startup of ADCaptureLab this procedure will be run automatically once. First time after power-up of a digitizer the initialization sequence will be a bit longer, several seconds.

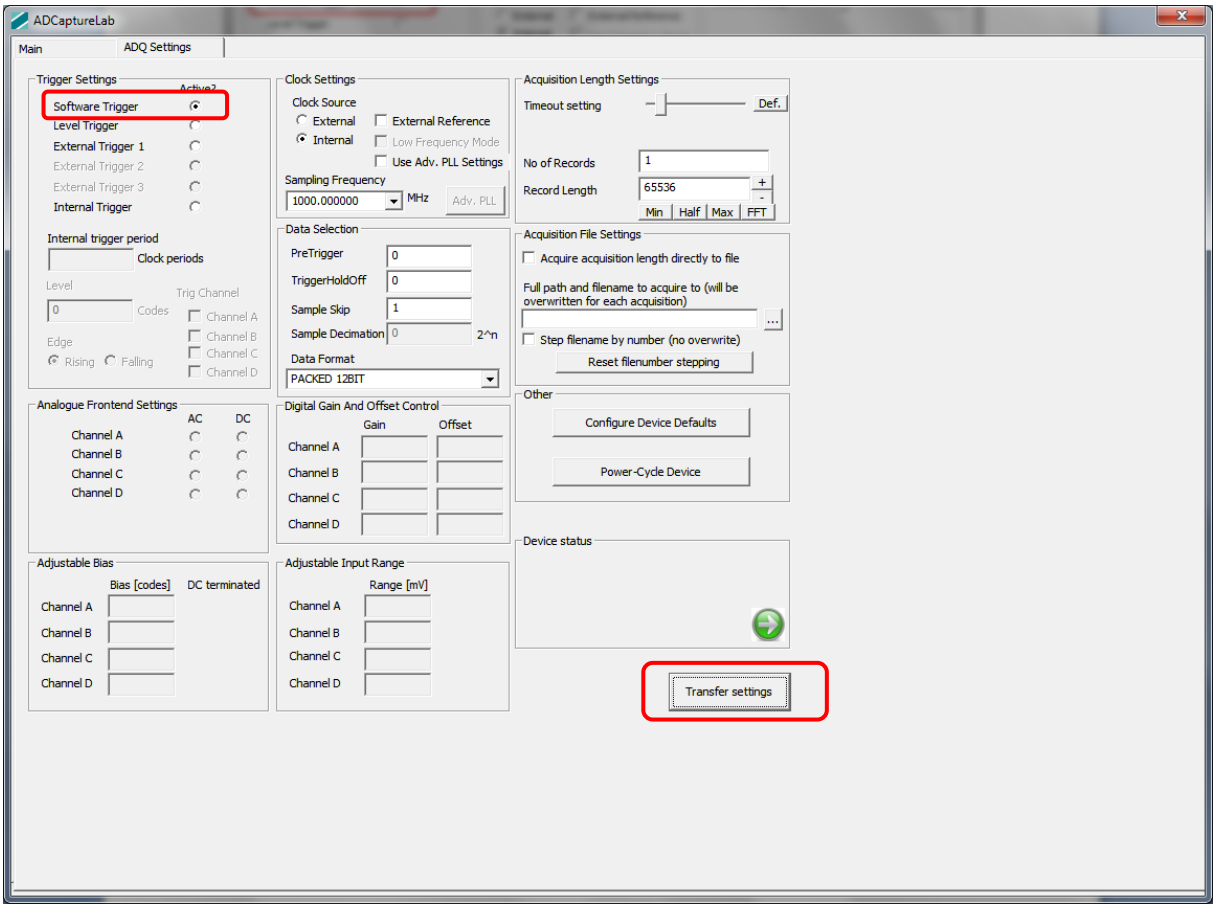
[1] This documentation shows ADCaptureLab v2.0, although newer versions may be in the installer you received. The window contents may differ slightly.



4) Once identified, all connected devices will be displayed in the Devices window. Status information on the enumeration of devices shows in the Log window.

5) Select the device of your choice by clicking it in the Devices window.

6) When an ADQ device is found or selected a tab called “ADQ Settings” will appear (see top opf window). Click this tab to bring up the settings window.

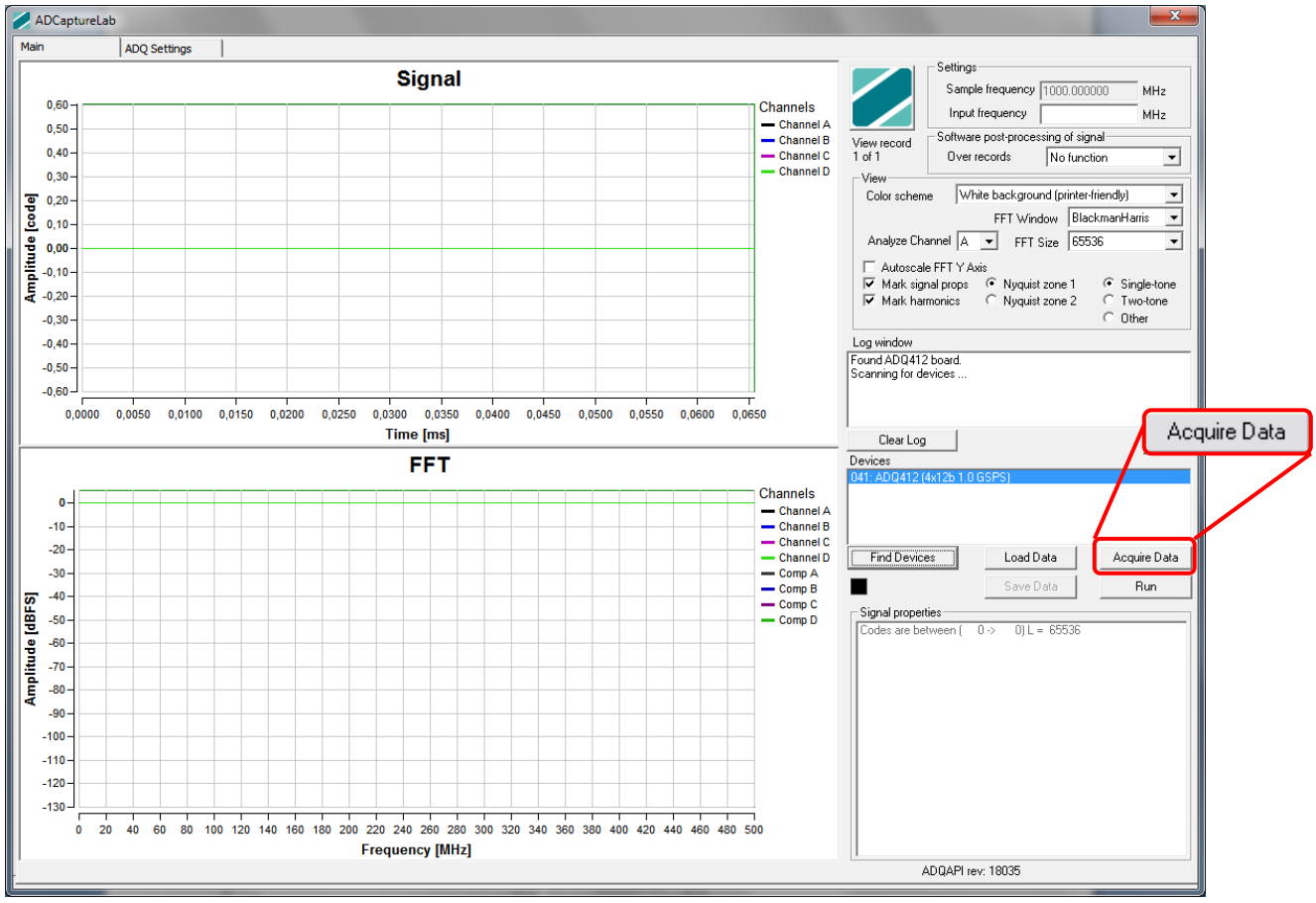


7) In Trigger settings, check “Software Trigger” so that acquisition will be triggered from inside ADCaptureLab, via the API call SWTrig().
In Clock settings, select internal clock by checking “Internal”. This will eliminate the need of an external source.
Select sampling frequency “1000 MHz” (for an ADQ412). Or other appropriate for your specific device.

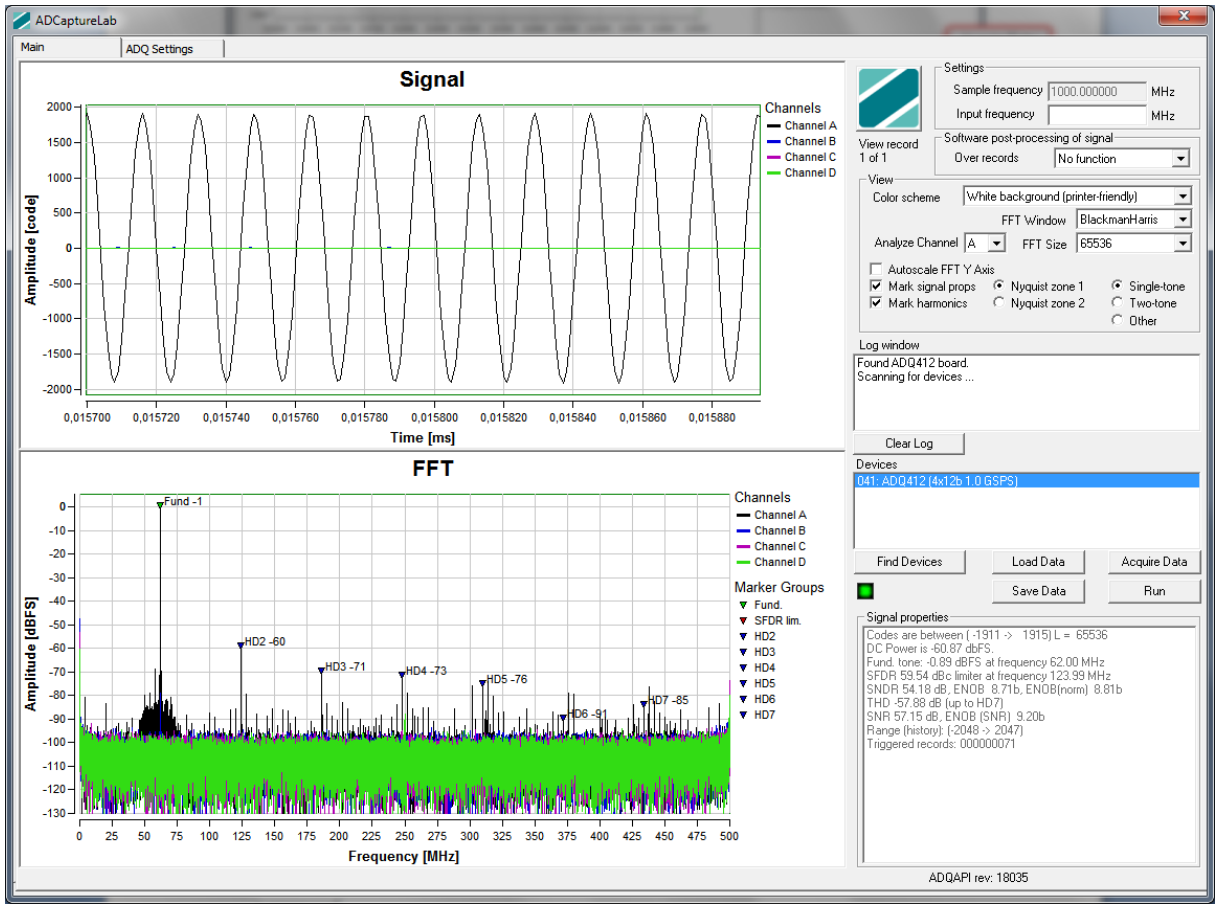
8) Finally, transfer the settings to the device by clicking on “Transfer Settings” and return to the main window. Wait for the green arrow to turn into a green check mark, then settings have been transferred successfully.

9) Connect a signal source set to 0.60 Vpp amplitude and 62 MHz to the A[2] channel SMA input (or appropriate amplitude, frequency and input for your specific device).
There is no need to connect a signal source to the clock input since we have chosen to use the internal clock.

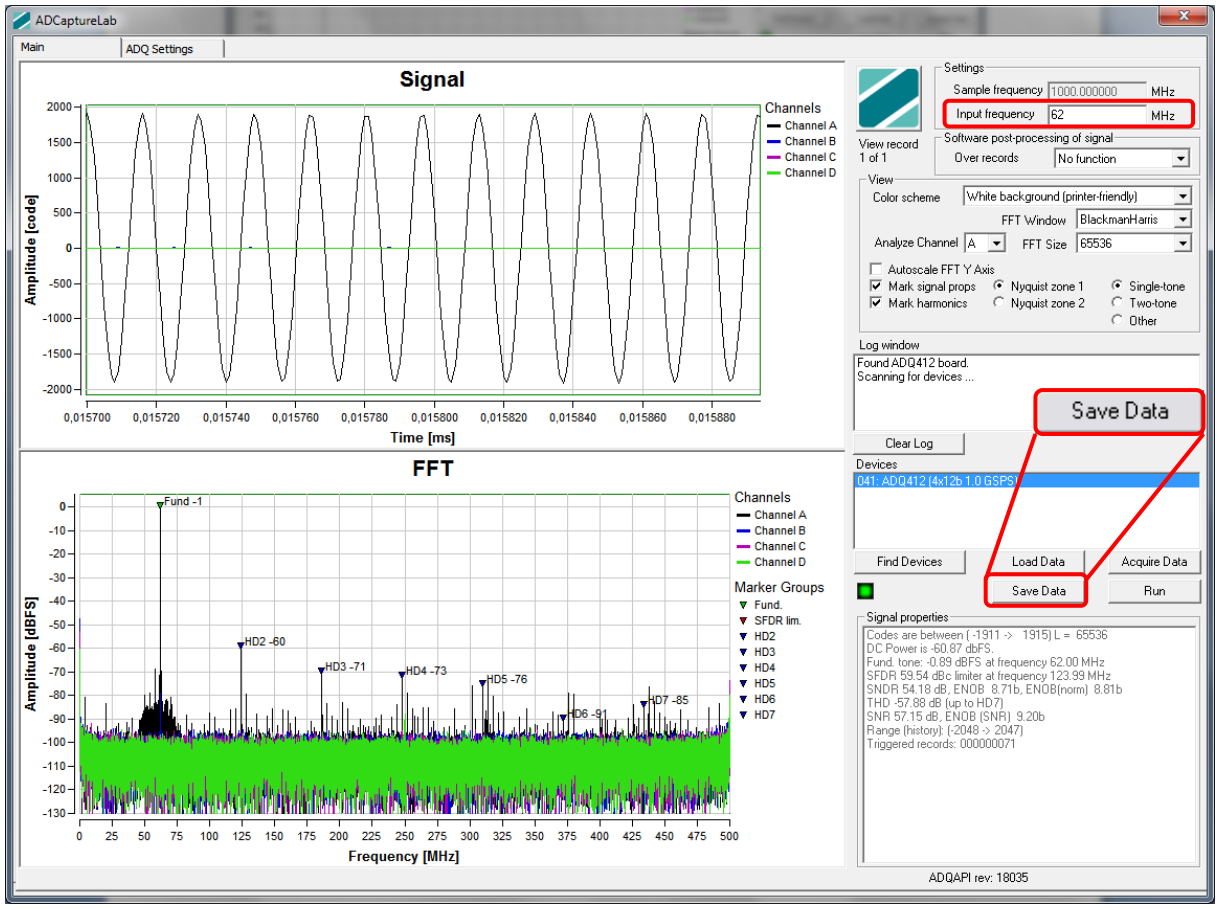
[2] Note that different ADQ digitizers might have different number of inputs and other designated names on the SMA inputs.



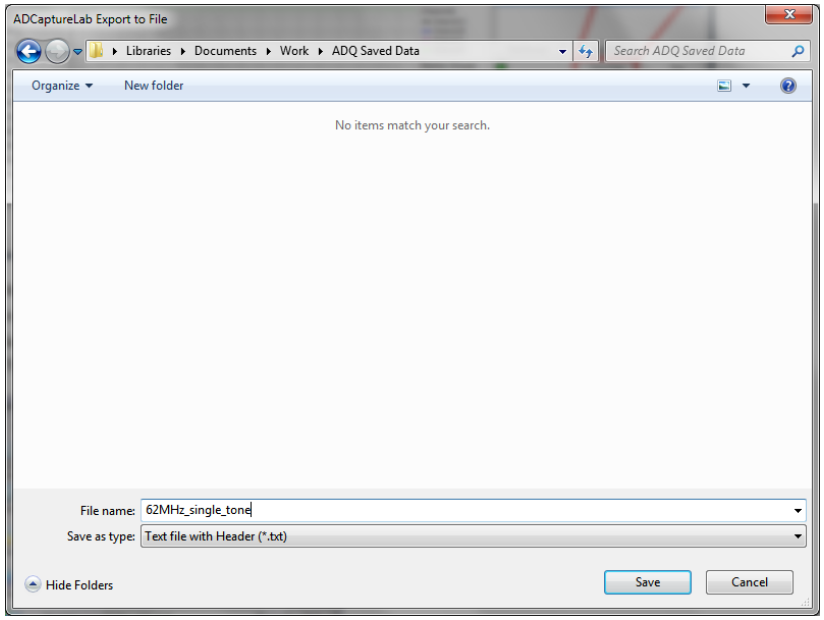
10) Press “Acquire Data” to collect one batch of samples.
The number of samples collected in the batch is determined by “Total acquisition size” which is found in the settings dialog. To open this dialog, press F8 or click the “ADQ Settings” button.



11) The acquired samples are displayed both in time and frequency domain (FFT).
The signal fidelity depends highly on the signal source. For best performance, the signal source has to be filtered so that harmonics and unwanted spurs are suppressed.



12) Write 62 in the “Input Frequency” field to indicate the frequency of the sampled signal. This information will be saved to the data file so that the input frequency can be displayed again at a later time after data import.
Then press “Save Data”.



13) Navigate to the target directory by clicking the drop-down box named “Save in”.
Provide a file name, for example “62MHz_single_tone”.

Choose file type “Text file with Header (*.txt)”.
Press “Save”.

Congratulations, you have now acquired and saved your first signal using your ADQ digitizer and ADCaptureLab! For further information on how to use ADCaptureLab, please refer to section “Using ADCaptureLab” on page 28.

Using ADCaptureLab

Overview

Figure 1 shows the main window of ADCaptureLab. The main window contains different tabs related to different settings. The user may activate more Tabs by switching to Advanced View mode, by pressing F4. A detailed description of each part shown in the main window is given in the section shown in the figure.

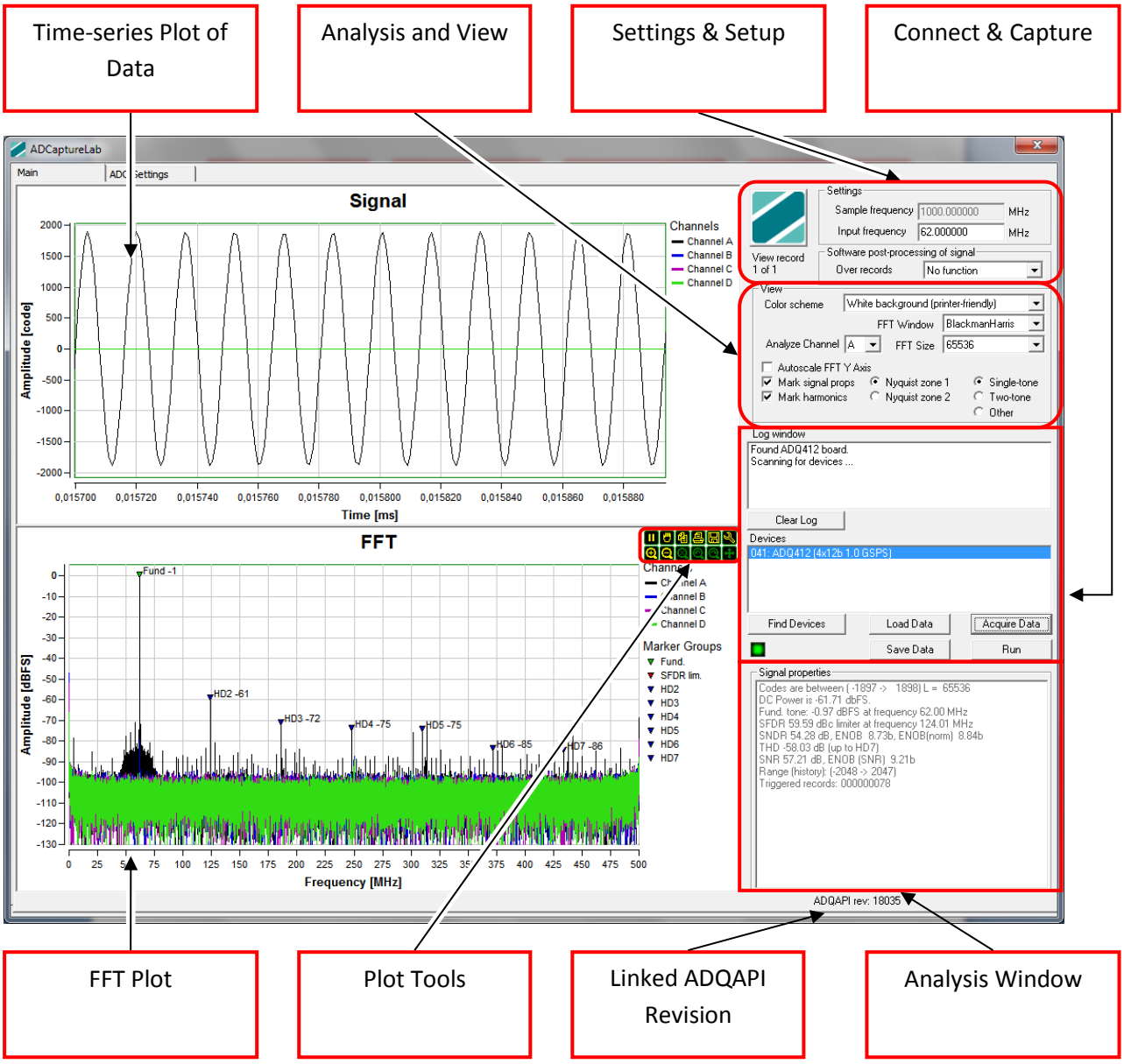


FIGURE 1. ADCAPTURELAB MAIN WINDOW.

Capturing Data

Settings & Setup

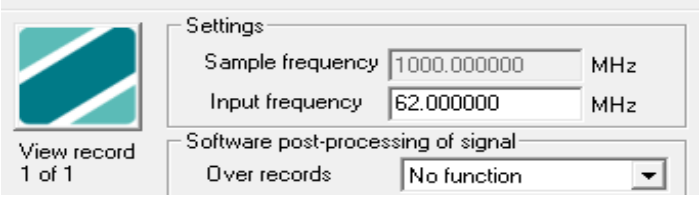


FIGURE 2. SAMPLE FREQUENCY WHEN RUNNING WITH INTERNAL CLOCK (LEFT) AND EXTERNAL CLOCK (RIGHT).

Setting	Description
Sample frequency	Set the sampling frequency for the system. Frequency axis for FFT plot will be based on this and on Nyquist zone settings. The sample frequency can only be changed manually when running on external clock. If the ADQ digitizer is running on internal clock, this value will automatically be changed according to the frequency selected in the ADQ Settings dialog (which opens when pressing F8).
Input frequency	Set the input frequency. Only used for tagging when exporting data.
Software post-processing of signal	This function can be enabled over all records in one MultiRecord acquisition to obtain Waveform averaging – average of each sample over all records Waveform maximum – maximum of each sample over all records Waveform minimum – minimum of each sample over all records

Connect & Capture

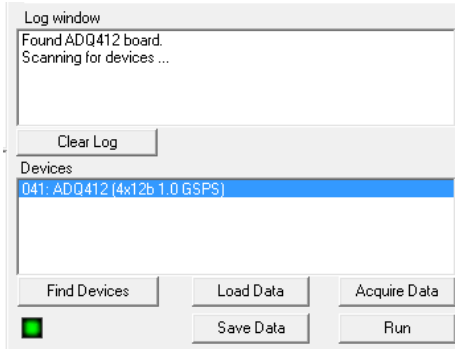


FIGURE 3. BUTTONS USED FOR CONNECT AND CAPTURE.

Connecting to the digitizer

1) To find the digitizer – press button “Find Devices”. The digitizers connected to the computer will then show up in the “Devices” box. Status information on the enumeration of devices will show in “Log window”.

2) Select a compatible device digitizer from the “Devices” list. The buttons “Acquire data” and “Run” will then be activated. If you use a generating device such as the SDR14, a tab for AWG Control will also show up in the tab collection.

Capture Single Batch

To capture a single batch from the digitizer, press “Acquire data”. Trigger mode must be set to “Software trigger”, see section Trigger Settings for further information on different trigger modes.

Continuous Capture

To capture continuously, press “Run”. Button will change name to “Stop”, and pressing it will stop the capturing. If plots are in “Play” mode, plots will be updated continuously as new data arrives from the digitizer. Trigger mode must be set to “Software trigger” for continuous capture, see section Trigger Settings for further information on different trigger modes.

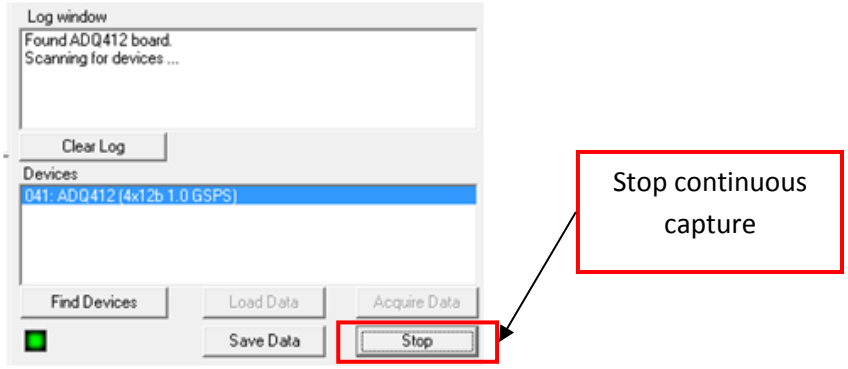


FIGURE 4. THE APPEARANCE AND FUNCTIONALITY OF THE START / STOP BUTTON CHANGES DURING CONTINUOUS CAPTURE.

Import and Export of Data

Import Data

Press “Load Data” to load previously saved results into ADCaptureLab. In the file dialog window that opens, select the target file and press “Open”. File contents will be loaded into the plot windows (unless they are in “Pause” mode). To import, you may also drag & drop the file to the ADCaptureLab main window directly.

Export data

To save the results of a measurement, press “Save Data”. Provide a filename in the file dialog window that opens, select a file format and press “Save”. Data can be exported as a text file format with a header, binary format with header, pure binary format, or as a pure ASCII file for use with for example MATLAB.

Record data automatically

By pressing F12 a mode for automatically writing all acquired records to disk is activated. This will typically write all data (in raw binary 16-bit data as default) to the directory where ADCaptureLab is started. This destination and format is possible to change by creating/editing the adcapturelab.ini file

(must be placed in the same location where ADCaptureLab.exe is run) on post record

```
record_save_location=your_file_dir
record_save_format=1
```

Format 1 is raw binary and Format 2 is ASCII files (readable directly into MATLAB or Excel). This configuration file is read when starting ADCaptureLab. Pressing F12 again, inactivates the disk writes.

Data Analysis

ADCaptureLab supports several data analysis functions that helps you interpret and evaluate the results of your measurements. The following sections explain the details about these functions.

Analysis and View Settings

The analysis and view settings determine which type of data analysis that is performed and how the result is displayed.

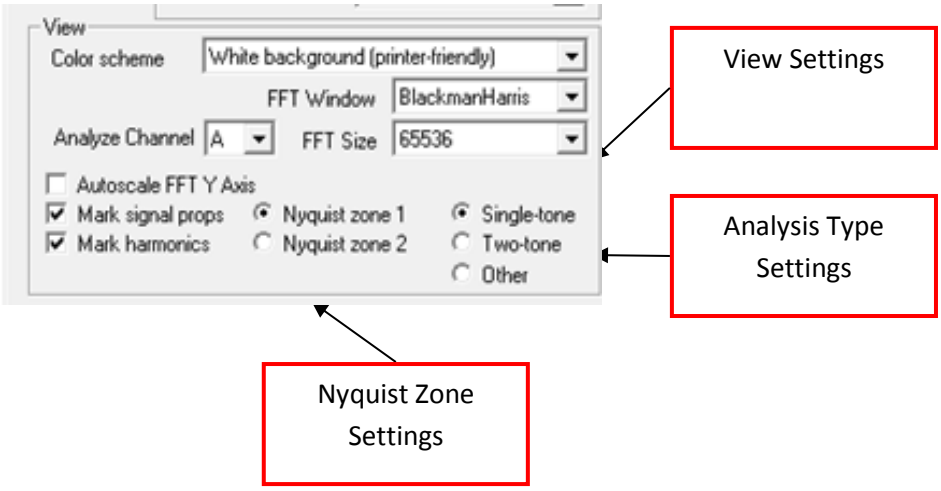


FIGURE 5. THE ANALYSIS AND VIEW SETTINGS.

Analysis Type Settings

Analysis Type	Description
Single-tone	Check this to indicate that the current measurement is a single-tone test. Supports analysis of code range, fundamental, harmonics, SFDR, and SNDR (ENOB).
Two-tone	Check this to indicate that the current measurement is a two-tone test. Supports analysis of code range, fundamentals, SFDR and SNDR (ENOB).
Other	Check this to indicate that the current measurement is other than above mentioned test types. Supports analysis of code range only.

Nyquist Zone Settings

Nyquist Zone	Description
Nyquist zone 1	Check this to indicate that the input signal frequencies are in the first

	Nyquist zone, i.e. DC < fin < fs/2. Frequency axis of FFT plot will be based on this and on the current sample frequency setting.
Nyquist zone 2	See description above. FFT plot frequency axis will change to fs/2 < fin < fs.

View Settings

Setting	Description
Color scheme	Sets the color scheme of the plot routines. Available modes are: ▪ White background (printer-friendly) ▪ Black background ▪ Grey background
Window	Windowing function used for FFT and analysis functions. Available windows are: ▪ Blackman ▪ Blackman-Harris ▪ Hamming ▪ Hanning ▪ Rectangular
Autoscale FFT Y Axis	When enabled, the y-axis of the FFT plot is automatically scaled. If disabled, the y-axis is locked between 0 and -130dBFS.
Mark signal props	When enabled, fundamental tone(s) and SFDR limiter are marked in the FFT plot.
Mark harmonics	When enabled, harmonics (2^{nd}-6^{th}) are marked in the FFT plot. Supported for single-tone tests only.

Analysis Window Output

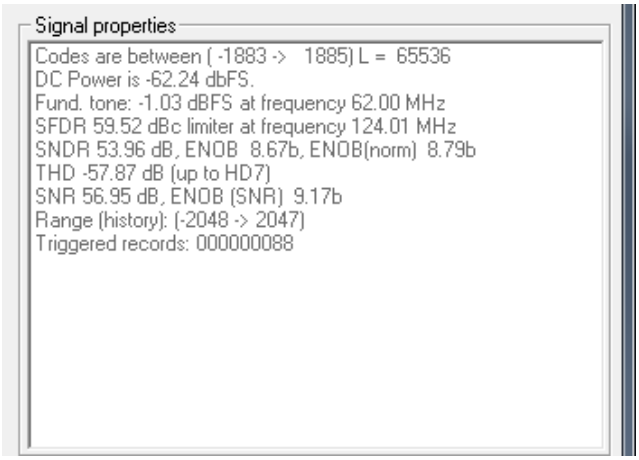


FIGURE 6. THE RESULT OF THE DATA ANALYSIS IS DISPLAYED IN THE ANALYSIS WINDOW.

Analysis Item	Applicable to Analysis Type(s)	Description
Codes	All	Code range and number of samples in the current data batch.
DC Power	All	DC power in dBFS.
Fund. Tone(s)	Single-tone Two-tone	Identified fundamental tones (power and frequency).
Power max	Other	Identified power maximum (power and frequency).
SFDR	Single-tone Two-tone	Spurious-Free Dynamic Range. Power relation between fundamental tone and largest distortion. For a two-tone test this is calculated as the relation between the largest fundamental tone and the largest distortion. Frequency position of limiting component is calculated.
SNDR	Single-tone Two-tone	Signal to Noise and Distortion Ratio. Power relation between fundamental tone and noise and distortion.
THD	Single-tone	Total Harmonic Distortion
ENOB	Single-tone Two-tone	Effective Number Of Bits. Based directly on the SNDR value.
SNR	Single-tone Two-tone	FFT estimated SNR
Range	All	Code range history (max and min) since start
Trigger counter	All	Counts acquired triggers from start

Plot Tools

Move the mouse cursor over any of the plot windows (time-series plot or FFT plot) to display the plot tools toolbar. When a plot tool is marked green, as for example the “Zoom to Fit” tool shown in Figure 7, it means that this specific tool is currently not a valid choice. In the case of the “Zoom to Fit” tool, this happens when the plot is already zoomed to show the full signal plot.

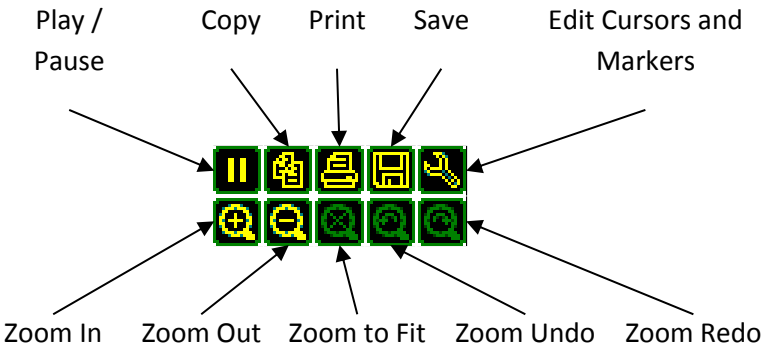


FIGURE 7. THE PLOT TOOLS APPEAR WHEN PLACING THE MOUSE OVER ANY OF THE PLOT WINDOWS.

Plot Tool	Description
Play/Pause	To put plot in Play/Pause mode. In play mode, plot will display new data as it arrives either by acquiring or by import from file. In pause mode, plot will not update.
Copy	Copies plot window to the clipboard. The result can for example be pasted into a document or similar.
Print	Prints plot window to printer.
Save	Exports plot window to bitmap or jpeg image file.
Edit Cursors and Markers	Edits the cursors & markers of the plot window. When pressed a dialog window will open which will allow for changing properties such as channel name and visibility, display color for the channel and marker shapes and colors.
Zoom In	Zooms in.
Zoom Out	Zooms out.
Zoom to Fit	Zooms to the original setting.
Zoom Undo	Returns to previous zoom setting.
Zoom Redo	Returns to zoom setting before undo press.

Trigger Settings

The ADQ digitizers supports several trigger types which are explained in further detail in the following sections. Press the “ADQ Settings” tab to open the ADQ settings tab from which the trigger settings can be changed.

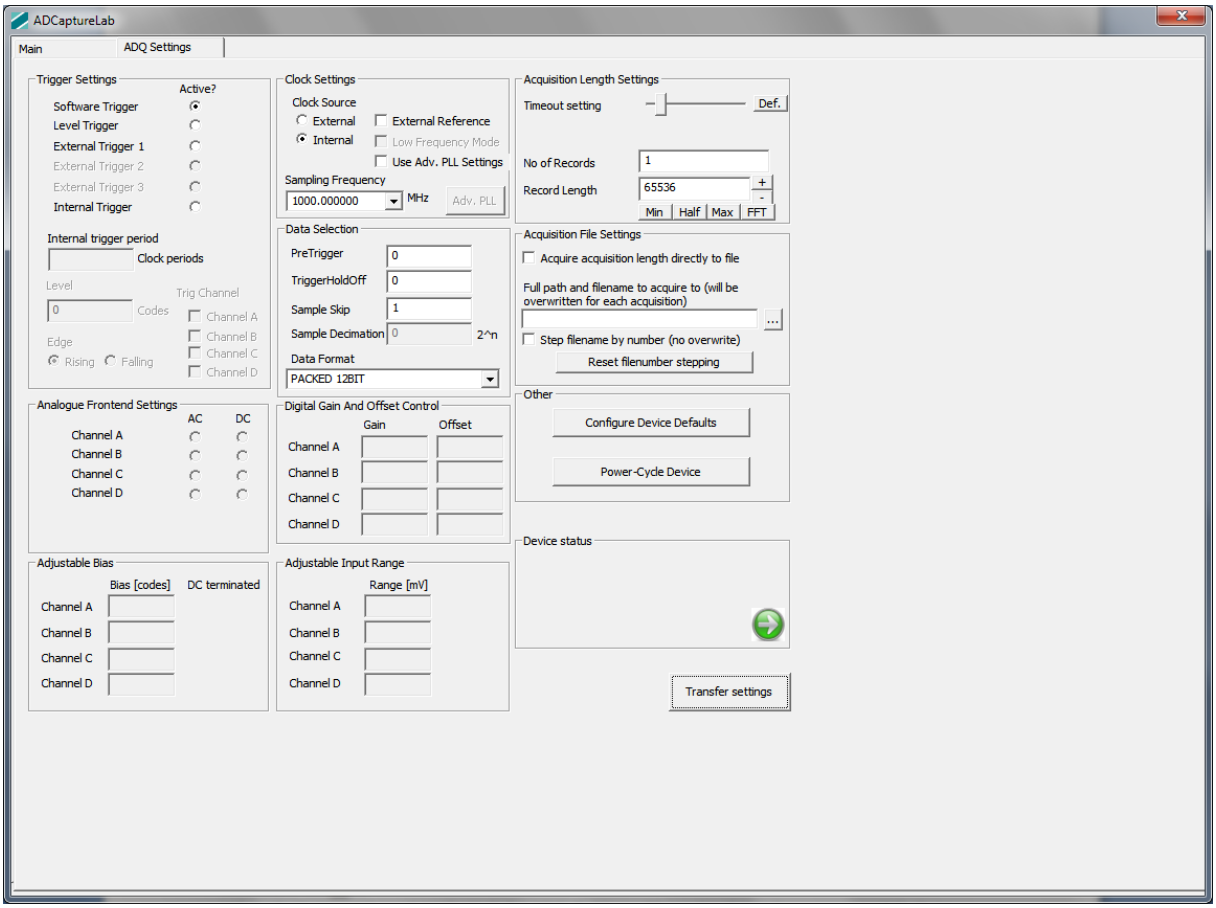


FIGURE 8. THE ADQ SETTINGS DIALOG ALLOWS FOR MODIFICATION OF TRIGGER SETTINGS.

Software Trigger

When the software trigger is activated, the ADQ digitizer will acquire data whenever any of the buttons “Acquire Data” or “Run” is pressed in the main window of ADCaptureLab. The software trigger mode is activated by checking the “Software Trigger” checkbox in the ADQ settings dialog. See Figure 8 for an example of where the button trigger mode is active.

Level Trigger

When the level trigger is activated, the ADQ will monitor the input(s) and wait for a level trigger condition to occur. The specified trigger level, chosen edge and selected input channel are all monitored to determine whether or not the trigger condition is fulfilled. Open the settings (F8) to activate and configure a level trigger:

1) Activate the level trigger by checking the “Level Trigger” checkbox.
   Note that the rest of the level trigger settings becomes enabled.

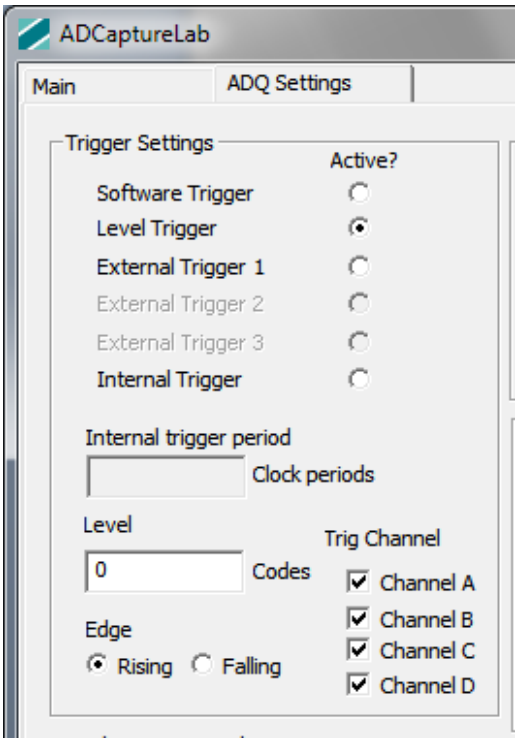


FIGURE 9. LEVEL TRIGGER ACTIVATED FROM THE ADQ SETTINGS DIALOG WINDOW.

2) Specify a trigger level (code) by writing the value into the "Level" field.
   As an example, the ADQ 412 has 2^{14} = 4096 different codes, which gives a valid level trigger range between
   -2048 to 2047.

3) Choose an edge by clicking either "Rising" or "Falling".

4) For digitizers with several channels, such as the ADQ412, the trigger can be assigned to a specific channel. This is done by clicking the checkboxes for Channel A – D.

5) Press "OK" when the trigger has been configured to return to the main window.

The example settings shown in Figure 9 illustrate a level trigger armed for acquiring data starting on a transition from an input level (code) below 0 to a level above 0.

Capture Single Batch with Level Trigger

Press the button "Acquire Data" in the main window of ADCaptureLab to arm the trigger. While armed, and as long as no trigger event occurs, the text of the button changes to "Cancel" to indicate that the button can be used to disarm the trigger and return to normal operation.

External Trigger

When the external trigger is activated, the ADQ digitizer will monitor the input signal at the "TRIGGER IN"[3] SMA connector. The trigger input port operates on LVTTL signal levels, and a trigger event will occur on a logic low-to-high transition (rising edge). To activate the external trigger, enter the ADQ settings by choosing the tab and click the checkbox marked "External Trigger". Some boards have multiple external trigger inputs (up to 3 different ports).

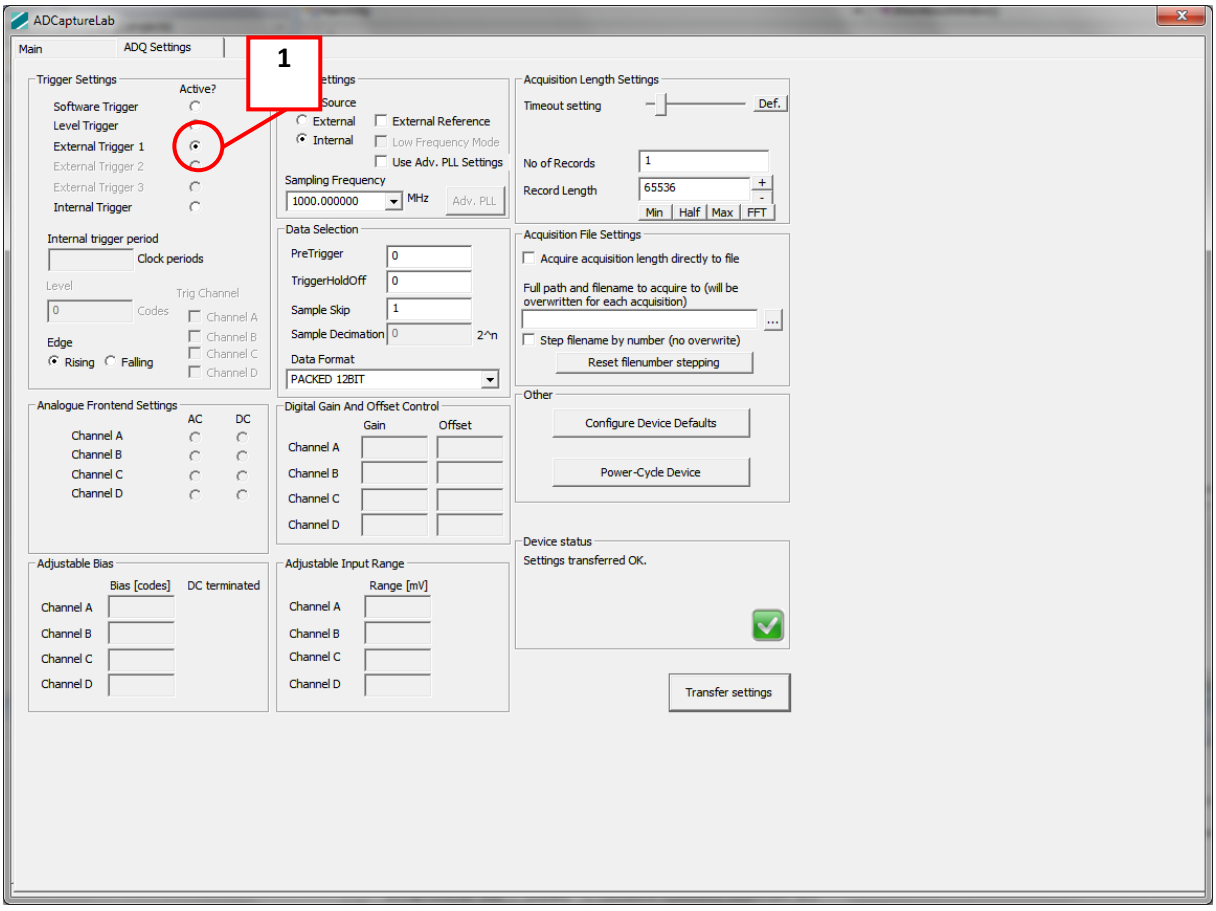


FIGURE 10. ACTIVATE THE EXTERNAL TRIGGER IN THE ADQ SETTINGS DIALOG.

Capture Single Batch with External Trigger

Data acquisition using external trigger is performed in the same way as with level trigger. Therefore, please refer to section Capture Single Batch with Level Trigger for an overview of the acquisition procedure.

Clock Settings

There are three basic clock configurations that can be used with the ADQ digitizers:

- Internal Clock Source with Internal Reference (default clock setting)

[3] This input is marked "External Trigger" on some of the ADQ digitizers.

- Internal Clock Source with External Reference
- External Clock Source

The clock settings are configured in the ADQ settings dialog.

Internal Clock Source with Internal Reference

This is the default clock setting. The frequency of the internal clock source, and hence the sampling frequency, can be changed to a number of pre-defined frequencies. Open the settings tab to activate and configure this clock setting.

1) Click “Internal” in the clock settings to choose internal clock source (the internal clock reference is implied).

2) Use the sampling frequency drop-down box to select any of the pre-defined sample frequencies.

3) Press “OK” to apply the setting.

Internal Clock Source with External Reference

Use this clock setting to synchronize the ADQ digitizer with another instrument. The other instrument must provide an output clock reference of 10 MHz that should be connected to the “CLKREF IN”/”CLOCK”[4] SMA input on the ADQ. The clock reference amplitude should be from 0.35 to 1.0 Volt peak-to-peak.

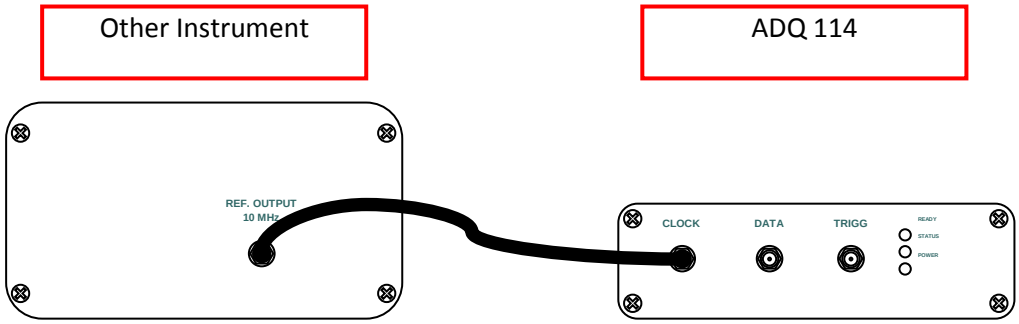


FIGURE 11. START BY CONNECTING THE 10 MHZ REFERENCE OUTPUT CLOCK FROM THE OTHER INSTRUMENT TO THE CLOCK INPUT OF THE ADQ DIGITIZER.

To configure ADCaptureLab for use of internal clock source with external reference, follow the same procedure as explained in section “Internal Clock Source with Internal Reference”, but make sure to also click the “External Reference” checkbox. See Figure 12.

FIGURE 12. MAKE SURE TO CLICK THE EXTERNAL REFERENCE CHECKBOX WHEN SYNCHRONIZING WITH ANOTHER INSTRUMENT.

[4] This input is marked ”External clock/reference” on some of the ADQ digitizers.

External Clock Source

Use this clock setting when the sample frequency is entirely provided by an external signal source. Connect the output of the signal source to the “CLKREF IN”/“CLOCK”[5] SMA input on the ADQ digitizer. This clock setting allows for a more flexible choice of sampling frequency than internal clocking. Make sure to keep the provided frequency within the specifications listed in “Electrical Characteristics” on page 7. Note that signal source jitter will have a significant impact on system performance. The jitter specifications of the internal clock given in section Electrical Characteristics indicate suitable performance.

[5] This input is marked ”External clock/reference” on some of the ADQ digitizers.

AWG Control (applies to SDR14 only)

This tab will show up if you are using a signal generating devices, such as the SDR14. This is the tab where you control the AWG. Synthesize different types of digital signals by designing, loading from external programs or drawing them in the window. Signals are defined into segments, which you add to the AWG channels with selected number of repetitions etc. You also set up the trigger conditions, or if to run continuous, and which channels to upload segments to and activate.

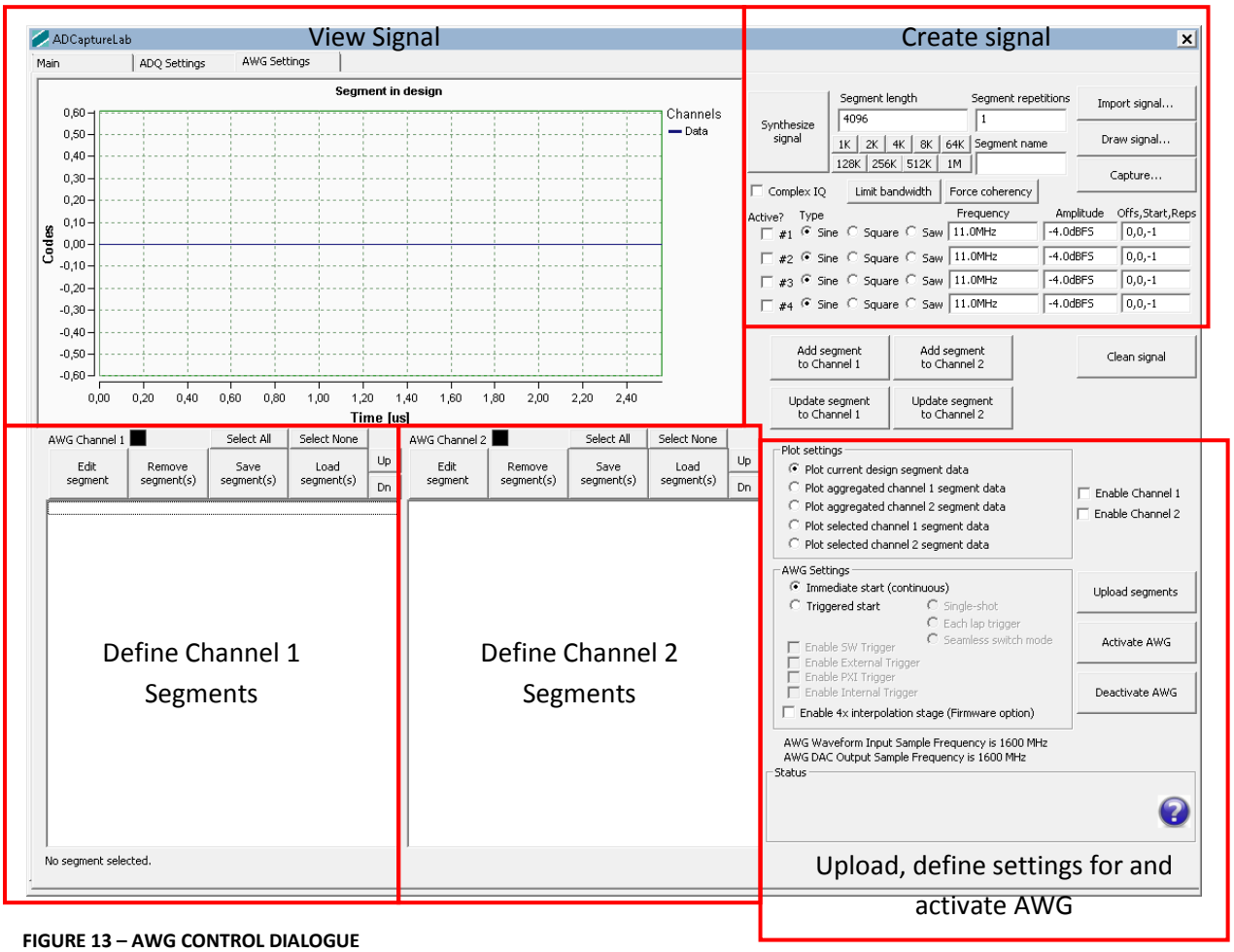


FIGURE 13 – AWG CONTROL DIALOGUE

Create a sinusoidal, upload and run the AWG

1) First choose a segment length of 8K.

2) Activate signal #1 and set it to Sine, 5.0MHz and an amplitude of -3.5 dBFS.

3) Use “Force coherency” button to get a coherent sinusoidal signal. This will change the frequency to 4.8828125MHz.

4) Now press “Synthesize signal” and you will get a plot of the signal. You can zoom and work with this plot in the same way as the other plot windows.

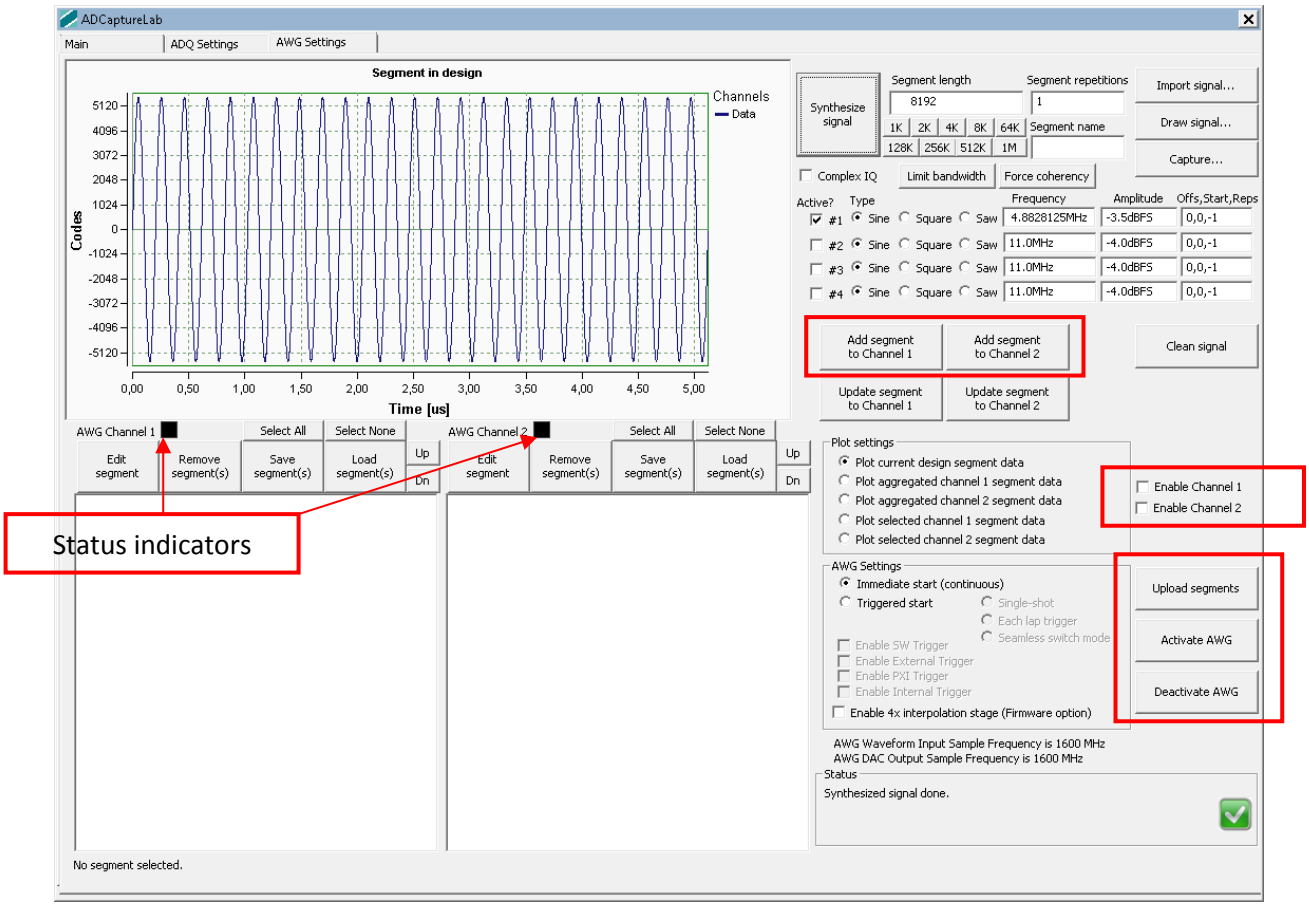


FIGURE 14 – AFTER SYNTHESIZE SIGNAL

5) Add this segment to Channel 1 and Channel 2 by pressing the Add segment buttons.

6) Enable Channel 1 and Channel 2 by checking their marks in “Enable Channel 1 / 2”.

7) Upload segments by pushing “Upload segments” and then Activate AWG. Now you will see the status indicator for the channels turn green.

8) Now the AWG outputs your sinusoidal on both its channels. To disable the AWG, push “Deactivate AWG”.

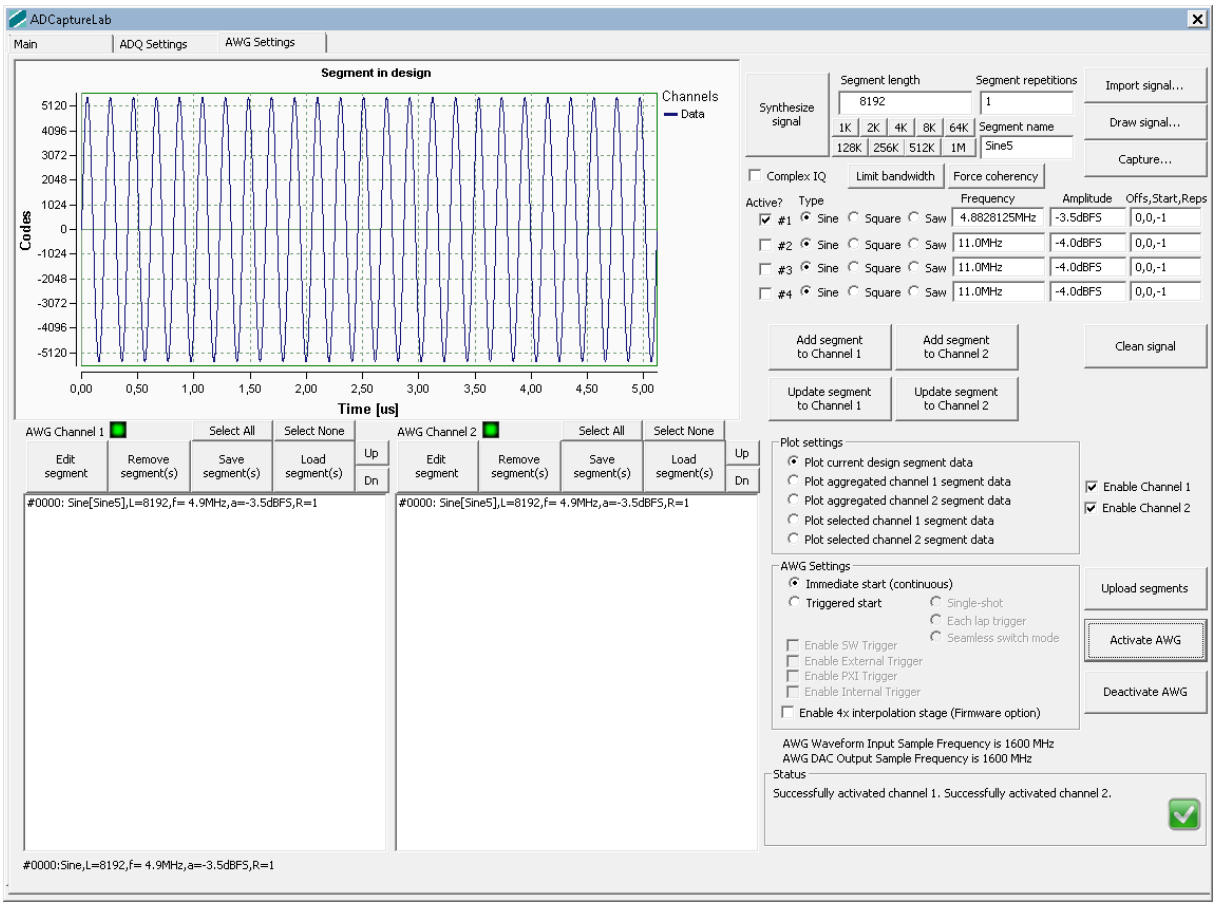
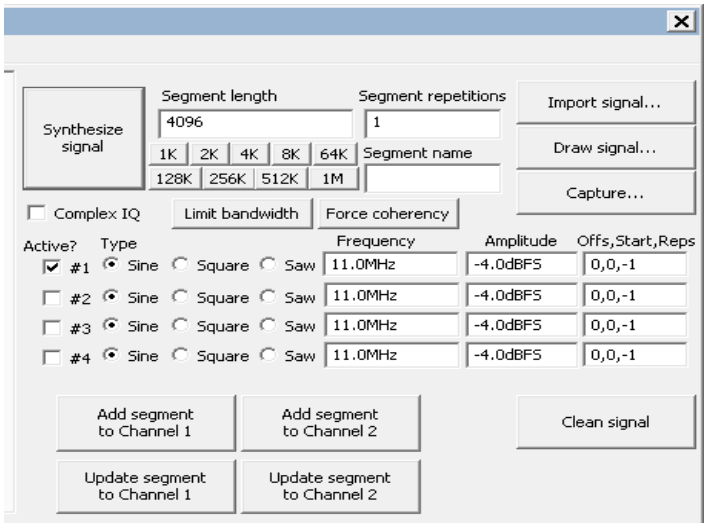


FIGURE 15 – AWG ACTIVATED WITH SIGNALS DEFINED

Details on signal creation

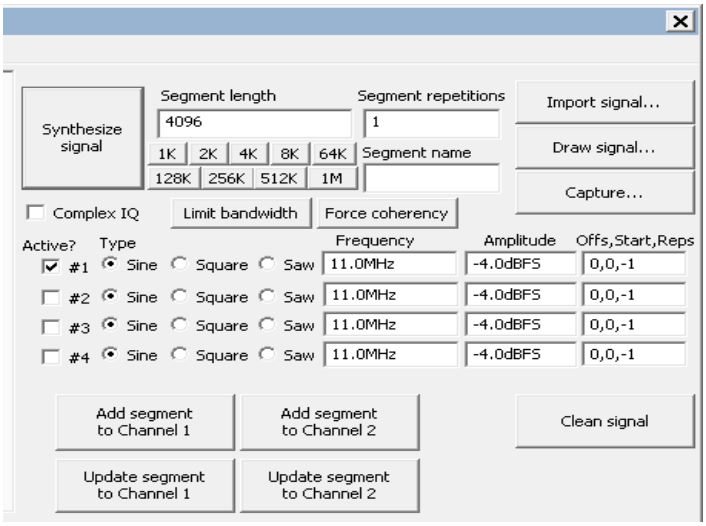


There are several ways to define a signal:

- Synthesize signal. Signal is defined by the properties in this window and the computer will synthesize it when pressing “Synthesize signal”.
- Import signal. This imports a signal from a file.
- Capture. This captures the signal from the digitizer portion of the device. You select which channel to capture and then it copies it.

- Draw signal. This makes you able to draw/edit the signal with your mouse.

Synthesize signal



- Segment length: Number of samples in segment
- Segment repetitions: The number of repeats this segment will be run
- Segment name: Optional name to keep track of segments

For each signal row (all of them will be added in the resultant signal):

- Active? Whether to include row in synthesis or not.
- Type. Sine/Square/Saw.
- Frequency: Enter the frequency you desire.
- Amplitude: Enter the amplitude you desire.
- Offs,Start,Reps:
    - Offs: First value means offset from zero in the value axis.
    - Start: Means where on the time line (samples) to start generating signal with phase = 0.
    - Reps: The number of period repetitions (-1 infinitely). Example, if type is sine and Reps are defined to 1, exactly one period of the sine will be generated.

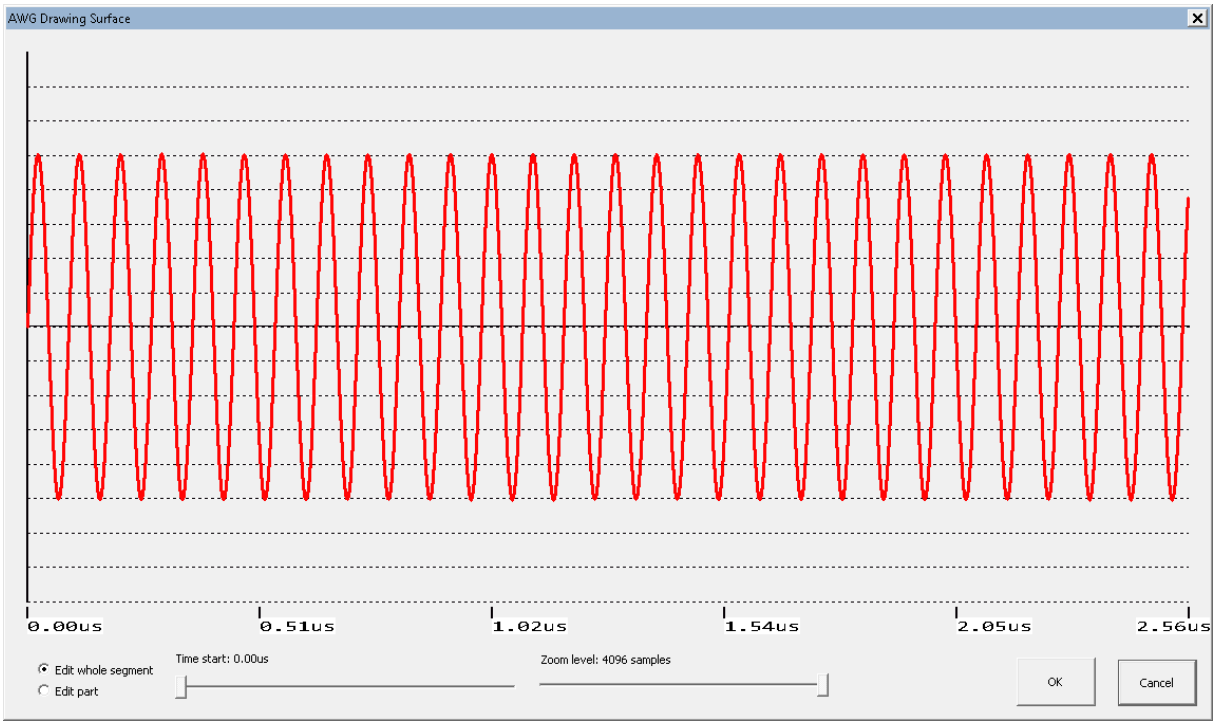
Import signal

When you click this button a dialogue will appear in which you can select a file for loading. Acceptable formats are pure ASCII (where samples are aligned in one column written as decimal integers) or pure binary where each 2-bytes tuple in the file represent a sample (16-bit signed integer format).

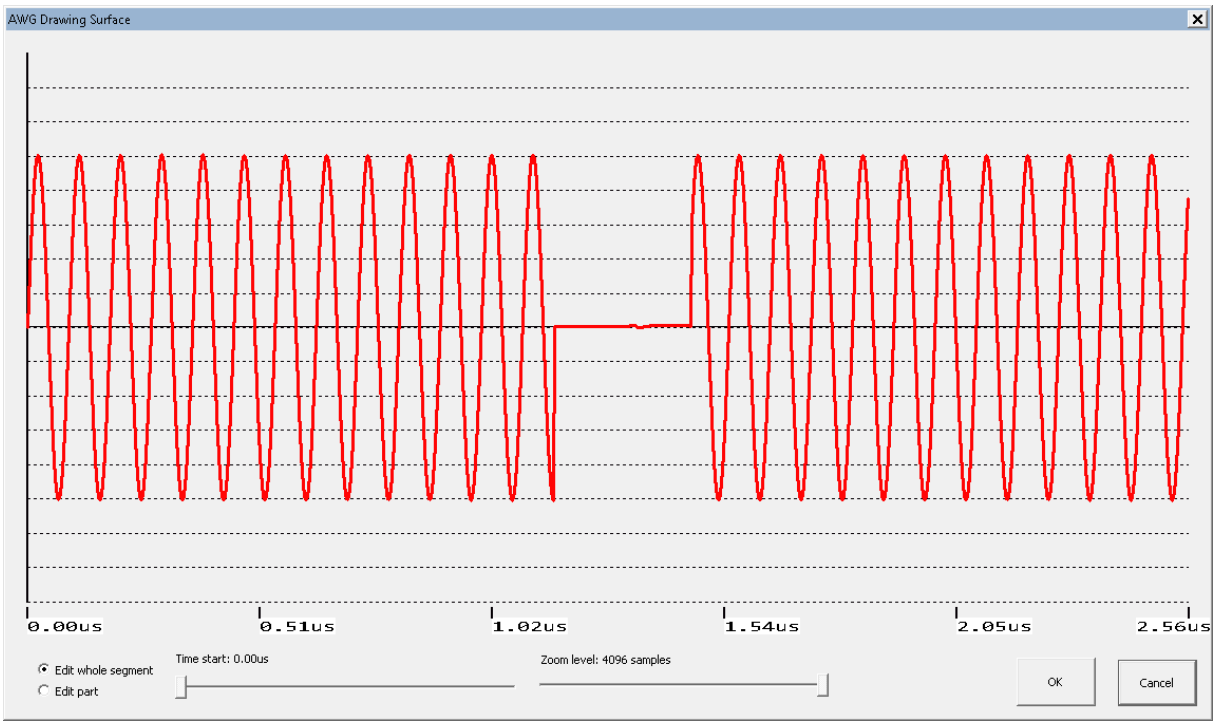
Capture signal

When you click this button you may choose which channel to import from the acquisition window and also if you want to perform a scaling of the signal when converting it from the acquisition window to the AWG Synthesizer window.

Draw signal



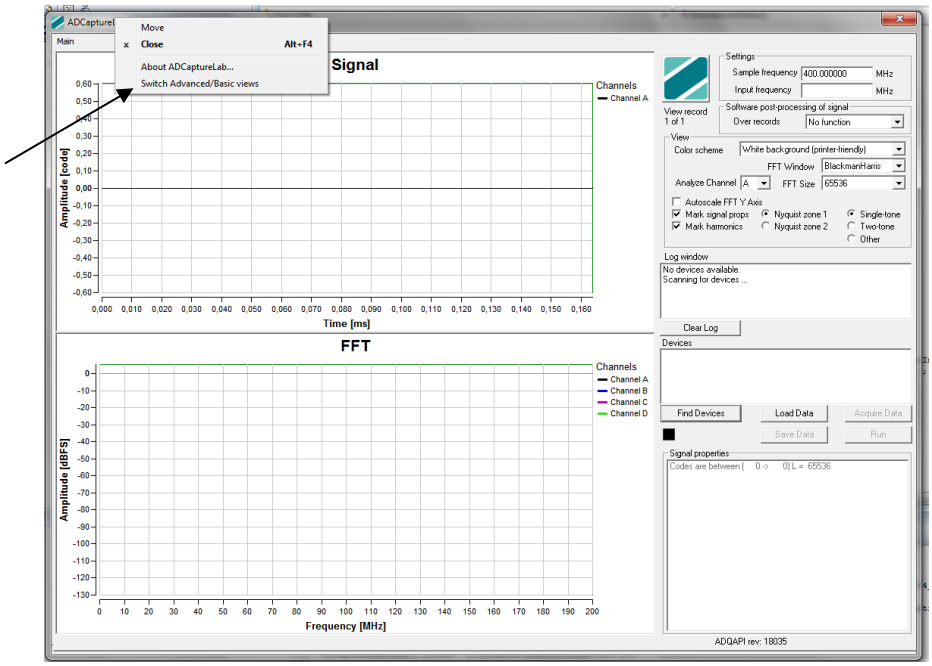
In this mode, you edit the signal with your mouse. You can edit whole/part and zoom and set start of view with the sliders. Let's for instance push all samples close to zero in the middle of the segment.



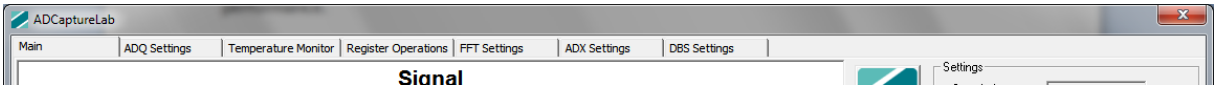
When selecting OK, this edited segment will be transferred back to the AWG Control Tab. If Cancel is selected, all changes will be ignored.

Advanced View Mode

By pressing F4 or selecting in the Window menu (right click window pane), you can switch between the Basic and Advanced View Modes of ADCaptureLab. In the Advanced Mode, several new tabs will be visible, dependent on the device used.



Tabs in Advanced View Mode



Tab name	Description
Temperature Monitor	This tab can be used to monitor the device's internal temperature sensors. It keeps track of maximum and minimum for the different sensors as well as providing a plot.
Register Operations	This tab can be used to write and read registers from the device. Use with care, as writing the wrong registers may damage the device or cause unexpected behavior. If you have a custom user logic module in the firmware it may be controlled from here.
FFT Settings	This tab is used for setting the FFT modes. It can be used to calculate the average FFT over time, track the peak for each frequency. Also, if you would like to show a complex FFT for I/Q channels, this is where it's done.
ADX Settings	This is the control window for the ADX Interleaving IP
DBS Settings	This is the control window for the DBS (Digital Baseline Stabilization)

	IP.

Keyboard Shortcuts

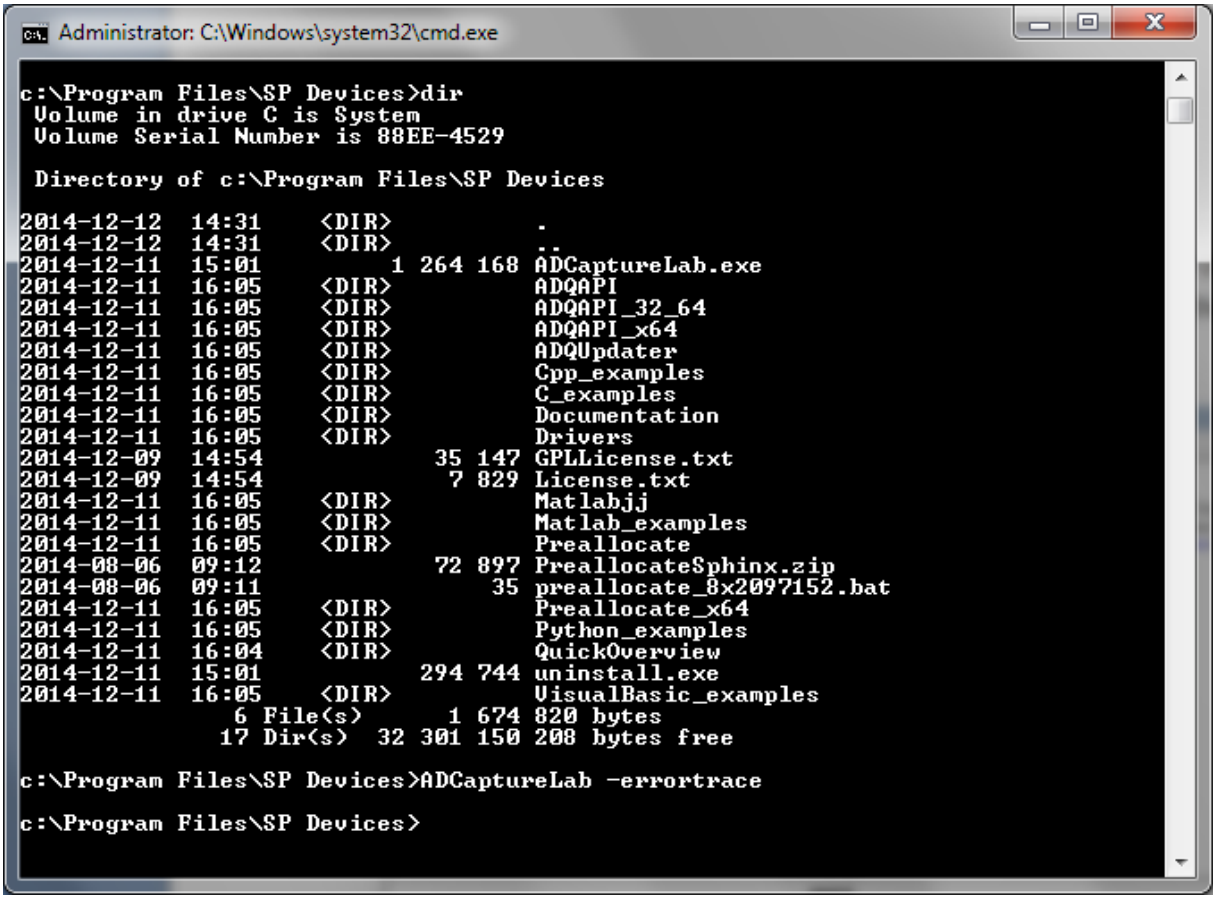
Key	Description
F1	Show version information for ADCaptureLab software.
F2	Show version information for FPGA firmware and FPGA firmware status.
F3	Show digitizer status.
F4	Switch Advanced/Basic View modes
F5	Refresh plots.
F6	Clear plots.
F11	Toggle full-screen modes and “normal” display mode
F12	Toggle the automatic record disk write mode
CTRL+F	Find Devices
CTRL+A	Acquire Data
CTRL+R	Run/Stop
CTRL+S	Save Data
CTRL+I	Import Data
CTRL+UP	Show previous record (in MultiRecord mode)
CTRL+DOWN	Show next record (in MultiRecord mode)
CTRL+F7	Toggle the user logic bypass (on V6 devices only)

Troubleshooting

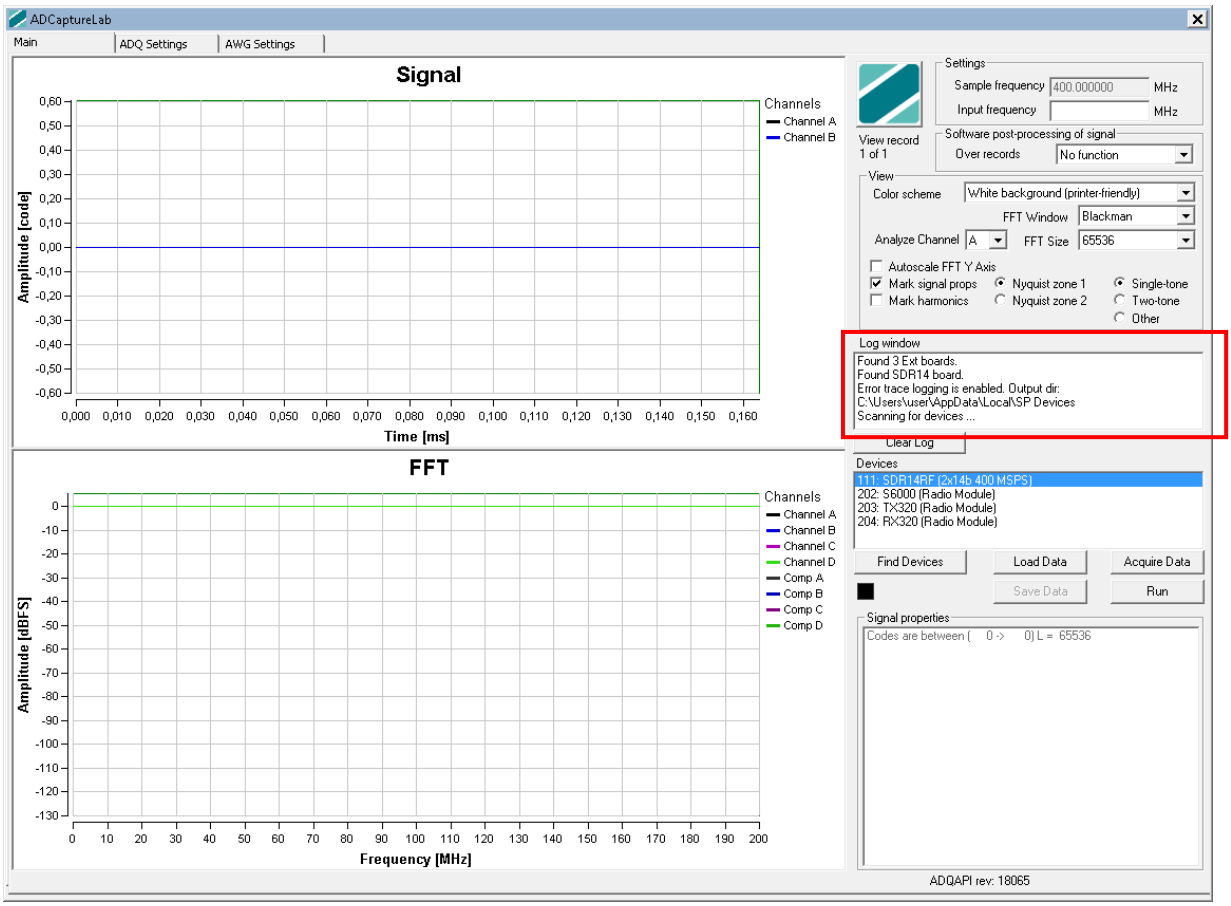
Problem	Remedy
"No devices found" is displayed in the log window when pressing "Find USB Devices".	Check if a compatible digitizer is plugged in via USB. Check if digitizer is powered. Try to turn the power off and on again. Press "Find Devices" again. Restart the software and try again.
Digitizer is found but failed to start. Last Error code was XXXXXX	Try to turn the power off and on again. This could be dependent on software inconsistencies, try to uninstall all SP Devices software and reinstall. If this doesn't help, contact support with information on version and the error code.
Digitizer is connected and found in list, but when trying to acquire digitizer does not respond correctly.	Check if digitizer is powered. Check that correct digitizer format is selected. Try to turn the power off and on again. Press "Find Devices" again, select digitizer and retry.
Time-series plot or FFT plot does not update when acquiring or importing data.	The plot which is not updating may be in "Pause" mode. Move the mouse over the plot to bring up the plot tools. If in "Pause" mode, press the pause symbol so that it changes into a play symbol. See figure below. Press here…  … to change to play mode. 
The "ADQ Settings" tab does not appear.	Make sure that "Find Devices" have been pressed, and that the digitizer has been found.
The "AWG Settings" tab does not appear.	Make sure that "Find Devices" have been pressed, and that the digitizer has been found. Make sure that you have a compatible device for generating signals, such as the SDR14.

ADCaptureLab error logging

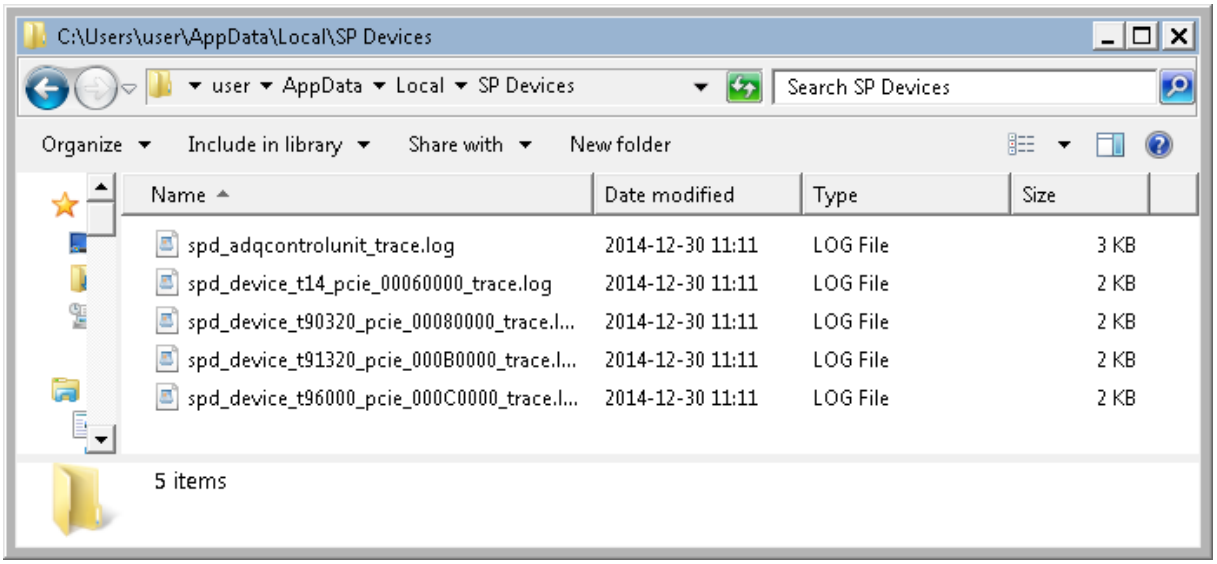
If you have problems with using the device, it could be helpful to provide error logs to our support team. To create such error logs, please run ADCaptureLab from the command line with the command "`ADCaptureLab -errortrace`". See below.



Then ADCaptureLab will start and in the Log Window you will see where the error logs are created.



After failing to use the device, close ADCaptureLab and go to this directory.



Typical contents of spd_adqcontrolunit_trace.log:

```
Log and error trace for ADQControlUnit
API Revision : 18065
INFO : (ADQControlUnit::ListDevices:237) : ListDevices found 0 USB devices.
INFO : (ADQControlUnit::ListDevices:317) : ListDevices found 4 PCIe devices.
INFO : (ADQControlUnit::GetDeviceStatus:1526) : Device at location Bus:6 Slot:0 Function:0 is currently ENABLED.
INFO : (ADQControlUnit::GetDeviceStatus:1545) : Successfully retrievedstatus for device Bus:6 Slot:0 Function:0.
INFO : (ADQControlUnit::ListDevices:361) : Created info entry for PCIe ADQ with pID 0021.
INFO : (ADQControlUnit::ListDevices:468) : ListDevices found 6 USB devices.
INFO : (ADQControlUnit::ListDevices:548) : ListDevices found 4 PCIeLite devices.
INFO : (ADQControlUnit::ListDevices:581) : Created info entry for PCIeLite ADQ with pID 2019.
INFO : (ADQControlUnit::ListDevices:581) : Created info entry for PCIeLite ADQ with pID 201A.
INFO : (ADQControlUnit::ListDevices:581) : Created info entry for PCIeLite ADQ with pID 201C.
INFO : (ADQControlUnit::OpenDeviceInterface:649) : OpenDeviceInterface: Opening interface to device from info list entry 0.
INFO : (ADQControlUnit::OpenDeviceInterface:882) : OpenDeviceInterface: Device interface successfully opened.
INFO : (ADQControlUnit::SetupDevice:902) : SetupDevice: Setting up device from info list entry 0.
INFO : (ADQControlUnit::SetupDevice:908) : SetupDevice: Found opened ADQ object that matches info entry.
INFO : (ADQControlUnit::OpenDeviceInterface:649) : OpenDeviceInterface: Opening interface to device from info list entry 1.
INFO : (ADQControlUnit::OpenDeviceInterface:882) : OpenDeviceInterface: Device interface successfully opened.
INFO : (ADQControlUnit::SetupDevice:902) : SetupDevice: Setting up device from info list entry 1.
INFO : (ADQControlUnit::SetupDevice:908) : SetupDevice: Found opened ADQ object that matches info entry.
INFO : (ADQControlUnit::OpenDeviceInterface:649) : OpenDeviceInterface: Opening interface to device from info list entry 2.
INFO : (ADQControlUnit::OpenDeviceInterface:882) : OpenDeviceInterface: Device interface successfully opened.
INFO : (ADQControlUnit::SetupDevice:902) : SetupDevice: Setting up device from info list entry 2.
INFO : (ADQControlUnit::SetupDevice:908) : SetupDevice: Found opened ADQ object that matches info entry.
INFO : (ADQControlUnit::OpenDeviceInterface:649) : OpenDeviceInterface: Opening interface to device from info list entry 3.
INFO : (ADQControlUnit::OpenDeviceInterface:882) : OpenDeviceInterface: Device interface successfully opened.
INFO : (ADQControlUnit::SetupDevice:902) : SetupDevice: Setting up device from info list entry 3.
INFO : (ADQControlUnit::SetupDevice:908) : SetupDevice: Found opened ADQ object that matches info entry.
End of Log Session for ADQControlUnit
```

Typical contents of a device log, such as the spd_device_t14_pcie_XXXXXXXX_trace.log:

```
Log and error trace from ADQ of type    14
CLEAR:   0: On line   81 in SDR14::Open (file c:\svn\sw_rattlesnake\adqapi\source\sdr14.cpp)
INFO : Industrial grade FPGA detected, increasing overheat limit.
INFO : (ADQ::ReadOptionFromADQDSPEeprom:4997) : Read out motherboard options: -PXIe
INFO : (ADQV6::CheckPLLPart:1281) : Identified PLL as AD9520-4.
INFO : (SDR14::CalibratePll:1349) : PLL VCO cal finished after 1 retry cycles.
 [Log Header]
Operating System       : Windows 7 Unknown architecture
Communication interface: PCIe (Link negotiated as x04g01)
Physical interface     : PCIe or PXIe
Device type (integral) : 14
Device serial no       : SPD-03598
Options                :
Revision of FW #2      : 0018038 (FIRMWARE) MOD
Revision of FW #1      : 0000000
API Revision           : 0018065
API DLL Path           : c:\SVN\SW_Rattlesnake\ADCaptureLab\Debug\ADQAPI.dll
DLL calling executable : c:\SVN\SW_Rattlesnake\ADCaptureLab\Debug\ADCaptureLab.exe
[End of Log Header]
INFO : Successfully initialized the SDR14 device.
End of Log Session for ADQ
```

ADCaptureLab Configuration file

ADCaptureLab reads (if available in same location as ADCaptureLab.exe's working directory) a configuration file called adcapturelab.ini. In this file you may specify some operating conditions for the application.

It is a pure text file, on each line there is a key/value pair as "key=value". Remember that all lines must be ended with a newline.

Key	Values
disable_splash_screen	0 = Use splash screen (default) 1 = Don't show splash screen
record_save_location	String path to the directory where automatic saves of records should be done. Example: record_save_location=C:\tmpdata
record_save_format	1 = 16-bit raw binary data format (default) 2 = 16-bit ASCII format, one sample value per line Example: record_save_format=1

Using MATLAB

Files

The MATLAB interface consists of a mex_ADQ.dll which gives access to the functions in the ADQ API. The calls to the to the mex file is listed in the interface_ADQ.m file. The format for calling interface_ADQ is

>> interface_ADQ('name_of_the_function',[parameter list])

The names of the functions are found in the ADQ API reference documentation. The parameter list is found by looking in the interface_ADQ.m source code.

At set-up, the MATLAB files are located in the folder C:\Program Files\SP Devices\Matlab. It also includes example files for getting started.

Further reference for using MATLAB can be found in the ADQAPI Reference User's Guide.

Functions reference

GPIO

See datasheet of the specific model for GPIO information.

Time stamp

The ADQ has a running counter that enables the user to establish when a certain set of data was captured. The counter runs 4 times the speed of the sampling clock of one ADC.

Operation modes

There are two different modes of operation.

1. Sync Off
2. Sync On

The output from the timestamp depends on which mode the time stamp is in, more about the vector in section 0.

Sync Off

In this mode the full 64 bits are used to represent the number of tics that the counter has achieved.

Sync On

In this mode the lower 42 bits are used for the tic counter, while the upper 22 bits are used for the sync counter.

The GPIO Pin2 is used as start pulse input, to generate sync pulses.

Restart counter

The counter is started automatically upon power on. It is possible to reset the counter by a API command. The counter can be started in two ways, either by software or by sending a pulse into the

GPIO Pin2, the same pin as the sync input. Default is to restart the counter by software upon resetting the counter.

Time stamp vector

Depending on if the sync mode is activated or not affects the time stamp vector, see Table 1 and Table 2.

63 0
Tic counter

TABLE 1 TIME STAMP VECTOR WHEN SYNC IS NOT ACTIVE

63 42	41 0
Sync counter	Tic counter

TABLE 2 TIME STAMP VECTOR WHEN SYNC IS ACTIVE

Translate time stamp to real time

To be able to relate the time stamp to real time one can use the following formulas

Sync off	$t = \frac{n_{tic}}{f_s * 2}$	ADQ214
	$t = \frac{n_{tic}}{f_s}$	ADQ112, ADQ114
Sync on	$t = \frac{n_{sync}}{f_{sync}} + \frac{n_{tic}}{f_s * 2}$	ADQ214
	$t = \frac{n_{sync}}{f_{sync}} + \frac{n_{tic}}{f_s}$	ADQ112, ADQ114

$t = real\ time, \quad n_{tic} = tic\ counter, \quad n_{sync} = sync\ counter$

$f_s = sampling\ frequency\ of\ the\ ADQ, \quad f_{sync} = sampling\ frequency\ of\ sync\ pulse$

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