AlazarDSO

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CHAPTER

ONE

GETTING STARTED

This chapter takes you from a freshly installed AlazarDSO to a measured waveform saved to disk. It assumes a digitizer is installed and its driver is working, and that you have not used AlazarDSO before.

Everything here is covered in more detail later. Where a control is only mentioned in passing, a cross-reference points to its full description.

1.1 What you need

- An AlazarTech digitizer installed in the host, with its driver loaded
- A signal to measure, connected to the digitizer's channel A input
- A cable matched to the input impedance you intend to use

1.2 Starting AlazarDSO

AlazarDSO opens with the configuration it last used. On a first run no saved configuration exists, so it starts from defaults, without saying so.

On a digitizer with four channels those defaults are, broadly:

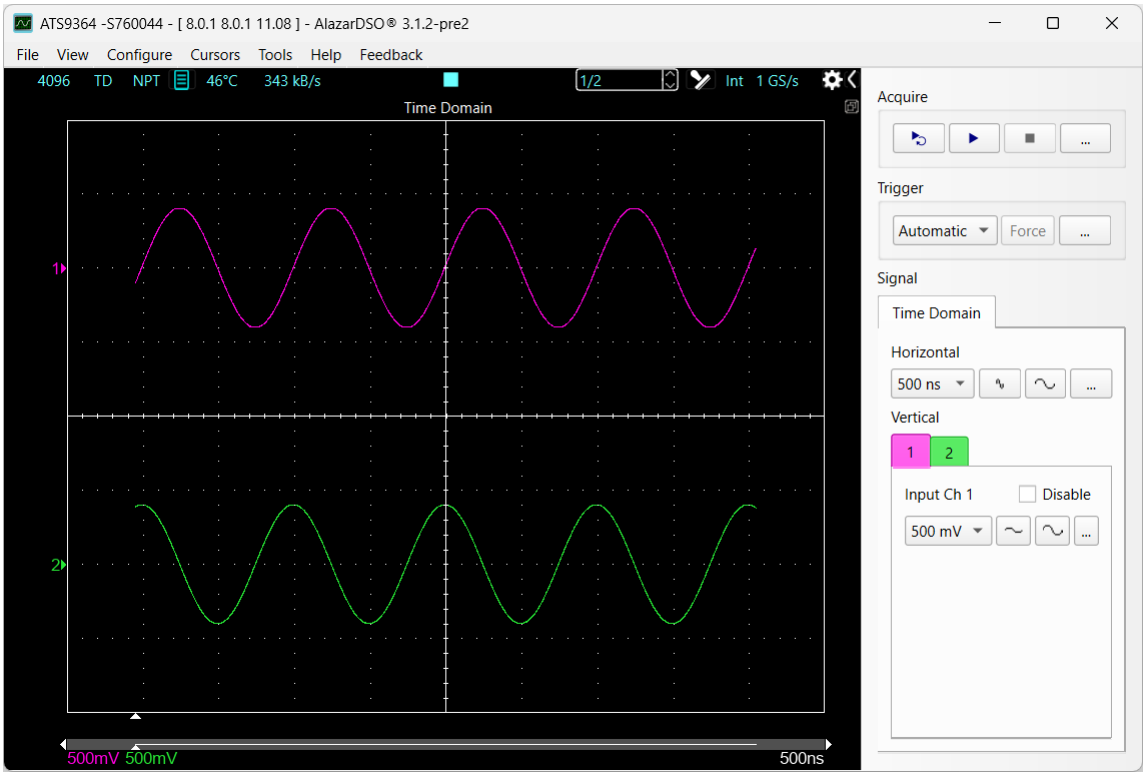


Fig. 1: AlazarDSO at startup

Setting	Default
Acquisition mode	Time domain
Channels	All enabled
Sample clock	Internal, at the digitizer's highest rate for two-channel operation
Record length	8192 samples, or the digitizer's maximum FFT length if it has the FFT firmware option
Records per buffer	1
Buffers per acquisition	Finite, at the smallest count the digitizer allows
AutoDMA mode	NPT
Trigger	Engine J only, on channel A, positive slope, level 140
Input impedance	50 Ω where the digitizer offers it
Input coupling	DC where the digitizer offers it
Input range	± 400 mV where available at that impedance
Probe attenuation	1x

Only the time-domain graph is shown. Every channel is plotted, stacked one above another, and the horizontal scale is set so that one record fills the width of the display.

Nothing is acquired until you ask for it. The graph is empty, the acquisition indicator shows a stop symbol, and the stop button is unavailable.

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1.2.1 Where your settings are kept

AlazarDSO keeps per-user files in the `AlazarTech\AlazarDSO` folder of your Documents directory: the configuration, the chosen language, the display engine, channel colours and labels, and any saved references.

The configuration is written when you close AlazarDSO, not as you change things. Closing the application is what preserves your settings.

> **Note**
>
> If the saved configuration does not match the hardware present — a different number of digitizers, or different models — AlazarDSO silently returns to defaults. No message is shown, and the old settings are replaced when you next exit.

1.3 Choosing an acquisition mode

Before anything else, decide what the digitizer should produce. AlazarDSO offers three acquisition modes, and the choice determines which settings apply and which displays appear.

Mode	What the digitizer produces
Time domain	Sample records, displayed as waveforms against time. The familiar oscilloscope behaviour, and the right choice for a first measurement.
On-FPGA FFT	Spectra, calculated on the digitizer itself. Far less data crosses the bus, so spectra can be captured at trigger rates a host could not keep up with. Requires a digitizer with the FFT firmware option.
ATS-GPU	Processing performed on a graphics card, including the resampling and dispersion correction used in optical coherence tomography. Requires a CUDA-capable GPU.

Set the mode in **Configure ▸ Acquire…**; see *Configure Acquire*.

A transform can also be calculated by the host processor while acquiring in the time domain, which needs neither FFT firmware nor a GPU. See *Configure CPU FFT*.

For the rest of this chapter, leave the mode set to Time domain.

1.4 Your first acquisition

1.4.1 Setting up the input

Open **Configure ▸ Input ▸ Ch 1…**.

1. Set **Input impedance** to match your cable and source. Use 50 Ω for a 50 Ω line; use 1 MΩ for high-impedance probing.
2. Set **Input range** to the smallest range that contains your signal. A signal larger than the range is clipped; a range far larger than the signal wastes resolution.

3. Leave **Input coupling** at DC unless you need to block a DC offset.
4. Set **Probe attenuation** to match your probe. Leave it at 1x for a direct cable connection.

Press **Ok**. See *Input Channel* for the full description.

> **Warning**
>
> Check the digitizer's specifications before connecting a signal. Exceeding the maximum input voltage can damage the converter, and the limit at 50 Ω is usually much lower than at 1 MΩ.

1.4.2 Setting up the trigger

A trigger tells the digitizer when to start a record. Without a stable trigger the display will not settle.

Open **Configure ▶ Trigger…**.

1. Set **Source** under **Engine J** to the channel carrying your signal.
2. Leave **Slope** at positive.
3. Leave **Level** at its default for now.

If the display does not settle, set **Level** to roughly the middle of your signal's excursion. The level is a code from 0 to 255 spanning the input range, so a signal centred on zero triggers at **128**.

Press **Ok**. See *Configure Trigger*, which includes a table converting between the level code and volts.

1.4.3 Setting the timebase

Open **Configure ▶ Clock…** and choose a sample rate at least five times the highest frequency of interest — considerably more if you want to see the shape of a waveform rather than just measure its frequency.

Press **Ok**. See *Configure Clock*.

1.4.4 Acquiring

Press the start button in the settings sidebar.

The acquisition state indicator in the heads-up display shows what is happening:

- a **play** symbol while data is arriving normally
- an **hourglass**, rotating, while AlazarDSO waits for data

A persistent hourglass means triggers are not arriving. Check the trigger source and level, and that your signal is actually present.

See *The Main Window* for the rest of the heads-up display.

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1.5 Reading the display

The waveform is drawn against a graticule of five divisions horizontally and eight vertically.

Horizontal scale
: Set per division from the **Horizontal** list in the settings sidebar. The buttons either side zoom out and in.

Vertical scale
: Set per division from the **Vertical** tab for the channel. The scale ladder runs from 500 μV to 20 V per division, so a setting of 1 V spans 8 V from top to bottom.

To separate overlapping channels, use **Vertically equidistant** in **Configure ▶ Display. . .** ; see *Time-Domain Display*.

1.6 Measuring with cursors

Cursors measure intervals on the graph.

1. Open the **Cursors** menu and choose **Horizontal** for the time-domain graph. A pair of vertical lines appears, with a readout window.
2. Drag each cursor to the points you want to measure between.
3. The readout gives both positions and the interval between them, as Δ**T**.

Vertical cursors work the same way for levels, giving Δ**V**.

See *The cursor window*, which also explains why horizontal cursors are drawn as vertical lines.

1.7 Saving your data

Stop the acquisition, then choose **Save Data** from the **File** menu.

1. Enter a file name, or accept the date and time AlazarDSO offers.
2. Choose a directory.
3. Choose a format. **JSON** is the only format AlazarDSO can read back, and it writes a companion `.bin` holding the sample data.
4. Press **Save**.

See *Save Records* for the controls, and *File Formats* for what each format contains.

> **Note**
>
> Sample values are written as raw converter codes, not volts. Converting them requires the input range, which is recorded in the JSON file.

To reopen a saved acquisition, choose **Load Data** from the **File** menu. The records appear as reference traces in a separate window.

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1.8 Saving your configuration

Once the instrument is set up the way you want it, save the settings so you can return to them.

Choose **SaveConfig** from the **Configure** menu, or press `Ctrl+S`. **LoadConfig**, or `Ctrl+O`, restores them.

> **Note**
>
> Configuration files are tied to the digitizer model they were saved from. A configuration saved on one model will not load onto a different one.

LoadDefault returns everything to its initial state, which is the quickest way to recover from a configuration you no longer understand.

1.9 Where to go next

To do this	See
Understand every control in a window	*Configuration Reference*
Acquire spectra instead of waveforms	*Configure On-FPGA FFT*, *Configure ATS-GPU*, *Configure CPU FFT*
Measure the dynamic performance of a signal	*Spectrum information*
Acquire from more than one digitizer	*Configure System*
Stream data continuously	*Stream To Memory*
Find out whether your system can sustain a rate	*Bus benchmark*
Understand a message AlazarDSO displayed	*Messages*
Write your own reader for a saved file	*File Formats*

1.10 If you have no digitizer yet

With no digitizer detected, AlazarDSO offers a **No boards found!** dialog box listing eighteen models. Choose one and press **Ok** to continue in simulation mode, or press **Exit** to close.

Simulation mode builds a stand-in from the chosen model's published capabilities, so you can open every configuration window and see the ranges, impedances, sample rates and trigger sources that model offers.

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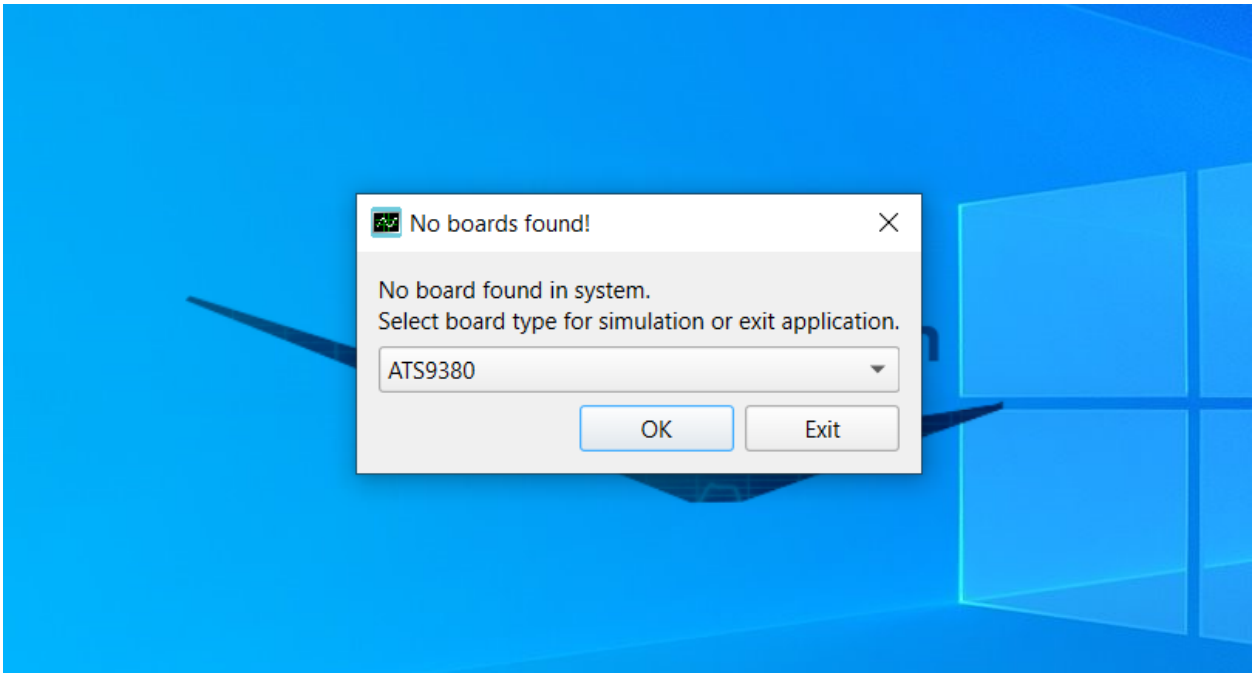


Fig. 2: No boards found

Warning

Simulation mode does not generate any data. Pressing start reports that the board system could not be opened. There is no synthetic waveform.

What simulation mode is good for:

- exploring the configuration windows for a model you are evaluating
- opening previously saved data files, with cursors, references and a CPU FFT
- setting up display, language and configuration preferences

What it cannot do: acquire, stream to memory, or run the bus and managed-buffers benchmarks. The firmware and driver versions shown in Board Properties are placeholders, not real values.

Note

Digitizers of an older, single-ported generation are not supported. AlazarDSO reports that it does not support single-port boards and suggests using a version of AlazarDSO earlier than 3.

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CHAPTER

TWO

THE MAIN WINDOW

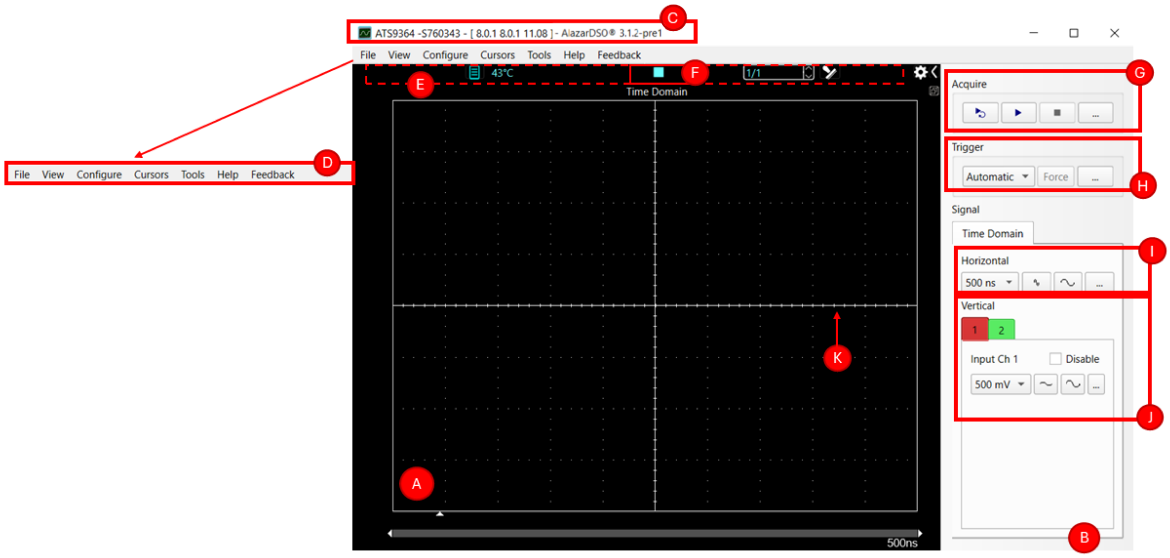


Fig. 1: Main window

	Region
A	**Graph area.** Waveforms and spectra are drawn here. Right-click for **Center** and **Take Screenshot**.
B	**Settings sidebar.** The controls used while measuring. Hide it with the arrow in the heads-up display.
C	**Title bar.** The digitizer model and serial number, the firmware versions, and the AlazarDSO version.
D	**Menu bar.** See *Menu Reference*.
E	**Heads-up display.** Acquisition state and settings, described below.
F	**Acquisition state indicator.** Stop, play or a rotating hourglass.
G	**Acquisition controls.** Start, start looping and stop.
H	**Trigger.** The trigger mode, **Force**, and a button opening *Configure Trigger*.
I	**Horizontal scale.** The scale per division for the selected graph, with zoom buttons either side.
J	**Vertical channel tabs.** One tab per channel, carrying that channel's vertical controls. Right-click a tab to change its colour or label.
K	**Graticule.** Five divisions horizontally and eight vertically, against which the scale settings are read.

2.1 The heads-up display



Fig. 2: Heads-up display

The heads-up display reports the state of the acquisition without taking space from the graph area. Most of its indicators have no visible label; hover over one to see what it shows.

2.1.1 Acquisition state

A single icon reports what the acquisition is doing.

Icon	Meaning
Stop	No acquisition is running.
Play	Acquiring, with data arriving normally.
Hourglass	Waiting for data from the digitizer. The icon rotates while waiting.

While the hourglass is shown, hovering over it displays how long AlazarDSO has been waiting, counting up each second. A wait that continues to climb usually means triggers are not arriving — check the trigger configuration and the signal at the trigger source.

This icon is an indicator; there is nothing to click.

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2.1.2 Acquisition indicators

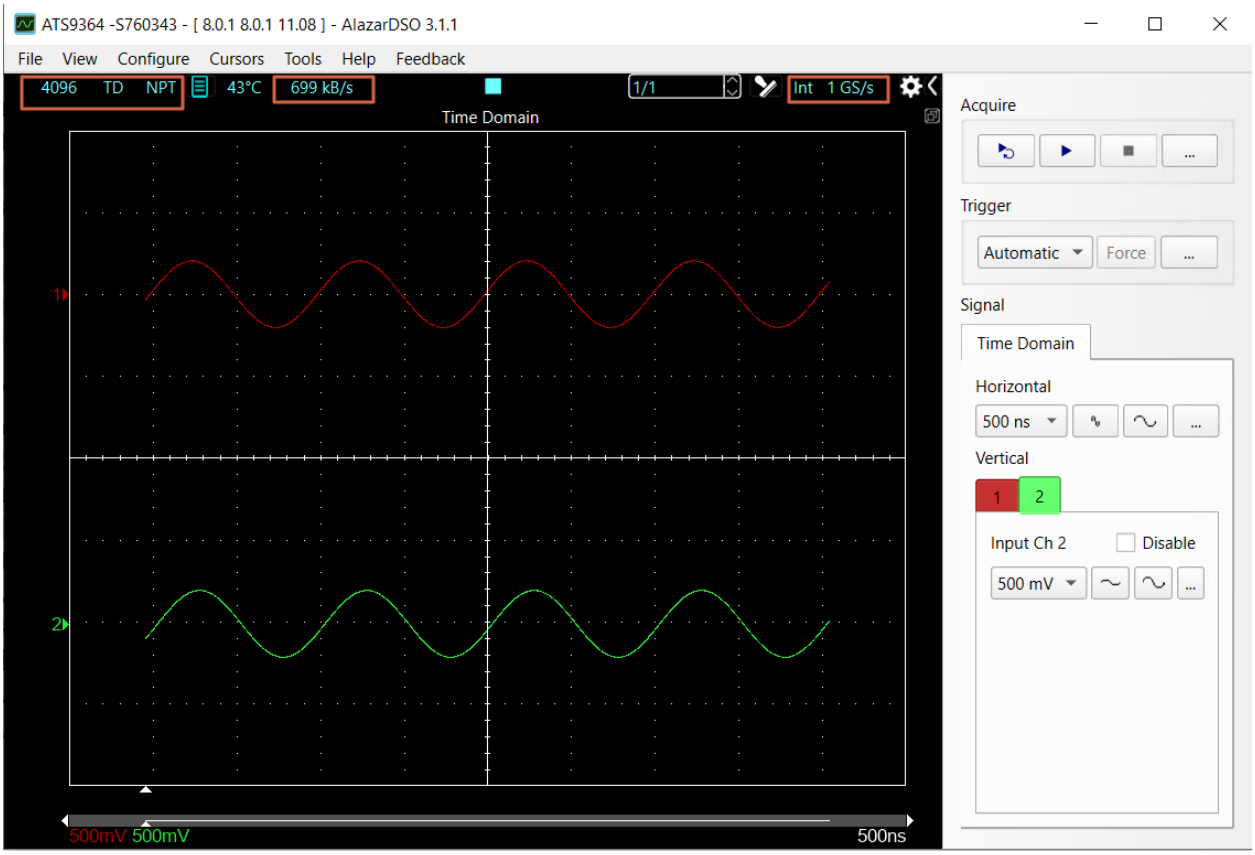


Fig. 3: Acquisition indicators

Indicator	Shows
Rate	Either the number of FFTs calculated per second, or the data throughput in bytes per second, depending on the acquisition mode. The tooltip says which.
Sample rate	The current sample rate. Empty when an external clock is in use.
Record length	The record length in samples.
Acquisition mode	`TD` for time domain, `FPGA` for on-FPGA FFT, or `GPU` for ATS-GPU.
AutoDMA mode	`TR`, `CS`, `NPT` or `TS`. The tooltip gives the full name.
Clock source	`Int` or `Ext`.
Temperature	The digitizer's FPGA temperature, or `--°C` if the model does not report one.

Note

Double-clicking an indicator opens the configuration window that controls it. Double-clicking the record length or either mode indicator opens *Configure Acquire*; double-clicking the sample rate or clock source opens *Configure Clock*.

2.1.3 Record selection

A record selector shows which record of the current buffer is displayed, as `n/N`. Change it to step through the records in the buffer.

Beside it is a button carrying a stamp icon, which opens the NPT footer viewer. See *NPT Footers*. The record selector there and this one follow each other.

2.1.4 Other controls

Control	Action
Gear	Opens *Configure Display*.
Arrow	Hides or shows the settings sidebar. The arrow reverses to indicate which it will do.
Page	Shows whether ATSApi logging is on, through its tooltip.

2.2 The settings sidebar

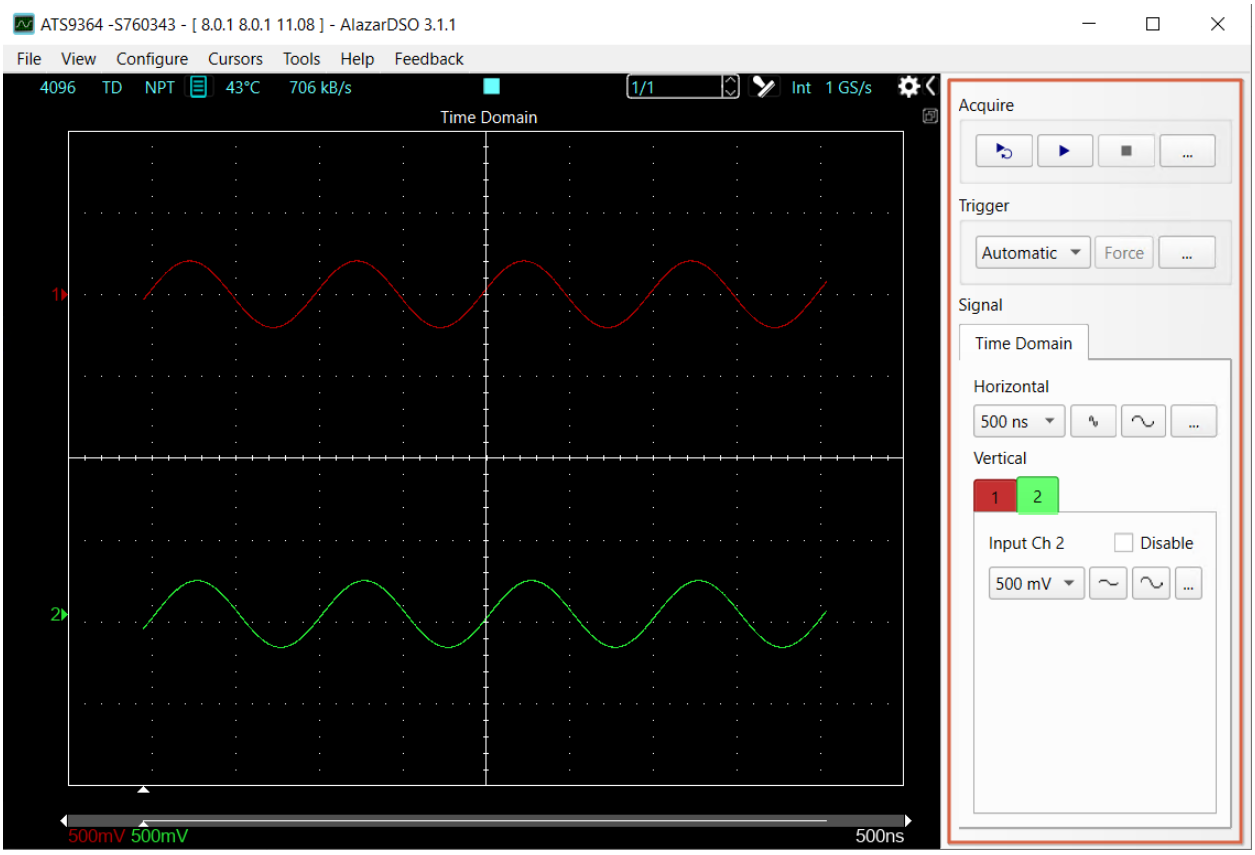


Fig. 4: Settings sidebar

The sidebar holds the controls used *while* measuring, as opposed to those used when setting an instrument up. Hide it with the arrow button in the heads-up display to give the graph area the full

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width of the window.

Each section carries a **...** button that opens the configuration window behind it, so the settings are reachable without going to the **Configure** menu.

2.2.1 Acquire

Three buttons control the acquisition: start, start looping, and stop.

Start
: Begin acquiring. With a finite number of buffers set in *Configure Acquire*, acquisition stops once they have been captured.

Start looping
: Begin acquiring and restart automatically each time the acquisition completes successfully, until **Stop** is pressed.

Stop
: End the acquisition. It stops after the buffer in progress rather than immediately.

> **Note**
>
> With an infinite number of buffers the two start buttons behave identically, since the acquisition only ends when stopped or when an error occurs, and neither case restarts it.

2.2.2 Trigger

Force
: Trigger the digitizer immediately, without waiting for the trigger condition. Use this to capture a record when the expected trigger is absent, or to confirm the signal path is working.

The **...** button opens *Configure Trigger*.

2.2.3 Signal

Two tabs, **Time Domain** and **FFT**, carry the display controls for the corresponding graph.

> **Note**
>
> There is no tab here for the two-dimensional FFT display. Its settings are in *FFT 2D Display*.

Each tab has the same structure.

Horizontal
: A list selecting the horizontal scale per division, with buttons either side to zoom out and in.

  On the Time Domain tab a **...** button opens *Configure Clock*.

Vertical
: One tab per channel, holding that channel's vertical controls — a **Disable** check box, the scale list, and a **...** button opening that channel's input settings.

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Channels are labelled **Input Ch 1**, **Input Ch 2** and so on in the time domain. On the FFT tab they read **Ch** *n* **- FFT**, becoming **Ch** *n* **- FPGA FFT** or **- GPU FFT** according to the acquisition mode.

A second row of tabs appears once reference traces exist, labelled **Reference 1** and so on. See *Time-Domain Display*.

2.2.4 Channel colour and label

Right-click a channel tab in the **Vertical** tab bar.

Change Color
Choose the colour used to draw this channel, in every graph and in the cursor readout. The channel's original colour is offered as a custom colour, so it can be restored.

Two colours have a special meaning. Entering one of them draws the trace using a colour map, so that its brightness varies along the trace rather than being a single flat colour:

Colour map	RGB	Hexadecimal
Viridis	34, 167, 132	`#22A784`
Plasma	204, 71, 120	`#CC4778`

The values must be exact. Choosing any other colour afterwards returns the trace to ordinary drawing.

Change Label
Enter a short name for this channel, used in place of its number wherever the channel is identified.

Labels are limited to three characters, and to unaccented Latin letters, digits and punctuation.

Colours and labels are remembered between sessions, and apply to reference traces as well as to input channels.

2.3 Working with graphs

Right-click a graph for two actions.

Center
Scroll the graph so that the point clicked becomes the horizontal origin.

This affects the horizontal position only. It does not change the vertical position, and it does not change either scale. It is unavailable on the two-dimensional FFT display.

Take Screenshot
Capture the graph and open a preview, from which the image can be saved to a file or copied to the clipboard. See *File Formats*.

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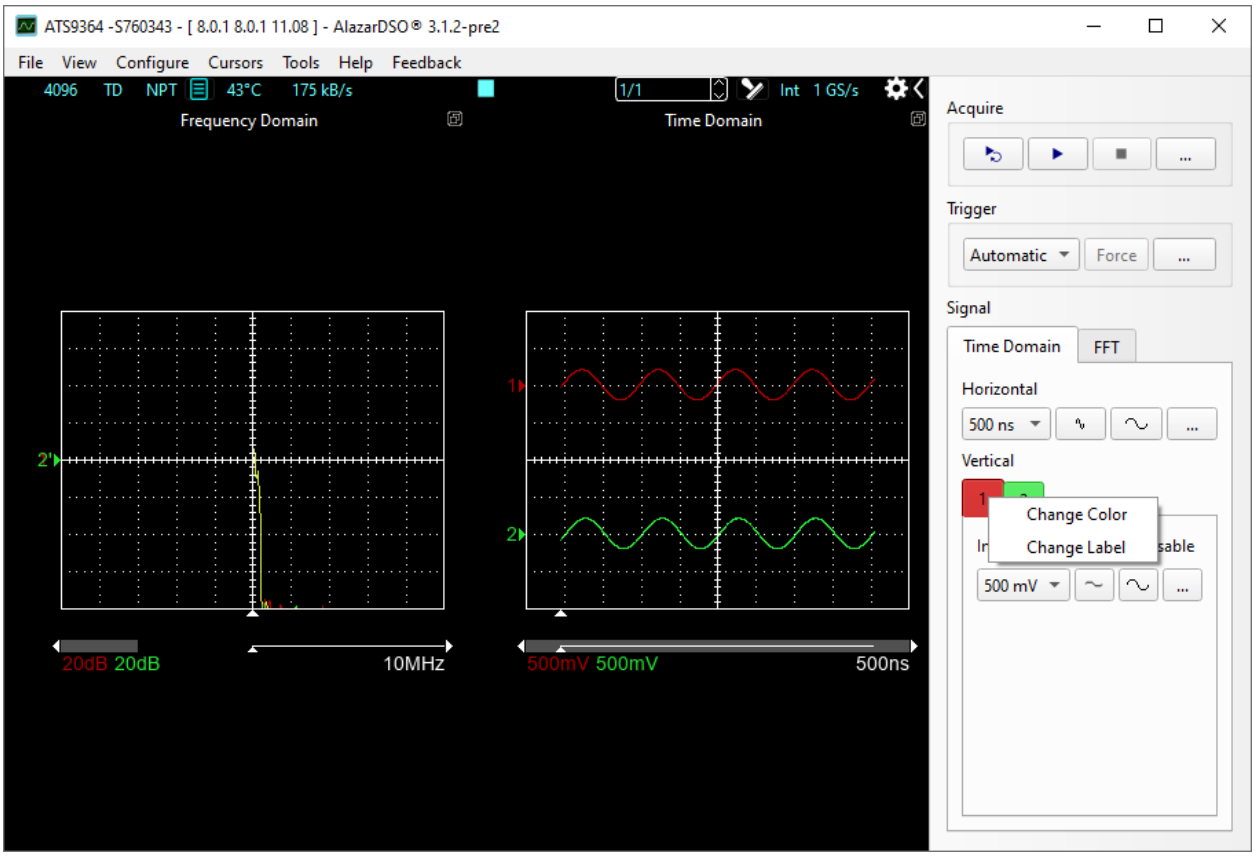


Fig. 5: Changing a channel's colour or label

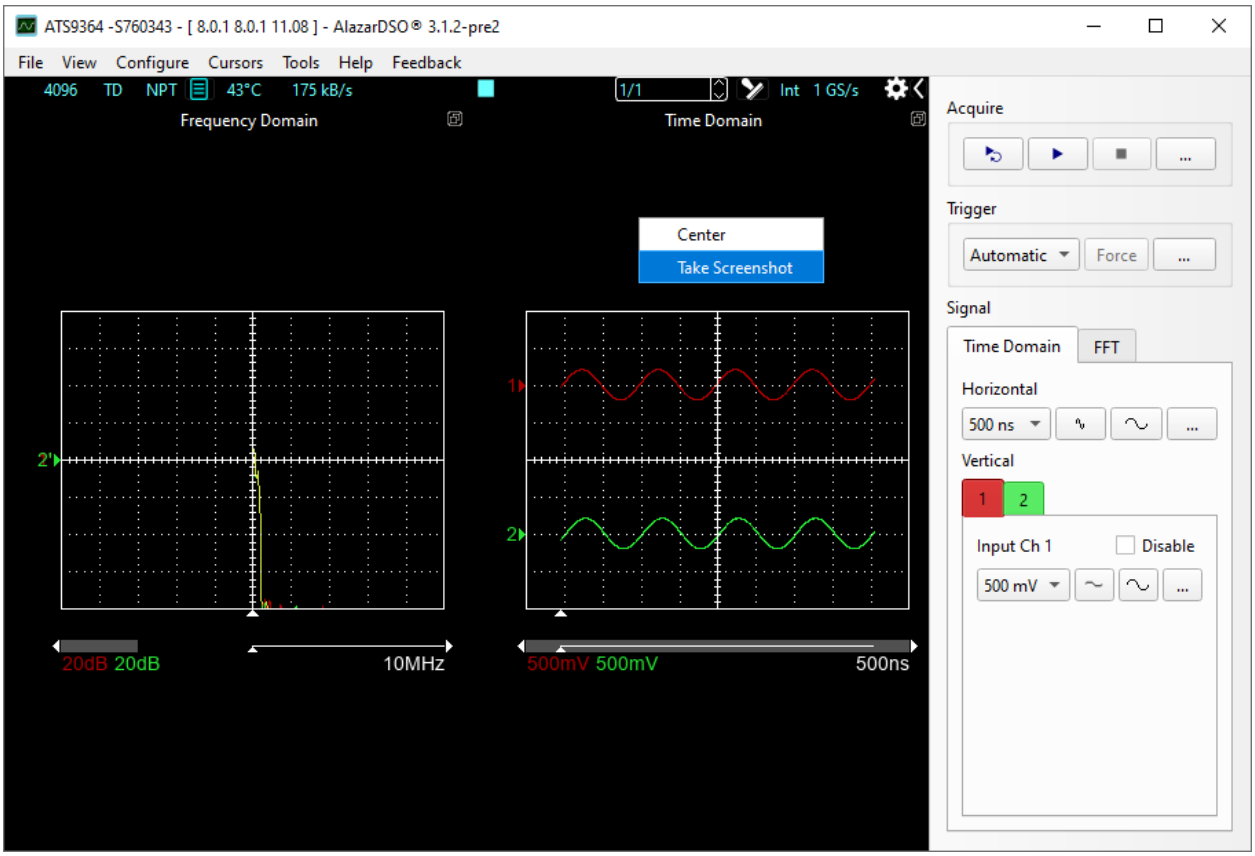


Fig. 6: Graph context menu

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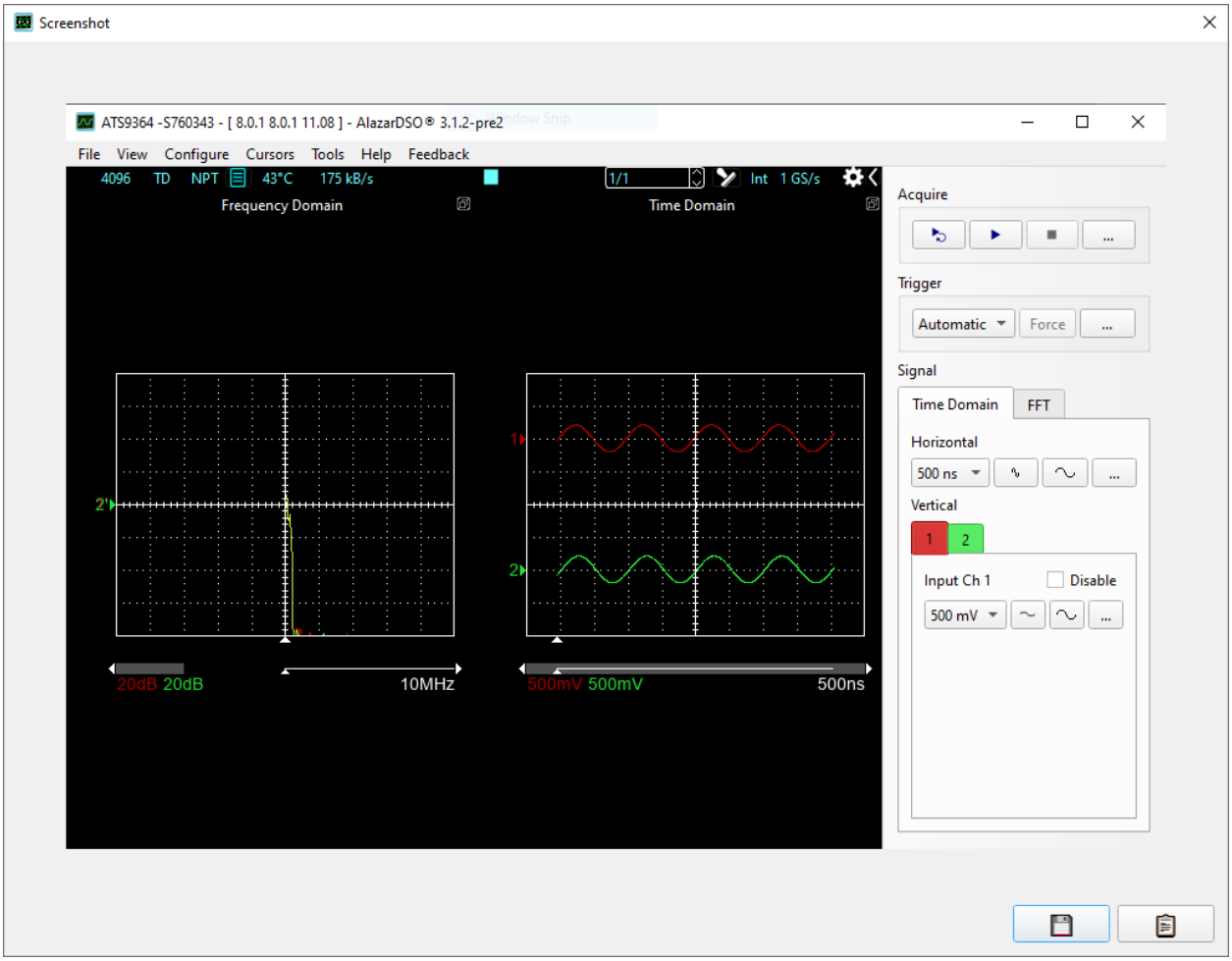


Fig. 7: Screenshot preview

2.4 The cursor window

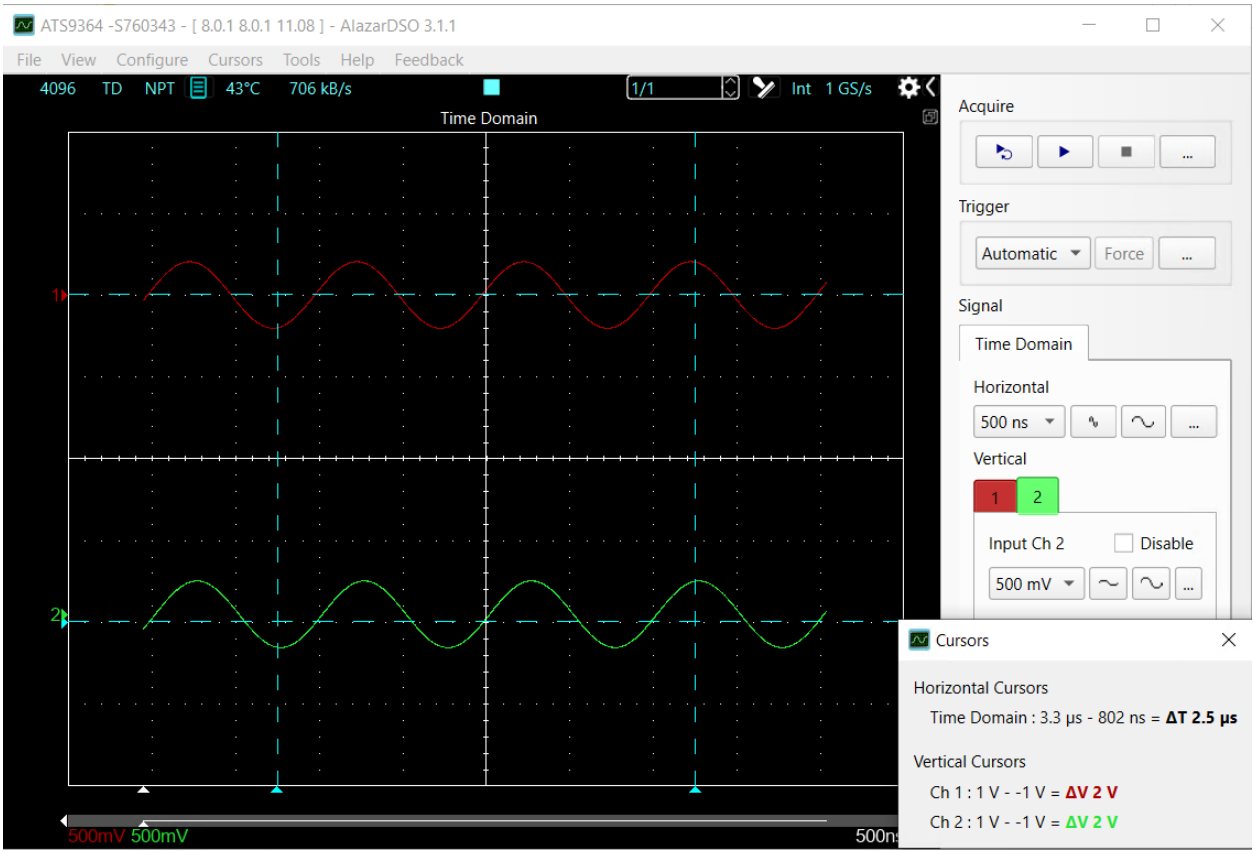


Fig. 8: Cursor window

Cursors measure intervals on a graph. Show and hide them from the **Cursors** menu; see *Menu Reference*. The readouts appear in a separate window, which opens when the first cursor pair is shown and closes itself when the last is hidden.

2.4.1 Horizontal cursors

One row per graph, giving the position of each cursor and the interval between them.

> **Note**
>
> **Horizontal cursors** measure along the horizontal axis, and are drawn as vertical lines. **Vertical cursors** measure along the vertical axis, and are drawn as horizontal lines.

Graph	Units	Interval
Time Domain	Seconds, or samples	ΔT
FFT	Hertz, or bins	Δf

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2.4.2 Vertical cursors

One row per channel per graph, giving each cursor's level and the difference between them. The difference is shown in the channel's own colour, so rows can be matched to traces at a glance.

Time-domain levels are in volts, with the difference shown as ΔV. Spectrum levels are in decibels.

Rows are labelled with the channel's label where one has been set, and its number otherwise. Spectrum rows are marked **- FFT** or **- CPU FFT** according to which transform produced them.

> **Note**
>
> Cursors are available on the time-domain and FFT graphs. The two-dimensional FFT display does not support them.

2.4.3 Positioning cursors

Cursors are moved by dragging them with the mouse. There is no keyboard control and no way to type a position.

2.4.4 Units

The units follow the sample clock and are not separately selectable.

With an internal clock, or an internal or external 10 MHz reference, the time-domain readout is in seconds and the spectrum readout in hertz.

With an external clock, AlazarDSO cannot know the true sample rate, so the readouts are in samples and in frequency bins instead.

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CHAPTER

THREE

CONFIGURATION REFERENCE

AlazarDSO settings are grouped into a number of configuration windows, each opened from the **Configure** menu. This chapter describes the controls in each one.

3.1 Working with configuration windows

Each window is independent. Several may be open at once, and the main window stays usable while they are, so a setting can be changed and its effect watched without closing anything.

Every configuration window carries the same three buttons.

Ok
: Apply the changes and close the window.

Cancel
: Discard the changes and close the window. The controls are restored from the last applied configuration.

Apply
: Apply the changes and leave the window open.

> **Note**
>
> Changing a control has no effect until **Ok** or **Apply** is pressed. Closing a window with the title bar close button discards changes, exactly as **Cancel** does, and no confirmation is asked for.
>
> Some controls do take effect immediately in one limited sense: editing them may enable or disable other controls in the same window. The values themselves are still not applied until **Ok** or **Apply**.

Configuration windows can be resized, and keep their position while the application is running. They are not restored to that position the next time AlazarDSO is started.

3.2 Where each window is

Most windows have their own entry in the **Configure** menu. Two do not.

Window	How to open it
Configure System	**Configure ▶ System...**
Configure Acquire	**Configure ▶ Acquire...**
Configure Trigger	**Configure ▶ Trigger...**
Configure Clock	**Configure ▶ Clock...**
Configure Channels	**Configure ▶ Input ▶ Ch 1...**
Configure AUX I/O	**Configure ▶ Input ▶ Aux I/O...**
Configure On-FPGA FFT	**Configure ▶ On-FPGA FFT...**
Configure ATS-GPU	**Configure ▶ GPU FFT...**
CPU FFT	**Configure ▶ CPU FFT...**
Configure Display	**Configure ▶ Display...**
Board Properties	**Configure ▶ System...**, select a board, then **Properties...**

The **Input** submenu carries one **Ch** entry per input channel in the active system, so the number of entries depends on the digitizer.

> **Note**
>
> The **GPU FFT...** menu item opens a window titled **Configure ATS-GPU**.

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Note

When AlazarDSO is opened on a saved data file rather than on a digitizer, only the FFT windows and **Display...** remain available. The other configuration entries are hidden for the lifetime of that window.

3.2.1 Configure System

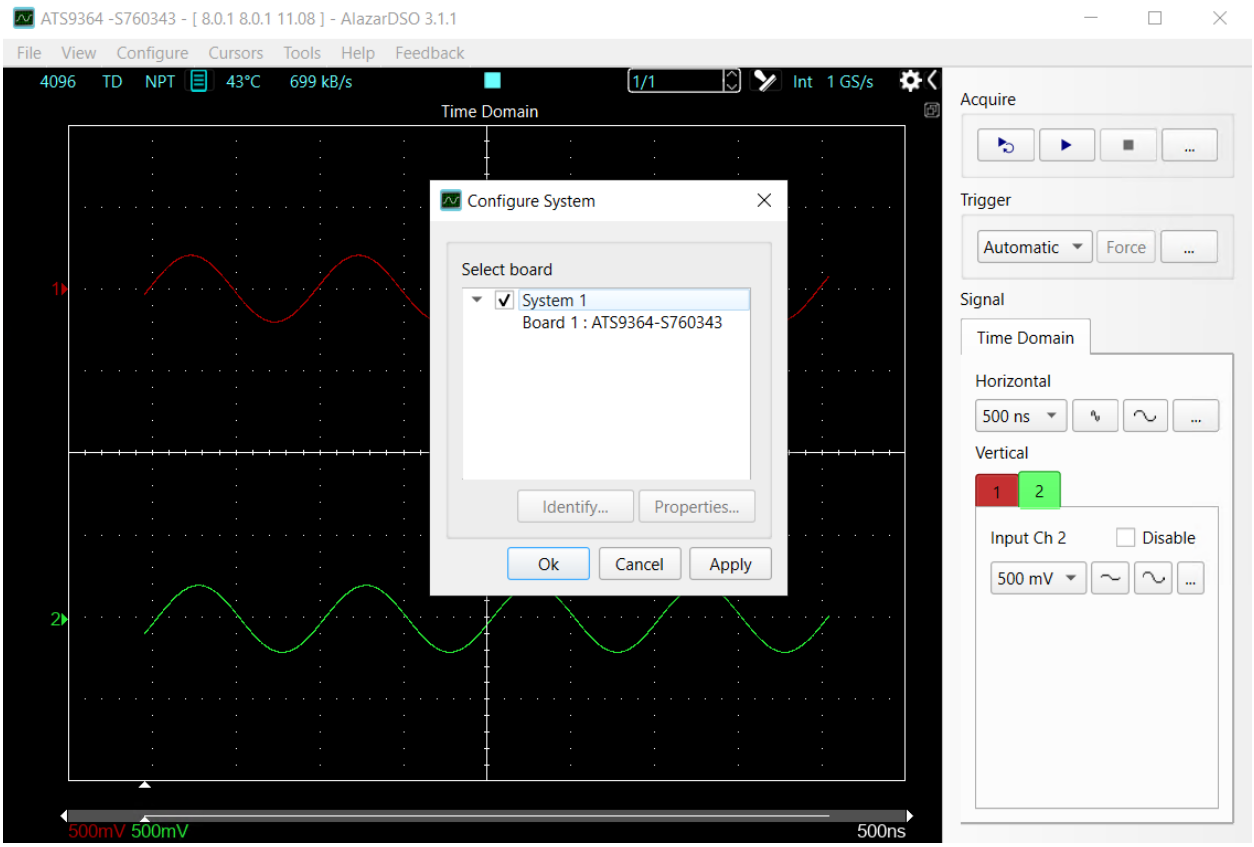


Fig. 1: Configure System window

The **Configure System** window defines which digitizers AlazarDSO acquires from, and how they are grouped.

Open it with **System...** from the **Configure** menu.

Board systems

A *board system* is a group of one or more digitizers that acquire together as a unit. Boards in a system are configured and started as one; each system acquires independently of the others.

A single digitizer is the common case and forms a system of one. Combining several digitizers into one system allows an acquisition to span more channels than any single board provides, with the boards sharing a clock and trigger through an ATS-SyncBoard.

Note

Support for acquiring from multi-board systems was added in AlazarDSO 3.1.0.

Window layout

The window has two trees. **Select board** on the left lists the digitizers not currently assigned to a system; **Systems** on the right lists the systems and the boards belonging to each.

The **Test** column beside the **Systems** tree shows each board's connection test result: a question mark until the board has been tested, and a tick once it passes. See *ATS Sync Connection*.

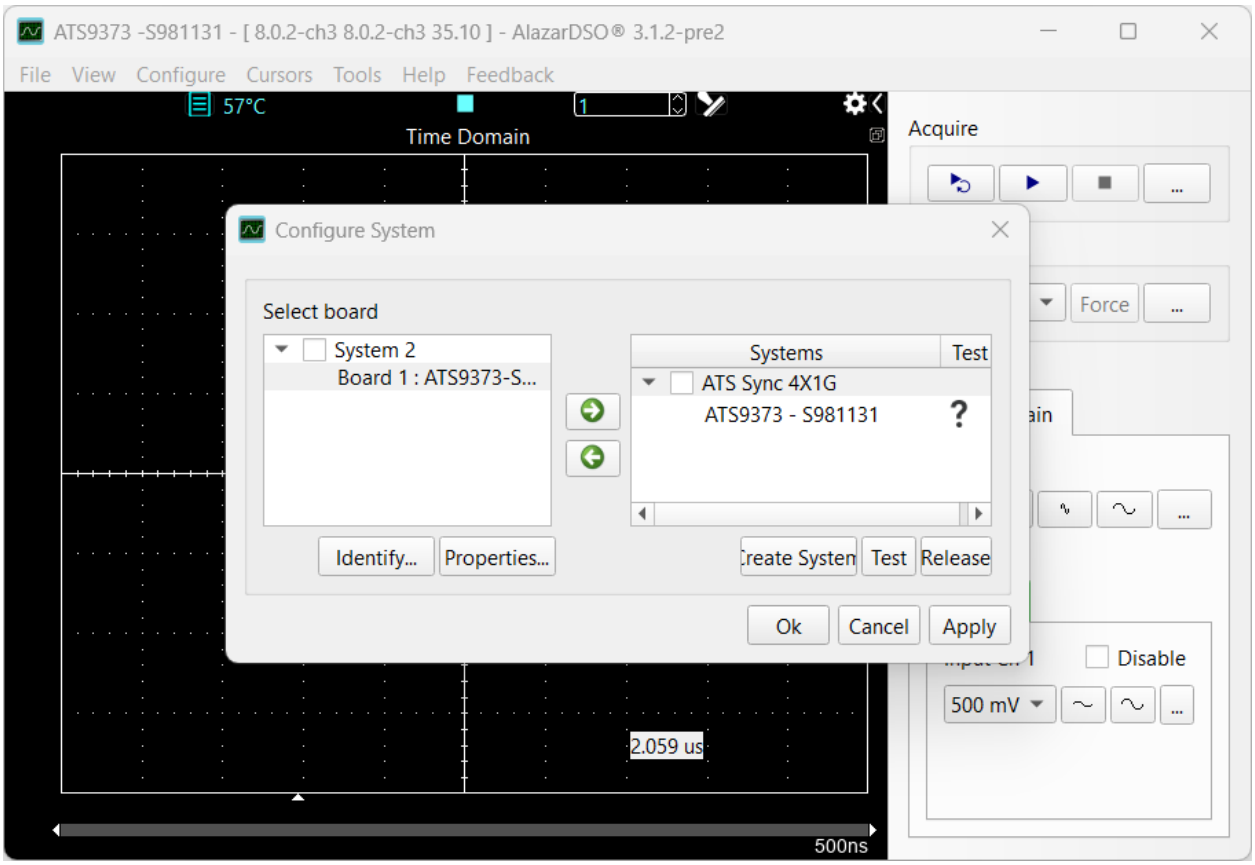


Fig. 2: One board assigned to an ATS-Sync system, one still unassigned

Boards are moved between the two trees by dragging them.

Controls

Identify. . .

Flash the LED on the selected digitizer's mounting bracket, so that a board named in software can be located physically in a host containing several. The LED continues to flash until the identify window is closed, and acquisition is not interrupted.

Properties. . .

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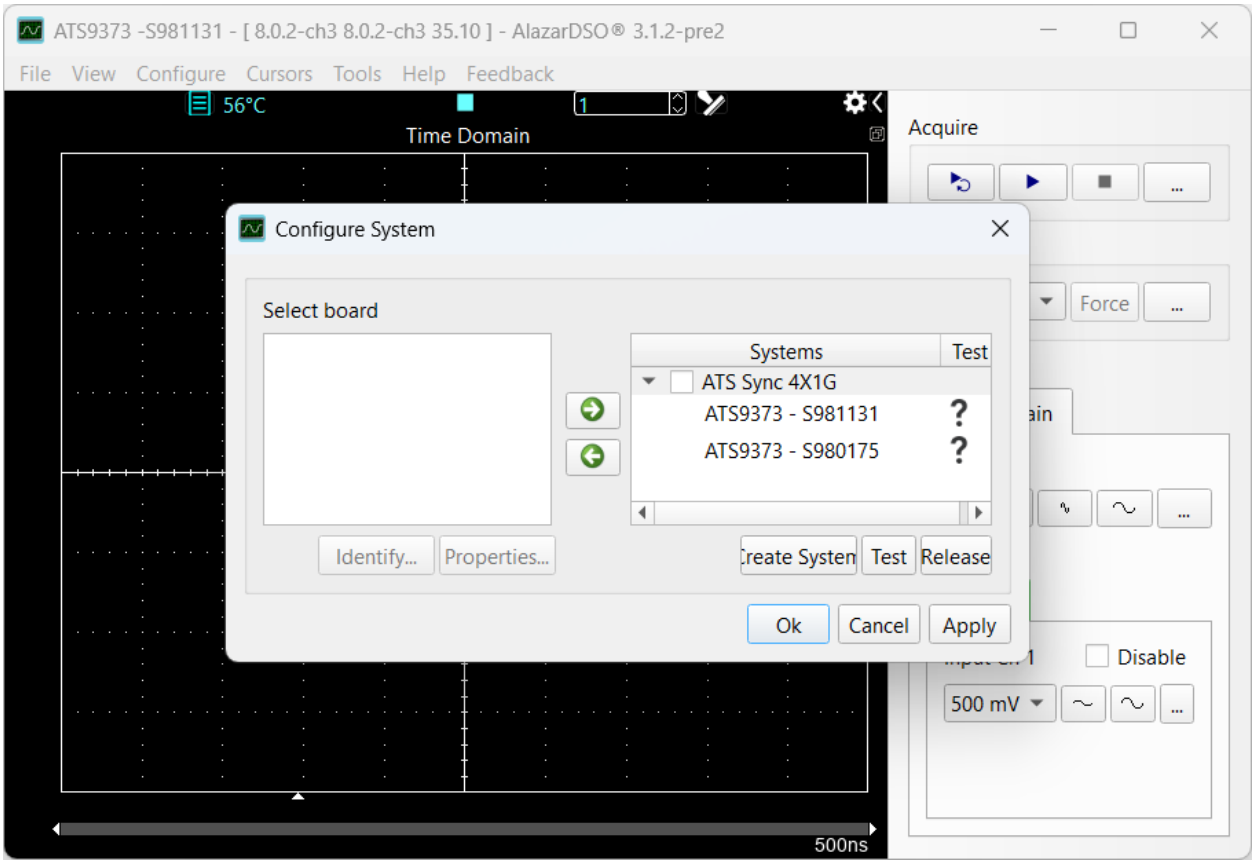


Fig. 3: Both boards assigned; the left tree is now empty

Display *Board Properties* for the selected digitizer.

Disabled until a board is selected. Selecting a system rather than a board leaves it disabled.

ATS-Sync systems

These three controls appear when ATS-Sync hardware is present.

Create System
Combine the digitizers in the **Systems** tree into an ATS-Sync system.

Test
Open the **ATS Sync Connection Wizard**, which guides the cabling and then tests the clock and trigger connections to each board. See *ATS Sync Connection*.

Release
Release the selected ATS-Sync system, returning its digitizers to the unassigned list so they may be assigned elsewhere.

> **Note**
>
> On a system with no ATS-Sync hardware these three controls and the arrow buttons are not shown at all — not merely unavailable — leaving **Identify...**, **Properties...**, **Ok**, **Cancel** and **Apply**.

Requirements for an ATS-Sync system

An ATS Sync 4X1G distributes a common clock and trigger to as many as four digitizers. The digitizers need not be the same model, and may even run at different sample rates, though in that case only the trigger is synchronised.

PCI Express and Thunderbolt 3 digitizers work with ATS Sync; older PCI digitizers do not.

Each digitizer must be set to use the external clock and to trigger on the external trigger input — see *Configure Clock* and *Configure Trigger* — and the cabling must be in place before the connection test will pass. See *ATS Sync Connection*.

3.2.2 Configure Channels

The **Configure Channels** window configures the analog input channels of the boards in the active system. It presents one tab per channel; the controls within a tab are described in *Input Channel*.

To open this window, select **Input** from the **Configure** menu and then the channel you want, **Ch 1...**, **Ch 2...** and so on. Each entry opens the same window with that channel's tab selected.

Channel numbering

AlazarDSO numbers input channels sequentially across every board in the active system. On boards with two analog inputs per digitizer:

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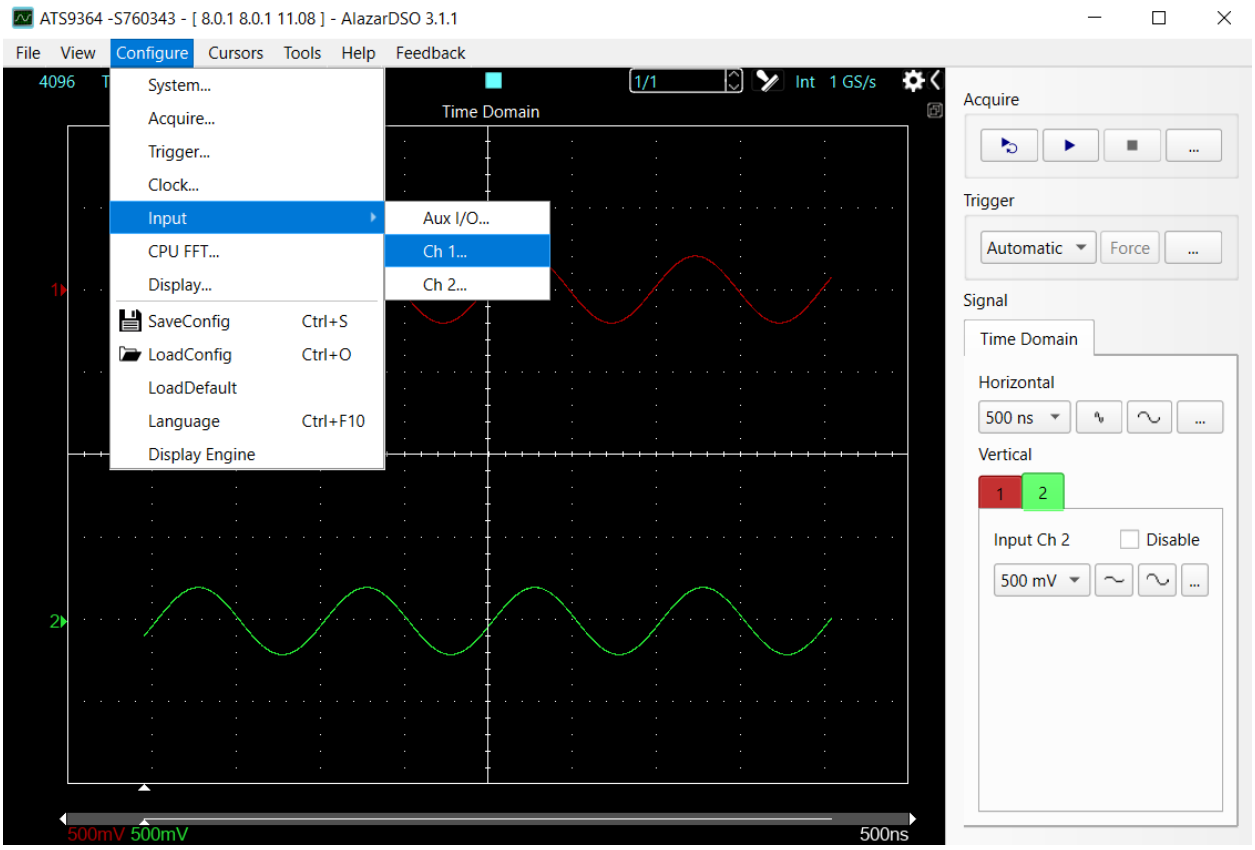


Fig. 4: Configure Channels window

Name	Board ID	I/O Connector
Ch 1	1	A
Ch 2	1	B
Ch 3	2	A
Ch 4	2	B

and so on, two channels per board. On boards with four analog inputs per digitizer:

Name	Board ID	I/O Connector
Ch 1	1	A
Ch 2	1	B
Ch 3	1	C
Ch 4	1	D
Ch 5	2	A

and so on, four channels per board.

Note

AlazarDSO supports up to 64 input channels across the boards of a system. A single ATS9416, for example, presents 16.

Controls

Channel tabs
: Select the tab of the channel to configure. Tabs are numbered from 1, in the order given in the tables above.

Apply options to all channels
: Apply changes made in the current tab to every input channel rather than only the selected one.

Note

The **Disable** state is propagated along with the other settings. Ticking this box while viewing a disabled channel disables every channel when **Ok** or **Apply** is pressed.

3.2.3 Input Channel

Each tab of the *Configure Channels* window sets the hardware configuration of one analog input channel: how the signal is terminated and coupled at the connector, and what voltage range the converter digitises.

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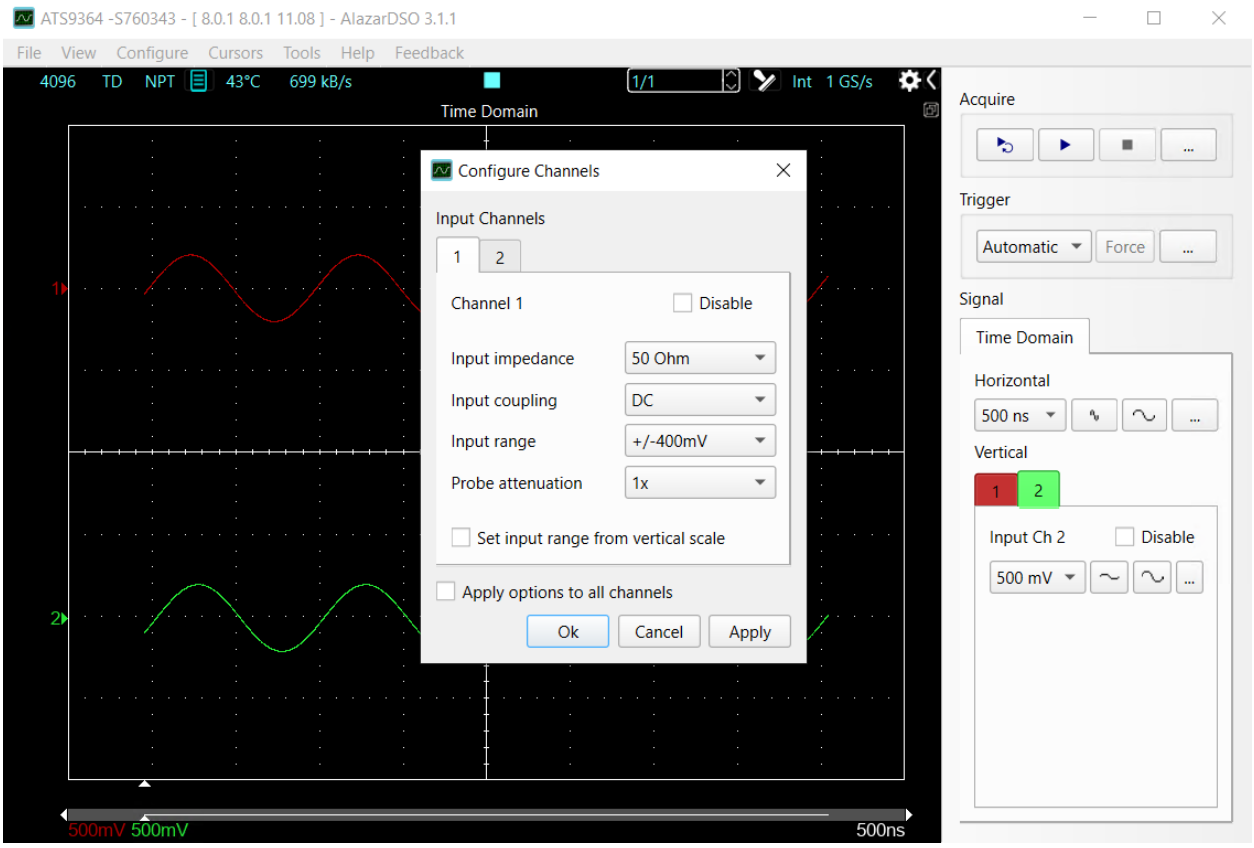


Fig. 5: Input channel tab

> **Note**
>
> Channel appearance — colour, label and waveform style — is not set here. See *The Main Window*.

Disable

Stop AlazarDSO acquiring, transferring and displaying data from this channel.

Disabling unused channels reduces the volume of data transferred across the bus, which raises the sustainable acquisition rate and reduces the memory required per buffer.

Ticking this box disables the rest of the controls on the tab.

> **Note**
>
> A disabled channel may still be used by the trigger system. See *Configure Trigger*.

Input range

Select the peak-to-peak voltage range digitised by this channel. A signal exceeding the selected range is clipped.

The range applies at the I/O connector. If a probe attenuation other than 1x is set, the range at the probe tip is this value multiplied by the attenuation factor.

The available values depend on the digitizer model. The default is ±400 mV where the digitizer supports it, otherwise the first supported range.

This list is disabled when **Set input range from vertical scale** is ticked.

> **Warning**
>
> The list of available ranges is fixed when AlazarDSO starts and does not change when **Input impedance** is changed, even on digitizers whose supported ranges differ between the two impedances.
>
> On an ATS9146, for example, the hardware supports fifteen ranges from ± 20 mV to ± 10 V at 1 MΩ, but only twelve, up to ± 4 V, at 50 Ω. AlazarDSO 3.1.2 offers whichever set corresponds to the digitizer's default impedance regardless of the impedance selected.
>
> Check the digitizer's specifications before relying on a range near the top of the list at the non-default impedance.

Set input range from vertical scale

Choose the input range automatically from the time-domain display's vertical scale, selecting the largest supported range that does not exceed the vertical scale divided by the probe attenuation.

While this is ticked, **Input range** is disabled and follows the display.

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Input impedance
Select the termination of the channel input, typically 1 MΩ or 50 Ω.

Use 50 Ω to terminate a 50 Ω transmission line, which avoids reflections at high frequencies. Use 1 MΩ for high-impedance probing, or where the source cannot drive a 50 Ω load.

The available values depend on the digitizer model. The default is 50 Ω where supported. Some models have a fixed input impedance, in which case this list offers a single value.

Input coupling
Select AC or DC coupling.

DC coupling passes the whole signal including its DC component. AC coupling blocks the DC component, which is useful for examining a small variation riding on a large offset.

The available values depend on the digitizer model. The default is DC where supported, otherwise AC.

Probe attenuation
Select the ratio by which the probe connected to this channel attenuates the signal: **1x**, **10x** or **100x**. AlazarDSO multiplies sample values by this factor so that waveforms and measurements are expressed at the probe tip rather than at the connector.

Set this to match the probe in use. A 10:1 probe with this control left at 1x displays every voltage ten times too small.

> **Note**
>
> When dual-edge sampling is enabled by the clock configuration, channel A is enabled and every other channel is disabled automatically. See *Configure Clock*.

3.2.4 Configure Trigger

The **Configure Trigger** window controls when a digitizer begins acquiring a record.

A digitizer has two independent trigger engines, J and K. Each watches one signal source for a level crossing in a chosen direction. The **Trigger Operation** setting combines the two logically, so that a record may be triggered by either engine, by both, or by one and not the other.

Open this window with **Trigger. . .** from the **Configure** menu.

> **Note**
>
> Trigger settings apply to the board selected in **Configure System**.

Trigger Operation
Select the logical combination of the two trigger engines.

Selecting an operation that uses only one engine disables the other engine's group box.

The entries are **J**, **K**, **J or K**, **J AND K**, **J XOR K**, **J AND NOT K** and **NOT J AND K**. They come from the ATS library rather than from this application, and are the same on every digitizer.

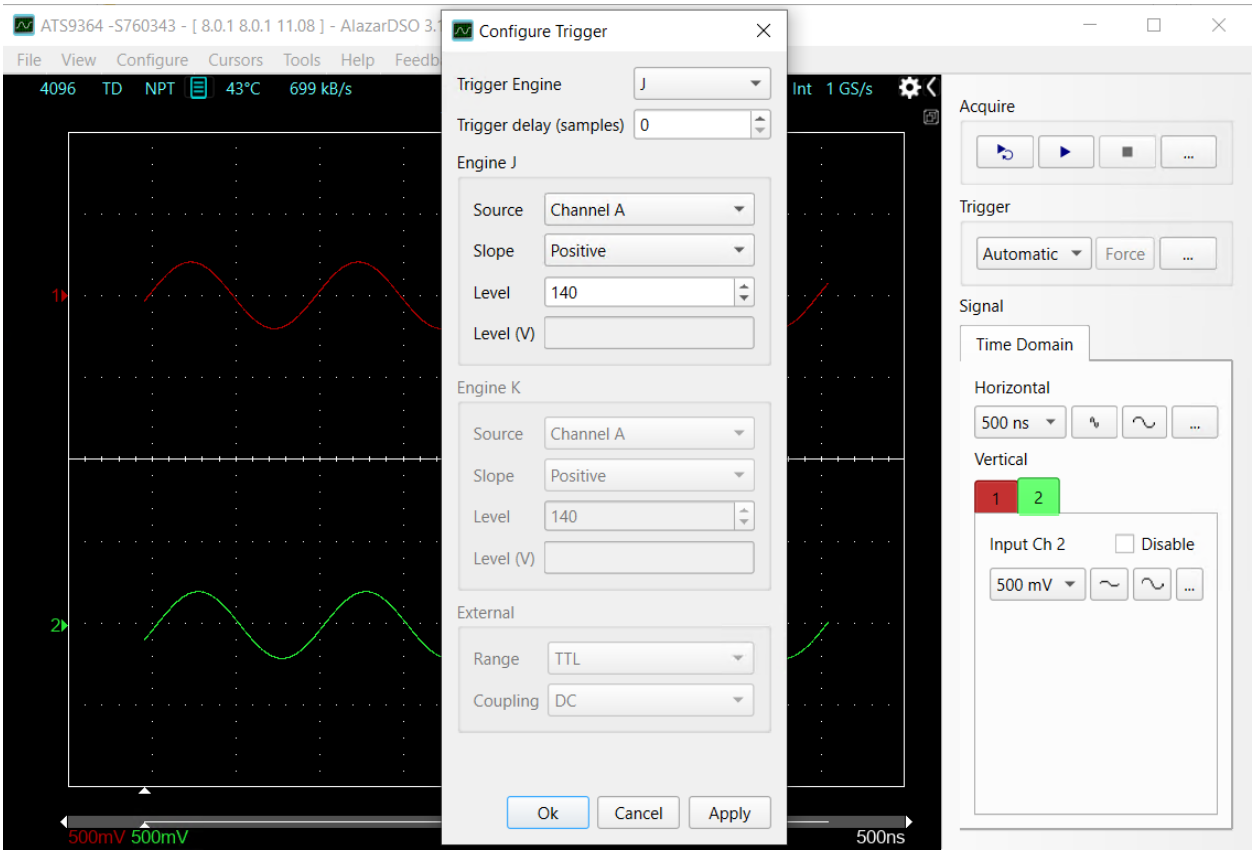


Fig. 6: Configure Trigger window

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Trigger delay (samples)
Enter the delay, in samples, between the trigger event and the start of the record.

> **Note**
>
> The delay is always in samples. To set it from a time, multiply by the sample rate set in *Configure Clock*.

Engine J

Source
Select the signal that engine J watches.

The list contains one entry per analog input channel on the board, followed by the external trigger input and a disable entry. The number of channel entries depends on the digitizer.

Selecting the external trigger input in either engine enables the **External** group box.

> **Note**
>
> On a system using an ATS-SyncBoard, the external trigger input is the only available source.

Slope
Select the direction of the level crossing that fires the engine, rising or falling.

Level
Enter the trigger level as a code between 0 and 255. The default is 140.

The code spans the full input range of the selected source, linearly: 0 is negative full scale, 128 is zero volts, and 255 is positive full scale. To convert a voltage to a code:

$$\text{code} = 128 + 127 \times \frac{V_{\text{trigger}}}{V_{\text{range}}}$$

where V_{range} is the input range set for the source channel in *Input Channel*, or the external trigger range if the source is the external trigger input.

Code	Fraction of range	Level at ± 1 V	Level at ± 5 V
0	-100 %	-1 V	-5 V
64	-50 %	-500 mV	-2.5 V
96	-25 %	-250 mV	-1.25 V
128	0 %	0 V	0 V
160	+25 %	+250 mV	+1.25 V
192	+50 %	+500 mV	+2.5 V
255	+100 %	+1 V	+5 V

> **Note**
>
> Because the code spans the input range, changing the source channel's input range changes the voltage a given code represents. Re-check the trigger level after changing an input range.

Engine K

The controls in the **Engine K** group box are identical to those in **Engine J**, and apply to the second trigger engine.

External

These settings apply when either engine's source is the external trigger input, and are disabled otherwise.

Range
: Select the input range of the external trigger signal.

  The available values depend on the digitizer model. The available ranges depend on the digitizer model and on its FPGA and CPLD versions. The default is the first supported range.

Coupling
: Select AC or DC coupling for the external trigger input.

  The available values depend on the digitizer model. The available couplings depend on the digitizer model and version.

3.2.5 Configure Clock

The **Configure Clock** window selects the sample clock that drives the digitizer's analog-to-digital converters, and sets the rate at which samples are taken.

Open it with **Clock...** from the **Configure** menu.

Clock Source

Clock type
: Select the source of the sample clock, either the digitizer's internal oscillator or a signal supplied to its external clock input.

  The available values depend on the digitizer model. An external clock input is an option on some models, and the external clock ranges a model accepts vary. Select an external clock type only if a suitable signal is connected to the clock input.

  Internal
  : Use the digitizer's own oscillator. Select the sample rate from **Frequency (Hz)** below.

  Internal 10 MHz reference
  : Use the internal oscillator, phase-locked to a 10 MHz reference supplied to the digitizer.

  Fast external
  : Use a clock signal supplied to the external clock input.

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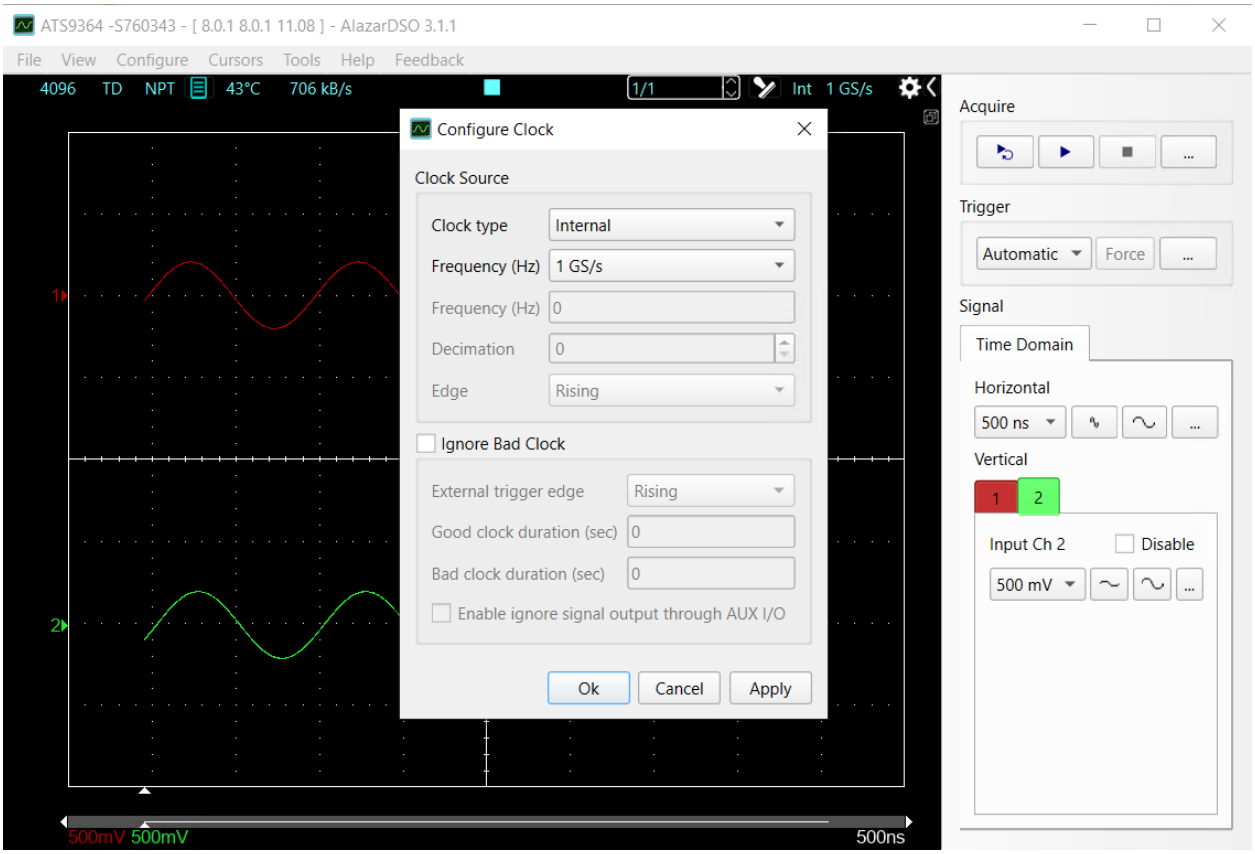


Fig. 7: Configure Clock window

External 10 MHz reference
Lock the sample clock to a 10 MHz reference supplied to the external clock input.

The available values depend on the digitizer model. The entries above are those offered by an ATS9364; other models may offer a different set.

Frequency (Hz)
With an internal clock type selected, choose the sample rate from the list.

The available values depend on the digitizer model. An ATS9364, for example, offers 1, 2, 5, 10, 20, 100, 200, 500 and 800 MS/s, and 1 GS/s.

With an external clock type selected, enter the nominal frequency in hertz of the signal connected to the clock input.

> **Note**
>
> With an external clock, this value does not set the sample rate — the external signal does. AlazarDSO uses the value to scale the horizontal axis and to calculate times from sample indices. If it does not match the actual clock frequency, waveforms display at the wrong timebase.

Decimation
Enter a divider for the sample clock. A decimation value of *n* causes the digitizer to retain one sample in every *n*.

Edge
Select which edge of the external clock signal the digitizer samples on, rising or falling.

> **Note**
>
> Some sample rate and edge combinations enable dual-edge sampling, which forces channel A on and every other channel off. See *Input Channel*.

Ignore Bad Clock

Check this group box to allow the digitizer to substitute an internally generated clock for the external clock during intervals when the external signal is known to be unusable.

This is intended for applications such as optical coherence tomography, where the clock signal supplied by the source is valid only during part of each sweep. The digitizer alternates between the two durations below: it uses the external clock for the good-clock duration, switches to its internal clock for the bad-clock duration, then switches back.

External trigger edge
Select which edge of the external trigger signal starts the good-clock and bad-clock timing window, **Rising** or **Falling**.

Good clock duration (sec)
Enter the interval, in seconds, during which the external clock signal is valid and will be used.

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Bad clock duration (sec)
Enter the interval, in seconds, during which the external clock signal is not valid and an internally generated clock will be used instead.

Enable ignore signal output through AUX I/O
Intended to output the ignore-bad-clock state on the AUX I/O connector, so that external equipment can observe when the digitizer is running on its internal clock.

> **Note**
>
> This shares the AUX I/O connector with the modes configured in *Configure AUX I/O*. Enabling it may conflict with the mode selected there.

> **Note**
>
> Enabling **Ignore Bad Clock** without an OCT trigger connected stops the acquisition and reports that no trigger was detected. See *Messages*.

3.2.6 Configure Acquire

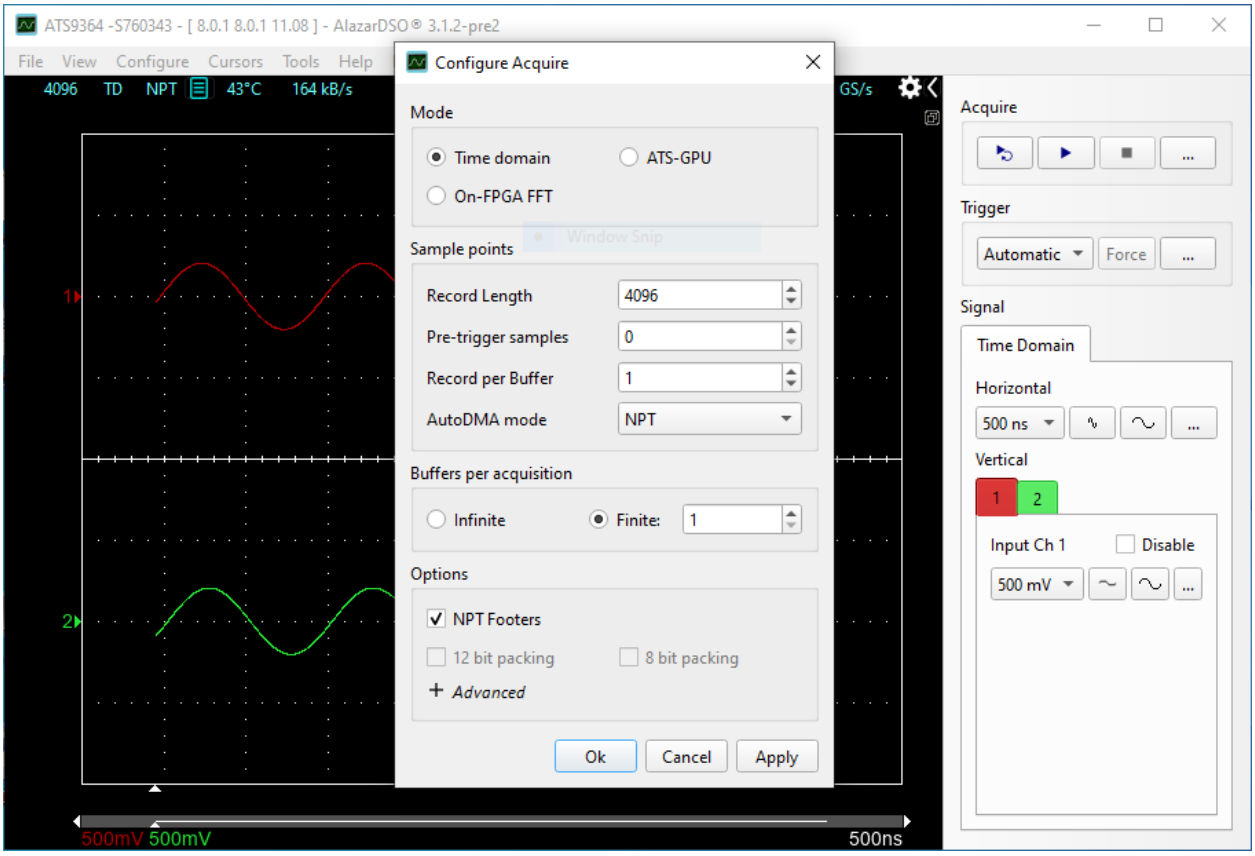


Fig. 8: Configure Acquire window

The **Acquire** section sets the acquisition mode, the geometry of records and buffers, and the options that control how sample data is transferred from the digitizer to host memory.

Open this window with **Acquire...** from the **Configure** menu.

Mode

The acquisition mode determines where the signal processing is performed and which of the remaining configuration windows apply.

Time domain
Acquire sample records and display them as waveforms against time. An FFT may additionally be calculated by the host processor; see *Configure CPU FFT*.

On-FPGA FFT
Calculate the FFT on the digitizer's FPGA and transfer spectra rather than time-domain records. See *Configure On-FPGA FFT*.

The available values depend on the digitizer model. This option is available only on digitizers with the on-FPGA FFT option.

ATS-GPU
Transfer sample data to a GPU for processing. See *Configure ATS-GPU*.

Sample points

Record Length
Enter the number of sample points per record per channel.

The minimum record length and the alignment requirement depend on the digitizer model; see *Record size and alignment by digitizer*. The maximum is a function of the board's on-board memory and the number of enabled channels.

Pre-trigger samples
Enter the number of sample points acquired before the trigger event in each record.

> **Note**
>
> Pre-trigger samples are not available when the acquisition uses NPT (no-pre-trigger) transfers. The pre-trigger alignment requirement is board dependent; see *Record size and alignment by digitizer*.

Record per Buffer
Enter the number of records in each DMA transfer from on-board memory to host memory.

Buffers per acquisition

Finite:
Acquire a fixed number of buffers and then stop. Enter the number of buffers in the adjacent field.

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Infinite
Continue acquiring until acquisition is stopped from the heads-up display.

> **Note**
>
> Some operations require a finite acquisition. The **Stream To Memory** wizard reports `Stream to memory requires finite acquisition` if started while this option is selected.

Options

AutoDMA mode
Select how the digitizer organises samples from its converters into records and buffers.

Traditional
Each record is transferred with a header and may include pre-trigger samples.

Continuous
Sample data is transferred continuously without reference to triggers.

NPT
No-pre-trigger mode. Records contain post-trigger samples only, which removes the per-record header and gives the highest record rate. Required for record footers; see **NPT Footers** below.

Triggered Streaming
Continuous transfer that begins on a trigger event.

The available values depend on the digitizer model.

Alloc buffers
Allocate the DMA buffers in advance of the acquisition rather than on demand.

FIFO only streaming
Transfer sample data directly from the digitizer's FIFO to host memory, bypassing on-board memory. Use this option for continuous acquisition at rates the on-board memory path cannot sustain.

NPT Footers
Append a footer to each record in NPT mode. Footers carry per-record metadata including timestamps. See *NPT Footers* for the footer contents and *File Formats* for how footers are written to file.

Sample interleave
Interleave samples from each channel within a record (A-B-A-B) rather than storing each channel's samples contiguously (A-A-B-B). Interleaving produces a higher transfer rate from on-board to host memory, at the cost of requiring software to de-interleave the samples.

> **Note**
>
> The benchmark wizards report `Select at least 2 channels for interleaved samples` if interleaving is enabled with a single channel selected.

Parallel DMA
Transfer from more than one digitizer concurrently.

> **Note**
>
> At least two channels must be selected. The benchmark wizards report `Select at least 2 channels for parallel DMA` otherwise.

8 bit packing
Pack sample data to 8 bits per sample during transfer, reducing the transfer size at the cost of resolution. The available values depend on the digitizer model.

12 bit packing
Pack sample data to 12 bits per sample during transfer. The available values depend on the digitizer model.

> **Note**
>
> The two packing options are mutually exclusive. Selecting one clears the other.

The available values depend on the digitizer model. Which packing modes a digitizer supports depends on the model and, on some models, the FPGA version:

Digitizer	Packing available
ATS9410, ATS9440	8-bit only, from a minimum FPGA version
ATS9280	8-bit only
ATS9358, ATS9360, ATS9370, ATS9371, ATS9373, ATS9380, ATS9416	8-bit and 12-bit, from a minimum FPGA version
ATS4001, ATS9362, ATS9364	8-bit and 12-bit

Options the digitizer does not support are unavailable.

Applying changes

Changes take effect when **Ok** or **Apply** is pressed, as in every configuration window. See *Configuration Reference*.

3.2.7 Configure AUX I/O

The **Configure AUX I/O** window configures the auxiliary input/output connector on the digitizer's mounting bracket.

The connector is bidirectional but serves one purpose at a time: it is either an input, carrying a signal that controls the digitizer, or an output, carrying a signal that reports the digitizer's state to other equipment. Choose the direction first, then the signal for that direction.

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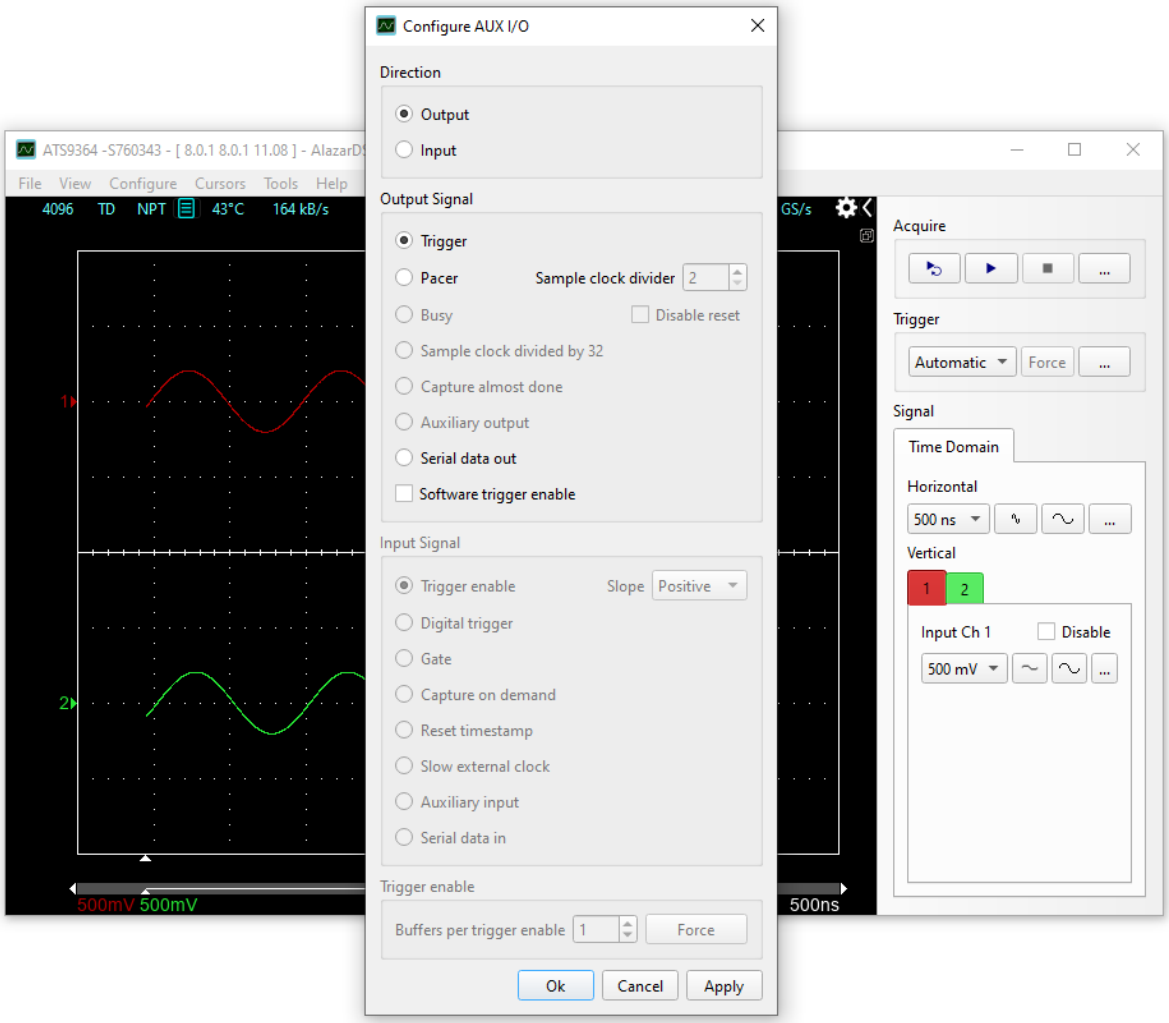


Fig. 9: Configure AUX I/O window

Open this window with **Input ▶ Aux I/O...** from the **Configure** menu.

> **Note**
>
> The AUX I/O configuration applies to every digitizer in the system, not to one board.

> **Note**
>
> The available values depend on the digitizer model. Not every mode is supported on every model.

Direction

Input
: Configure the connector to receive a signal. Select the signal from the **Input Signal** group box.

Output
: Configure the connector to transmit a signal. Select the signal from the **Output Signal** group box. This is the default.

Input Signal

Trigger enable
: The digitizer waits for a pulse on the connector before it accepts trigger events. Each pulse arms the digitizer to acquire the number of buffers set in the **Trigger enable** group below.

  Use this to gate acquisition to an external event — for example, to acquire only while a stage is in position.

  Slope
  : Select which edge of the pulse arms the digitizer, **Positive** or **Negative**. This list is available only while **Trigger enable** is selected.

Auxiliary input
: A general-purpose input whose state can be read by software. The state at trigger time appears in the NPT footers; see *NPT Footers*.

Output Signal

Trigger
: Output a signal marking when the digitizer is acquiring.

Pacer
: Output a continuous pulse train derived from the sample clock.

  Use the pacer to drive external equipment from the digitizer's timebase, so that the two remain in step without a separate clock source.

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Sample clock divider
Enter the division ratio. The field is available only while **Pacer** is selected.

> **Warning**
>
> **The output frequency is not simply the sample rate divided by this value.** A second, board-dependent factor applies — the number of samples per timestamp clock, which differs between digitizers.
>
> A divider of 2 does not work, and the field enforces no constraint, so a value it accepts may not produce the pulse train you expect.

Serial data out
Drive the connector to a fixed level, high or low, under software control.

Despite the name this is not a serial protocol: the ATS SDK describes it as an output level set directly by the configuration parameter.

Software trigger enable
Gate the acquisition under software control while the connector continues to drive the selected output signal.

Unlike the **Trigger enable** input mode, which waits for an external edge, this arms the digitizer when **Force** is pressed in the **Trigger enable** group below. It can be combined with any output signal.

New in AlazarDSO 3.1.2.

Trigger enable

Sets how many buffers each trigger enable event arms the digitizer for, and allows an event to be generated by hand.

> **Warning**
>
> **Trigger enable could not be made to work on an ATS9364.**
>
> With **Software trigger enable** checked and applied, pressing **Start** ran the acquisition immediately rather than waiting to be armed, and **Buffers per trigger enable** stayed unavailable throughout.
>
> Treat this whole group as unverified until someone demonstrates it on hardware that supports it.

This group is available only when trigger enable is in use: with **Direction** set to **Input** and the **Trigger enable** input signal selected, or with **Direction** set to **Output** and **Software trigger enable** checked.

Buffers per trigger enable
Enter the number of buffers to acquire following each trigger enable event.

> **Note**
>
> **Enter 0 to acquire without limit.** Nothing on screen indicates this.

The field accepts 0 to 9999, and the default is 1.

The available values depend on the digitizer model. This control is available only on digitizers whose firmware supports it; the capability depends on the FPGA version as well as the model. Where it is unavailable, the field is disabled and no limit is applied.

Force

Generate a trigger enable event immediately.

This acts at once, without waiting for **Ok** or **Apply**, and has an effect only while an acquisition is running. Pressing it with the acquisition stopped does nothing.

> **Warning**
>
> **Confirmed on an ATS9364:** the button is enabled as soon as **Enable trigger enable** is ticked, before **Apply** is pressed — and pressing it then does nothing at all.
>
> So it is live when it should not be, and inert when pressed. Raise as a defect.

> **Note**
>
> Trigger enable is configured here rather than in Configure Acquire.

> **Note**
>
> The **Ignore Bad Clock** group in *Configure Clock* offers to output its state on this connector, but that option has no effect, so there is no conflict with the mode selected here. The connector is always driven by this window.

3.2.8 Configure On-FPGA FFT

The **Configure On-FPGA FFT** window configures the fast Fourier transform calculated by the digitizer's FPGA. In this mode the digitizer transfers spectra rather than time-domain records, which greatly reduces the volume of data crossing the bus and allows sustained spectral acquisition at trigger rates that host-side processing could not keep up with.

This window applies when the acquisition mode in *Configure Acquire* is **On-FPGA FFT**. Open it with **On-FPGA FFT...** from the **Configure** menu.

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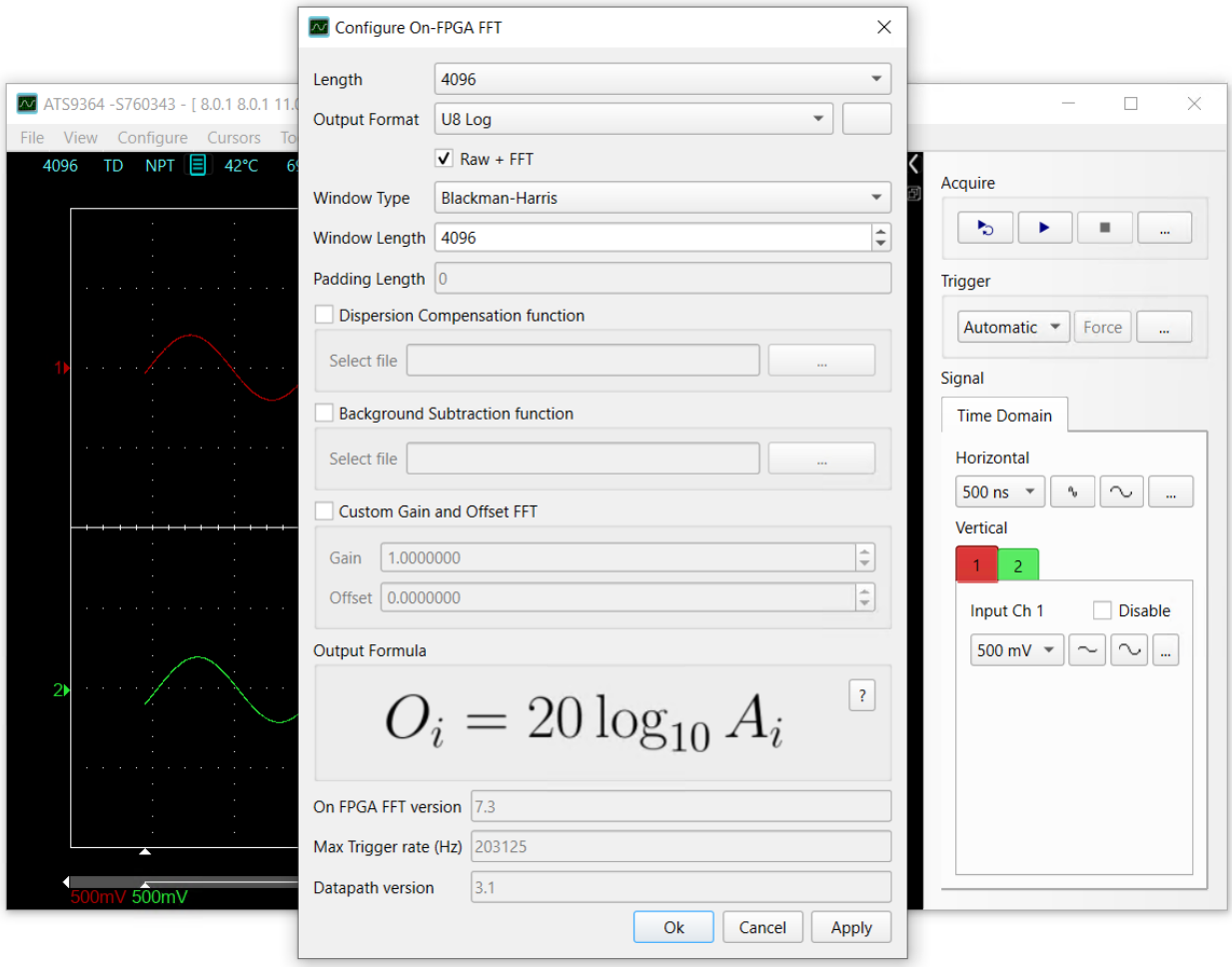


Fig. 10: Configure On-FPGA FFT window

Important

Two things are easy to miss, and neither is reported until you press **Start**.

Only one channel can be transformed at a time. Disable the others in *Configure Channels* first. With more than one enabled the acquisition stops immediately, reporting *Requested channels are not supported*; AlazarDSO does not prevent the combination beforehand.

The spectrum is not drawn until you ask for it. Check **Show FPGA FFT** on the **FFT** tab of *Configure Display*, or the graph stays empty however well the acquisition runs.

Note

The available values depend on the digitizer model. The on-FPGA FFT requires a digitizer with the FFT firmware option. Check **Board Options** in *Board Properties*.

Transform

Length

Select the FFT length in samples: **256**, **512**, **1024**, **2048** or **4096**. This determines the number of frequency bins produced; the bin width in hertz is the sample rate divided by this value.

A longer transform gives finer frequency resolution at the cost of a lower maximum trigger rate.

Padding Length

The number of zero samples appended to each record to reach the selected FFT length. This field is calculated and cannot be edited.

Zero padding interpolates the spectrum; it does not add frequency resolution.

Window Type

Select the window function applied to each record before the transform.

Windowing reduces spectral leakage — the spreading of energy from a tone into neighbouring bins that occurs when the record does not contain a whole number of cycles. Each window trades main-lobe width against side-lobe level.

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Window	Use
None	No window. Correct only when the record contains a whole number of cycles, or for transients that decay within the record.
Bartlett	Triangular. Moderate leakage suppression.
Hanning	General purpose. Good frequency resolution with rapidly falling side lobes.
Hamming	Lower nearest side lobe than Hanning, at the cost of a higher far-out side-lobe floor.
Blackman	Stronger leakage suppression, wider main lobe.
Blackman Harris	Strongest leakage suppression of the set. Use when a small signal must be resolved close to a much larger one.

Window Length

The number of samples the window function is applied over. This field is calculated and cannot be edited.

Output Formula

Format

Select the quantity held in each frequency bin and the word size it occupies. This directly affects the size of each transferred record.

The available values depend on the digitizer model. The available formats depend on the FFT datapath version the digitizer's firmware implements. Datapath 1 offers logarithm of squared amplitude, squared amplitude, and the real and imaginary parts of the transform. Datapath 3 offers logarithm of squared amplitude and amplitude.

Each entry names the stored type and the quantity, for example **U16 Log**.

Digitizers implementing **datapath 1** offer nine formats:

Entry	Bytes per bin	Quantity
U8 Log	1	Logarithm of squared amplitude
U8 Amp2	1	Squared amplitude
U16 Log	2	Logarithm of squared amplitude
U16 Amp2	2	Squared amplitude
U32 Amp2	4	Squared amplitude
S32 Real	4	Real part of the transform
S32 Imag	4	Imaginary part of the transform
Float Log	4	Logarithm of squared amplitude
Float Amp2	4	Squared amplitude

Digitizers implementing **datapath 3** offer three: **U8 Log**, **U16 Log** and **U16 Amp**, the last being amplitude rather than squared amplitude.

> **Note**
>
> The format names are not translated and appear in English in every language.

Beneath the format list, the window shows the formula AlazarDSO uses to produce the selected format, rendered as an equation. It changes when the format changes.

?

Explain the symbols used in the formula:

O_i	the output value sent back for bin i
R_i	the real part of the transform for bin i
I_i	the imaginary part of the transform for bin i
A_i	the amplitude of the transform for bin i
slice	the slice factor; datapath 1 only
scale	the scale factor; datapath 1 only
w	the output word's bit width, for example 16 for a 16-bit type

Raw + FFT

Transfer the time-domain record alongside its spectrum.

The raw record is **added to** the transferred record rather than replacing the spectrum, so each record grows by the size of the time-domain data. This allows the signal and its transform to be examined together.

This option is enabled by default.

Custom Scaling FFT

Check this group box to override the scaling applied to the transform output.

> **Note**
>
> This group is shown only on digitizers implementing FFT datapath 1. On datapath 3 digitizers the window has **Custom Gain and Offset FFT** but no scaling controls.

Scale

Enter the scaling factor applied to each bin.

Slice

Select where the FPGA's wide internal accumulator is truncated down to the output word, that is, which range of bits survives into the transferred sample.

A slice of 7 is the reference position, at which no shift is applied. Each increment moves the retained window one bit higher, halving the displayed magnitude. Raise the slice when large signals saturate the output; lower it when small signals are lost in the least significant bits.

Default

Restore the scale and slice appropriate to the selected output format.

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The defaults are re-applied automatically whenever the output format changes while **Custom Scaling FFT** is unchecked.

Custom Gain and Offset FFT

Check this group box to apply a gain and offset to the transform output. Both fields are unavailable until it is checked.

Gain
Enter the multiplier applied to each bin. The default is 1.

Offset
Enter the constant added to each bin. The default is 0.

Both accept seven decimal places.

> **Note**
>
> On a datapath 3 digitizer this is the only scaling group in the window; **Custom Scaling FFT** does not appear. See **Datapath version** below.

Background Subtraction function

Check this group box to subtract a stored background **record** from each acquired record before it is transformed, removing a fixed instrument response or a static interference pattern.

> **Note**
>
> The subtraction happens in the time domain, on the samples, not on the computed spectrum. The file holds one value per sample of the record.

Select file
Enter the path to the background function file, or press `...` to browse for one. The format is described in *File Formats*.

> **Warning**
>
> The file browser offers `*.bin` and `*.txt`, but the file is always read as binary. A text file will be rejected or misread.

Dispersion Compensation function

Check this group box to apply a dispersion compensation function to each record before the transform. This corrects the phase distortion introduced by unequal optical path lengths, and is used chiefly in optical coherence tomography.

Select file
Enter the path to the compensation function file, or press `...` to browse for one.

The same function may be applied to the GPU transform; see *Configure ATS-GPU*.

Information

These fields are read-only.

On FPGA FFT version
The version of the FFT firmware in the digitizer's FPGA.

Datapath version
The version of the FFT datapath the firmware implements. This determines which output formats are available, and whether the custom scaling controls apply.

> **Note**
>
> AlazarDSO reports that FFT datapath version 2 is deprecated. Digitizers reporting that version should be updated to current firmware.

Max Trigger rate (Hz)
The highest trigger rate the current configuration can sustain.

This is determined by the FFT length and the time the FPGA needs to transform one record. Triggering faster than this rate causes triggers to be missed. Reduce the FFT length to raise it.

3.2.9 Configure ATS-GPU

The **Configure ATS-GPU** window configures signal processing performed on a graphics processing unit. Sample data is transferred from the digitizer to the GPU, which calculates the transform and any preprocessing steps, leaving the host processor free.

In addition to the transform itself, the GPU path offers processing used in optical coherence tomography: resampling of a signal acquired against a non-linear k-clock, dispersion compensation, and a non-uniform FFT.

This window applies when the acquisition mode in *Configure Acquire* is **ATS-GPU**. Open it with **GPU FFT...** from the **Configure** menu.

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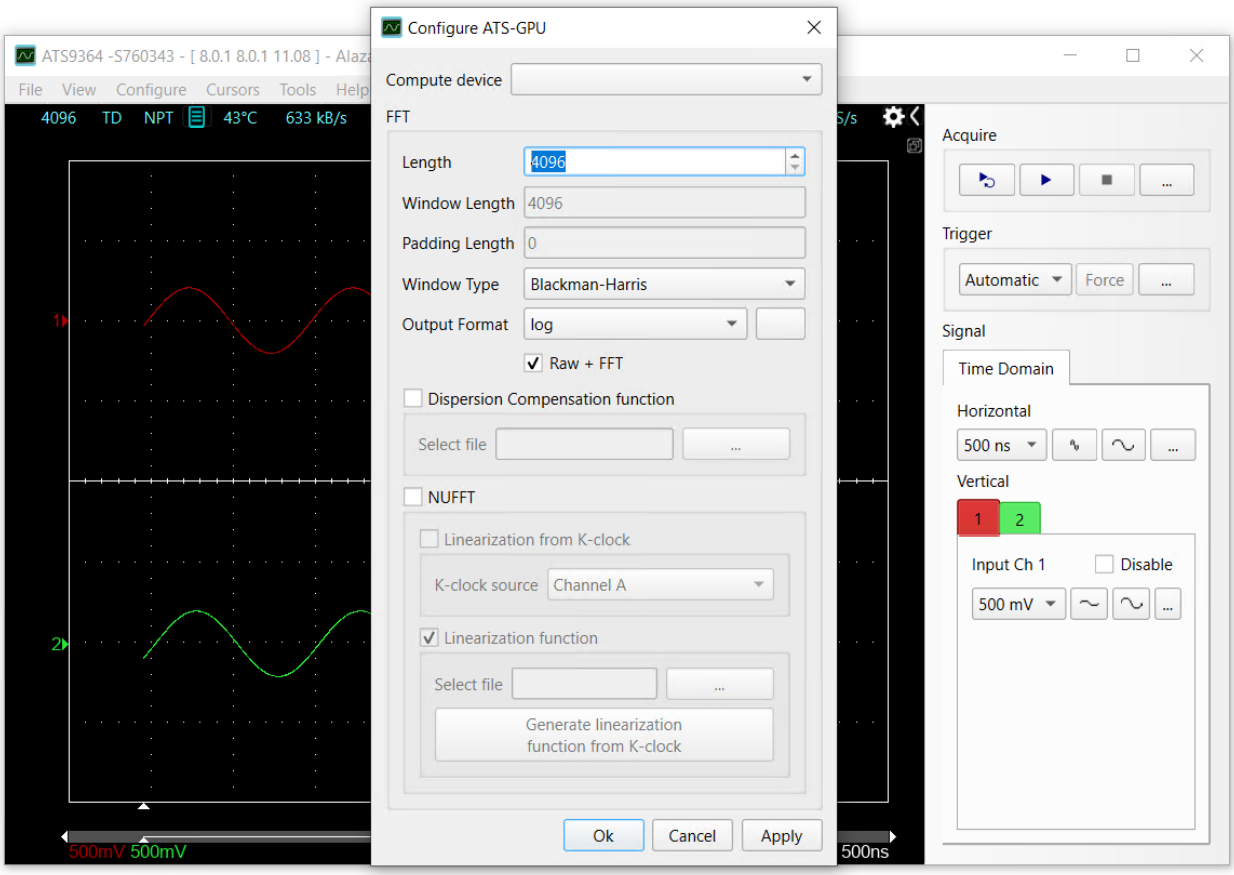


Fig. 11: Configure ATS-GPU window

> **Note**
>
> A CUDA-capable GPU and the ATS-GPU library are required. The libraries are built for **compute capability 5.2** and above — second-generation Maxwell or newer.

Compute device
Select the GPU that performs the processing. Hosts with more than one GPU list each of them.

FFT

Length
Set the FFT length in samples. The bin width in hertz is the sample rate divided by this value, so a longer transform gives finer frequency resolution and takes longer to compute.

Window Length
The number of samples the window function is applied over. This field is calculated and cannot be edited.

Padding Length
The number of zero samples appended to each record to reach the FFT length. This field is calculated and cannot be edited.

Zero padding interpolates the spectrum between bins; it does not add frequency resolution.

Window Type
Select the window function applied before the transform. The available windows and their trade-offs are described in *Configure On-FPGA FFT*.

Output Format
Select the quantity held in each bin: `log`, `amplitude`, `phase`, `real`, `imag` or `sqrt`. The default is `log`.

> **Note**
>
> This list is **not** the same as the on-FPGA list. It carries no word-size prefix, adds **phase** and **sqrt**, and has no squared-amplitude entry. The CPU FFT uses the same list; see *Configure CPU FFT*.

Raw + FFT
Transfer the time-domain record alongside its spectrum, rather than the spectrum alone.

Dispersion Compensation function

Check this group box to apply a dispersion compensation function to each record before the transform.

Dispersion mismatch between the sample and reference arms of an interferometer introduces a wavenumber-dependent phase error, which broadens the point spread function with depth. A compensation function removes that phase error.

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Select file
Enter the path to the compensation function file, or press **...** to browse for one.

See *Configure On-FPGA FFT* for the equivalent on-FPGA control.

NUFFT

Check this group box to calculate a non-uniform fast Fourier transform, which transforms unevenly spaced samples directly rather than resampling them first.

A swept-source laser does not sweep linearly in wavenumber, so samples taken at a uniform clock rate are unevenly spaced in k. Transforming them without correction broadens the point spread function and degrades depth resolution.

The two groups below are nested inside **NUFFT** and are unavailable until it is checked. They are mutually exclusive: the resampling function is either derived from a live k-clock or read from a file, and selecting one clears the other.

Linearization from K-clock

Derive the resampling function from a k-clock signal acquired alongside the data.

K-clock source
Select the input channel carrying the k-clock signal. This channel is used to derive the resampling function and is not displayed as a data channel.

Generate linearization function from K-clock
Acquire the k-clock signal and calculate a linearization function from it.

The function is written as `Linearization.bin` in AlazarDSO's working directory, and its full path is placed in the **Linearization function** field for you.

This button requires the ATS-GPU-NUFFT option and is otherwise unavailable, with a tooltip saying so.

Linearization function

Resample using a function read from a file instead of one generated from a live k-clock.

Select file
Enter the path to the linearization function file, or press **...** to browse for one. The format is described in *File Formats*.

3.2.10 Configure CPU FFT

The **Configure CPU FFT** window configures a fast Fourier transform calculated by the host processor from time-domain records.

Unlike the on-FPGA and GPU transforms, this one does not change what the digitizer acquires or transfers: records cross the bus as time-domain samples and are transformed afterwards. It is therefore available without FFT firmware or a GPU, at the cost of host processor time and a lower sustainable rate.

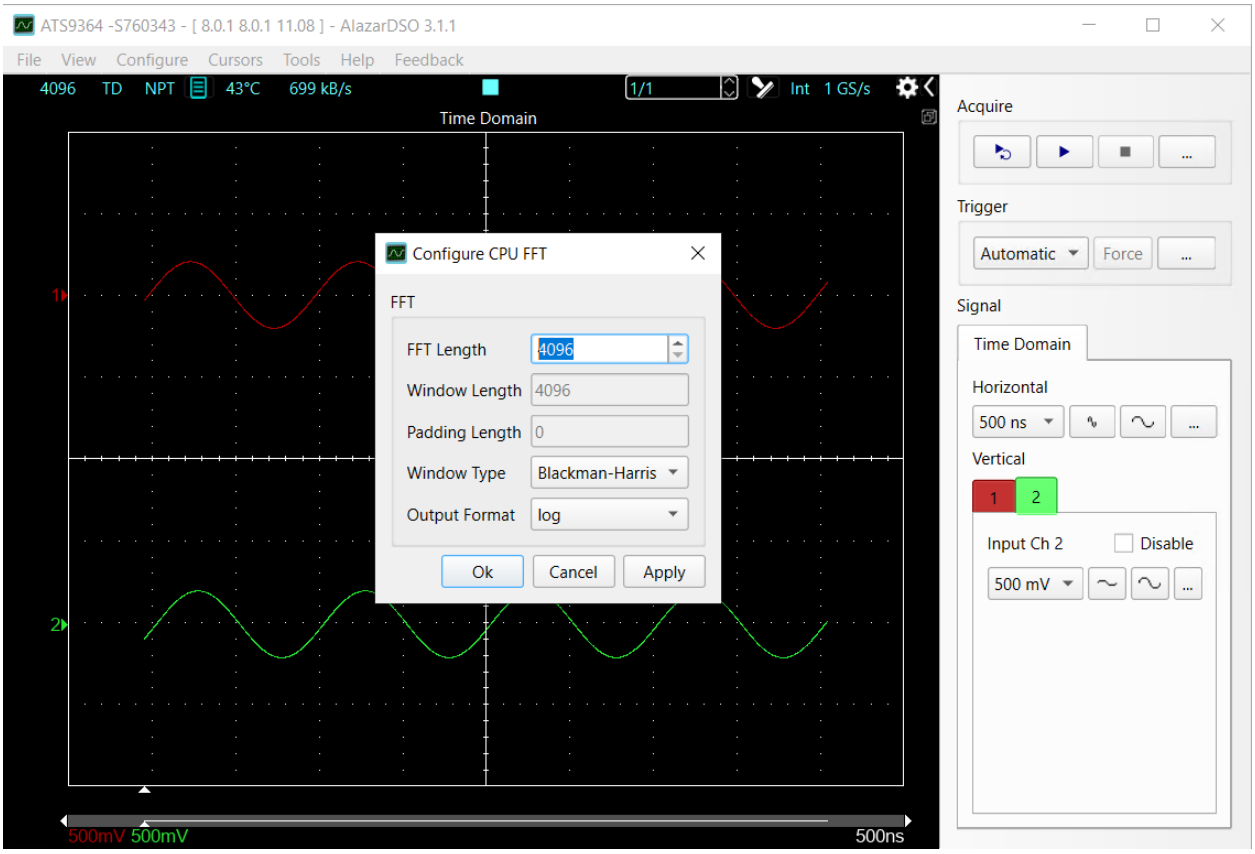


Fig. 12: Configure CPU FFT window

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This window applies when the acquisition mode in *Configure Acquire* is **Time domain**. Open it with **CPU FFT...** from the **Configure** menu.

> **Note**
>
> The CPU FFT was added in AlazarDSO 3.0.0.

FFT

FFT Length
Enter the FFT length in samples.

The value is always a power of two. Typing a value that is not one rounds it to the nearest power of two when the field loses focus.

The maximum is 16777216. The minimum is the smallest power of two at least as large as the current record length, so it rises and falls with the record length set in *Configure Acquire*.

The bin width in hertz is the sample rate divided by this value.

Window Length
The number of samples the window function is applied over. This is always the record length and cannot be edited.

Padding Length
The number of zero samples appended to each record to reach the FFT length — that is, the FFT length minus the window length. Calculated, and not editable.

Zero padding interpolates the spectrum between bins; it does not add frequency resolution.

Window Type
Select the window function applied to each record before the transform: **None**, **Hann**, **Hamming**, **Blackman**, **Blackman-Harris** or **Bartlett**. The default is **Blackman-Harris**.

The trade-offs between them are described in *Configure On-FPGA FFT*.

Output Format
Select the quantity displayed for each frequency bin:

Entry	Bin contents
`log`	Logarithm of the amplitude. The default.
`amplitude`	Magnitude of the transform
`phase`	Phase angle of the transform
`real`	Real part of the transform
`imag`	Imaginary part of the transform
`sqrt`	Square root of the amplitude

> **Note**
>
> This list differs from the on-FPGA list in *Configure On-FPGA FFT*. It carries no word-size prefix, it adds **phase** and **sqrt**, and it has no squared-amplitude entry. The same list is used by *Configure ATS-GPU*.

3.2.11 Configure Display

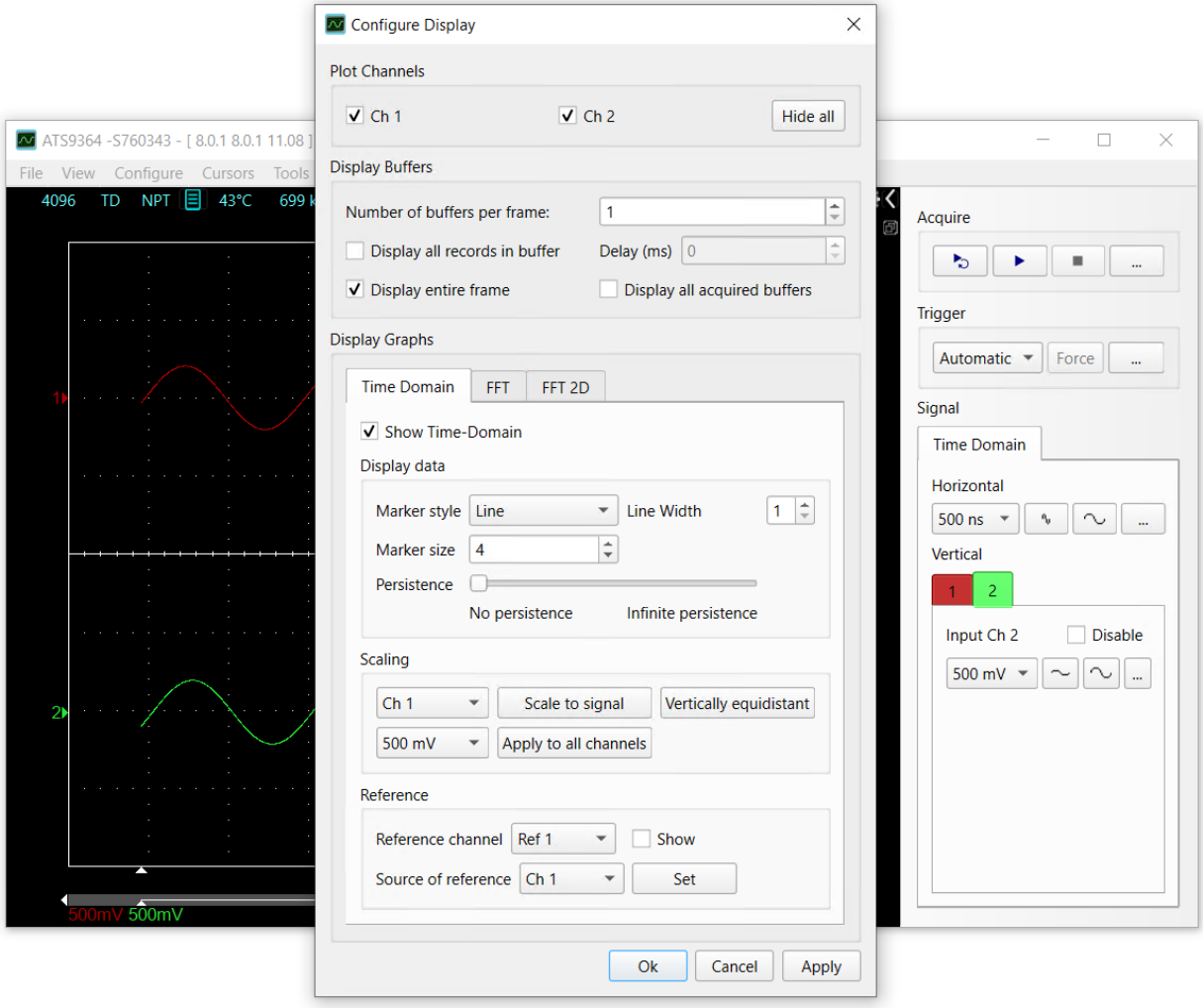


Fig. 13: Configure Display window

The **Display** section controls how much of an acquisition is drawn, and which channels and graphs appear.

Drawing every record of every buffer is rarely possible at high acquisition rates, and rarely useful — the screen cannot show more than a few hundred distinguishable traces per second. The controls here trade completeness against acquisition rate.

Open this window with **Display...** from the **Configure** menu.

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Display Buffers

Number of buffers per frame:
Enter how many acquired buffers make up one displayed frame.

Display all acquired buffers
Check this box to draw every buffer the digitizer transfers. Clear it to draw buffers only as fast as the display can keep up, discarding the rest.

> **Note**
>
> Drawing every buffer limits the acquisition rate to the display rate. For the highest acquisition rates, leave this clear.

Display all records in buffer
Check this box to draw every record within each displayed buffer, rather than a single record from it.

The adjacent field sets a delay between records, so that individual records remain visible rather than flashing past.

The delay is in milliseconds.

Display entire frame
Check this box to draw every record of the frame, end to end, as one trace.

Clear it to draw a single record at a time. Which record is drawn follows the record selector in the heads-up display, and changing that selector redraws immediately.

> **Note**
>
> **Display entire frame** and **Display all records in buffer** are mutually exclusive. Ticking one clears the other.

> **Note**
>
> This setting applies to the time-domain and FFT graphs. The 2-D FFT graph always shows the whole frame.
>
> A host-calculated **CPU FFT** trace is not drawn at all while this box is checked.

Plot Channels

Select which channels are drawn.

The group holds one check box per channel in the selected system, labelled **Ch 1**, **Ch 2** and so on, eight to a row. On a system with exactly sixteen channels the labels are the bare numbers **1** to **16**. All are checked by default, and the set is rebuilt when the active system changes.

> **Note**
>
> These check boxes control **display only**. Clearing one stops the channel being drawn but does not stop it being acquired or transferred. To stop acquiring a channel, use **Disable** in *Input Channel*.
>
> Clearing a channel does not remove it from the channel lists in the Time Domain and FFT scaling sections — those always list every channel. It does exclude the channel from **Vertically equidistant**.

Show all / Hide all
: Check or clear every channel at once. The button's label shows the action it will perform, so it reads **Hide all** while everything is checked.

> **Warning**
>
> Pressing **Apply** after changing **Plot Channels**, **Show FFT** or **Show CPU FFT** clears every graph and any accumulated persistence, empties the NPT Footers and Spectrum information windows, and returns the record selector to the first record. Reference traces are kept.

Display Graphs

Select which graphs are shown. Each graph has its own tab, and each tab carries the settings for that graph:

- *Time-Domain Display*
- *FFT Display*
- *FFT 2D Display*

The graph tabs appear in this window.

3.2.12 Time-Domain Display

The **Time Domain** tab of *Configure Display* controls the appearance of the time-domain graph: how waveforms are drawn, how they are scaled vertically, and whether a stored reference trace is shown alongside them.

> **Note**
>
> The **FFT** tab carries the same controls, applied to the spectrum graph. See *FFT Display*. Settings are held per graph, so changing one does not affect the other.

Show Time-Domain
: Draw the time-domain graph.

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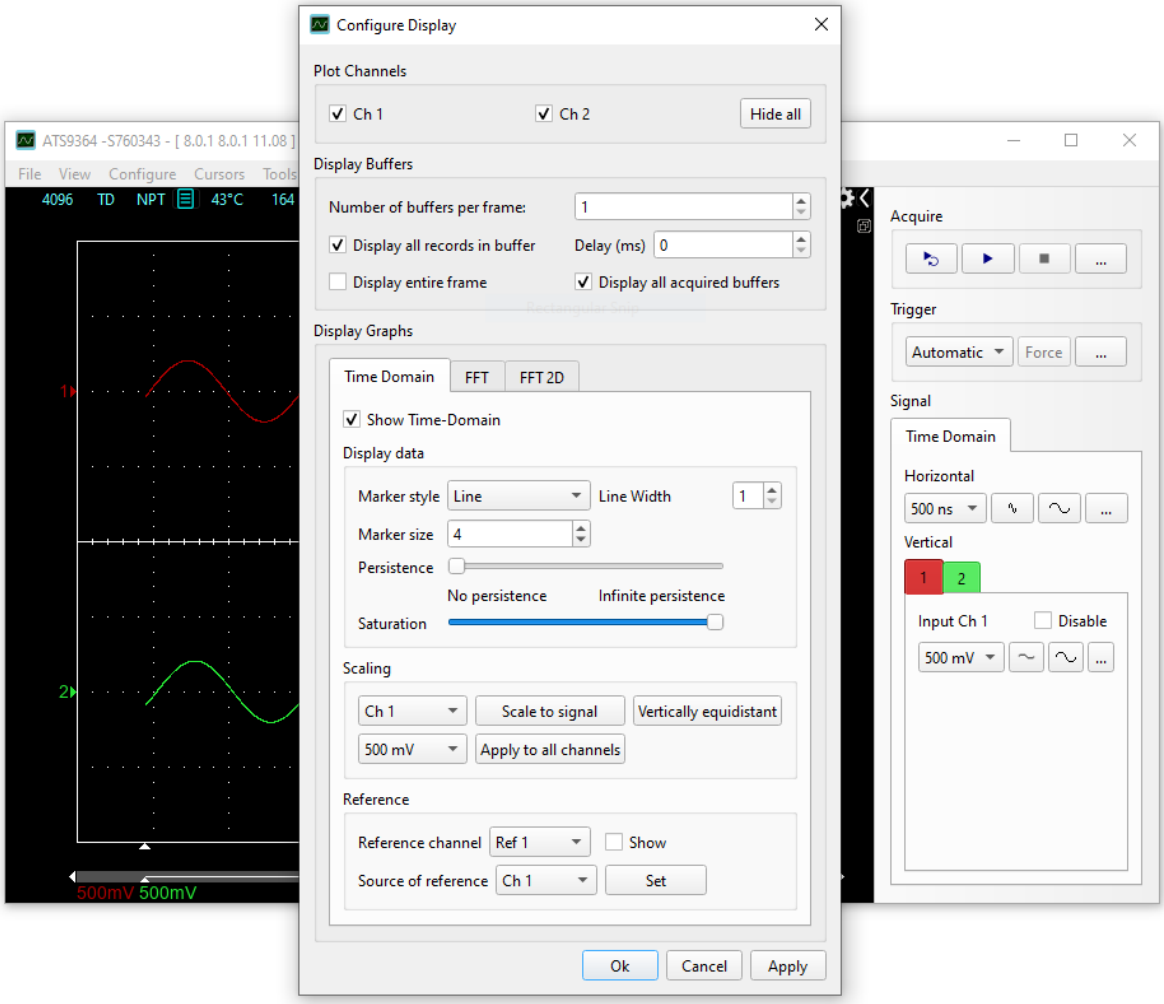


Fig. 14: Time Domain tab of Configure Display

Display data

Marker style
Select how sample points are drawn.

Marker
Draw each sample as a marker, with nothing between samples. Use this at high zoom, where individual samples matter.

Line
Draw straight line segments between samples, with no marker. This is the default, and suits dense records where markers would merge into a solid band.

Marker and Line
Draw both.

Marker size
Set the size of each marker.

Line Width
Set the width of the line joining samples.

Persistence
Set how long previously drawn traces remain on screen before fading. The slider runs from **No persistence** at one end to **Infinite persistence** at the other.

With no persistence, each frame replaces the last. Raising it accumulates successive traces, which reveals jitter, noise distribution and infrequent events that a single trace would not show.

Saturation
Set the intensity with which sample markers are drawn. The slider runs from 0 to 1000, and the default is full intensity.

This applies to every trace on this graph — input channels, host-calculated spectra and references alike — and is held separately for each graph.

> **Note**
>
> This affects marker-style drawing only. With **Marker style** set to **Line** it has no visible effect. See **Marker style** above.

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> **Note**
>
> Changes to this slider, and to **Marker style**, take effect only when **Apply** or **Ok** is pressed.

Scaling

This group contains two unlabelled drop-down lists, followed by three buttons.

Channel list (left)
: Selects the channel the vertical scale applies to, listed as **Ch 1**, **Ch 2** and so on. On digitizers producing more than one output per channel the entries read **Ch 1 - Out 0**, **Ch 1 - Out 1** and so on. A **Ref** entry appears when a reference trace is being shown.

  The number of entries depends on the digitizer and on the board system in use.

Vertical scale list (right)
: Selects the vertical scale, **per division**, from a fixed ladder:

  `500 µV`, `1 mV`, `2 mV`, `5 mV`, `10 mV`, `20 mV`, `50 mV`, `100 mV`, `200 mV`, `500 mV`, `1 V`, `2 V`, `5 V`, `10 V`, `20 V`

  The graticule is eight divisions tall, so a setting of `500 mV` spans 4 V from top to bottom. The ladder is the same on every digitizer.

  This list also follows the graph: zooming the display updates the selection.

Scale to signal
: Set the vertical scale of the selected channel automatically from the data currently displayed.

Apply to all channels
: Apply the selected channel's vertical scale to every displayed channel.

Vertically equidistant
: Space the displayed channels evenly across the graph, so that overlapping traces are separated.

Reference

A reference is a stored trace drawn alongside live data, for comparing an acquisition against a known-good one.

Source of reference
: Select the channel whose trace is stored when **Set** is pressed.

Reference channel
: Select which of the four reference slots, **Ref 1** to **Ref 4**, to store into or display.

Set
: Store the trace from the selected source into the selected reference slot.

Show
: Draw the selected reference alongside live data.

Note

References are written to `Documents\AlazarTech\AlazarDSO` as `reference<n>_td.json`, or `reference<n>_dsp.json` from the FFT tab, and are restored when AlazarDSO starts — so a stored reference survives between sessions.

A reference set while viewing a loaded data file is retained, and appears in the main window as well.

A displayed reference gets its own entry in the **Vertical** tab bar of the settings sidebar, where its colour and label can be changed in the same way as an input channel's. See *The Main Window*.

3.2.13 FFT Display

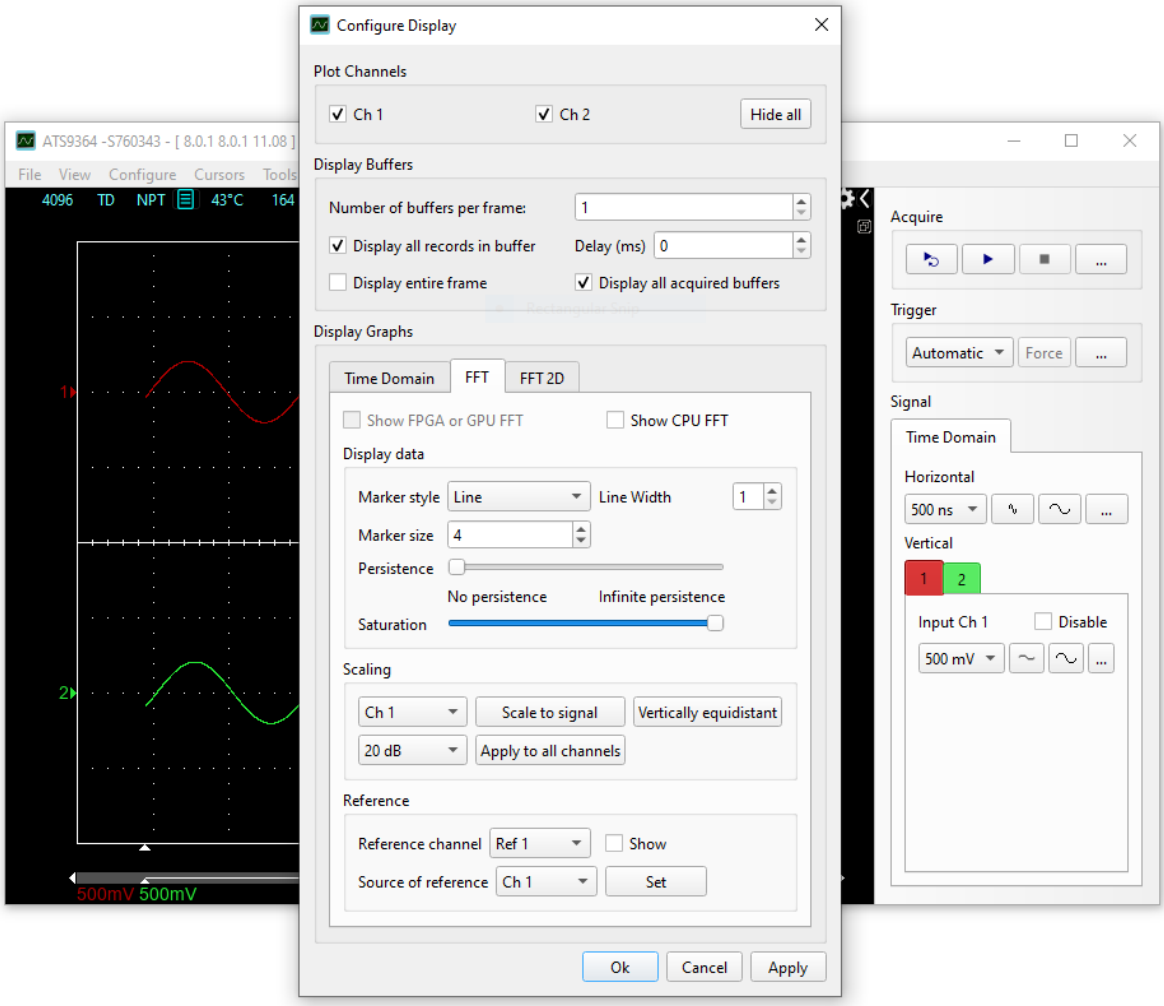


Fig. 15: FFT tab of Configure Display

The **FFT** tab of *Configure Display* controls the appearance of the spectrum graph, which draws the

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output of the on-FPGA, GPU or CPU transform against frequency bin rather than against time.

Show FPGA FFT / Show GPU FFT
Draw spectra produced by the on-FPGA or GPU transform.

Show CPU FFT
Draw spectra calculated by the host processor. See *Configure CPU FFT*.

> **Note**
>
> Both may be shown at once when the acquisition mode is **On-FPGA FFT**, which allows a hardware transform to be compared against a host-calculated one. In **Time domain** mode only **Show CPU FFT** is available, since no hardware transform is being produced.

Saturation

A **Saturation** slider, new in AlazarDSO 3.1.2, sets the intensity with which sample markers are drawn. It runs from 0 to 1000 with a default of full intensity, exactly as on the Time Domain tab, and affects marker-style drawing only. See *Time-Domain Display*.

Scaling

The scaling group works as it does on the Time Domain tab, with three differences.

The **vertical scale ladder is in decibels**, not volts: `5 dB`, `10 dB`, `20 dB`, `50 dB`, `100 dB`, `200 dB`, `500 dB`, then `1 KdB` through `200 KdB`.

The **channel list** carries a second block for host-calculated spectra, labelled **Ch 1 - CPU**, **Ch 2 - CPU** and so on.

Source of reference likewise offers the CPU FFT traces alongside the hardware ones.

Remaining controls

Every other control on this tab — marker style, marker size, line width, persistence and the four reference slots — behaves exactly as described in *Time-Domain Display*.

Settings are held per graph. Changing the persistence of the FFT graph does not change the persistence of the time-domain graph.

3.2.14 FFT 2D Display

The **FFT 2D** tab of *Configure Display* controls the two-dimensional spectrum graph, which draws a sequence of spectra as an image: one axis is the frequency bin, the other is the record index, and colour represents magnitude.

This is how a swept-source measurement is normally viewed — each record is one depth profile, and successive records build an image as the beam scans.

Selected Channel
Choose which channel's settings this tab edits. **Every control on this tab is held separately per channel.**

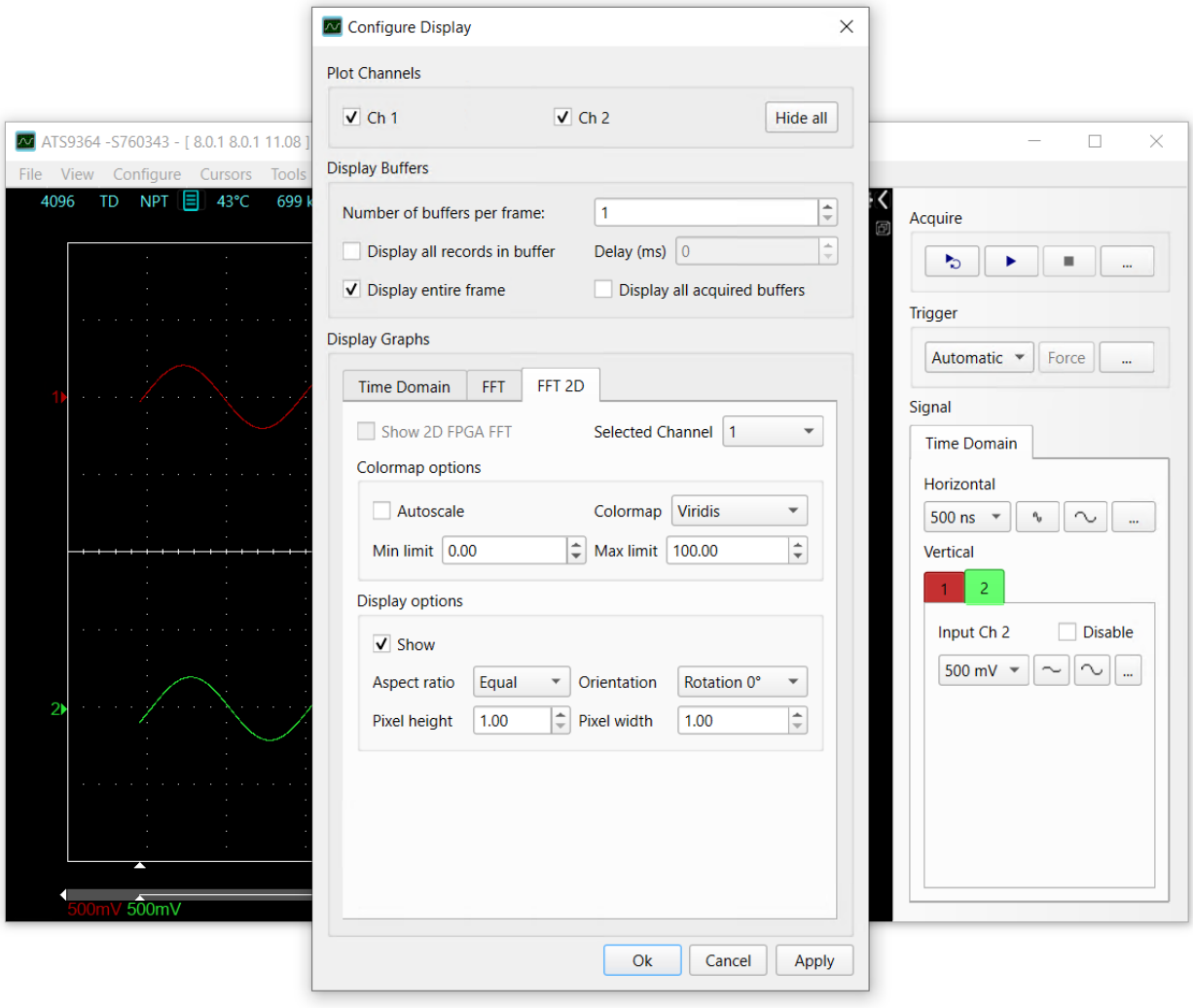


Fig. 16: FFT 2D tab of Configure Display

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Show 2D FFT
Show or hide the selected channel's 2-D window.

Each channel has its own window, titled **Frequency Domain - 2D - Ch** *n*. By default only channel 1 is shown.

A channel's image is drawn only while that channel is also checked under **Plot Channels** in *Configure Display*.

> **Note**
>
> This control is unavailable in **Time domain** mode, and on digitizers producing more than one output per channel.

Colormap options

Colormap
Select the mapping from magnitude to colour.

Gray
Linear greyscale.

Viridis, Magma, Inferno, Plasma
Perceptually uniform colour maps, in which equal steps in magnitude appear as equal steps in brightness. Prefer these for quantitative work: they do not create bands of apparent structure where the data is smooth. **Plasma** is the default.

HSV
Cyclic hue map. Useful for phase, misleading for magnitude.

Min limit, Max limit
Set the magnitudes mapped to the first and last colours of the map. Values outside this range are clipped.

Narrowing the range increases contrast over the span of interest, at the cost of saturating everything outside it.

Both accept values from -10000.00 to 10000.00. The defaults are 0 and 100.

Autoscale
Set the colour limits automatically from the data currently displayed.

Display options

Aspect ratio
Select how the image is proportioned.

Equal
Equal spacing per unit on both axes.

Square
Force the image into a square regardless of its dimensions.

Auto
: Fill the available area.

Orientation
: Rotate the image, so that the displayed orientation matches the physical geometry of the measurement. The choices are **Rotation 0°**, **Rotation 90°**, **Rotation 180°** and **Rotation 270°**.

Pixel height, Pixel width
: Set the physical size each data point represents, so that the axes can be labelled in your own units rather than in sample and record indices.

  The image has one row per record and one column per sample or bin, so **Pixel height** is the size of one record and **Pixel width** the size of one sample. The two swap when **Orientation** is 90° or 270°.

  Both accept 1 to 10000 in steps of 1, and default to 1 — at which setting the axes show raw indices.

> **Note**
>
> The sizes affect the image's proportions only while **Aspect ratio** is **Equal**. With **Square** or **Auto** they change the axis labels but not the shape of the image.

Changes take effect when **Apply** or **Ok** is pressed.

3.2.15 Save Records

Writes records from the current acquisition to disk.

Open it with **Save Data** from the **File** menu. If nothing has been acquired, AlazarDSO reports *No buffer to save* instead.

The window keeps its settings between uses: the format, the directory and the check boxes are all as you left them. Only the file name, the record and sample ranges and the channel list are reset each time it opens.

Controls

File name
: The name the files are built from. AlazarDSO offers the current date and time, in the form `yyyy.MM.dd_hh.mm.ss`, and resets it every time the window opens.

  Each format adds its own suffixes and extension; see *File Formats*.

Directory
: Where to write the files. Defaults to the `AlazarTech` folder in your Documents directory. Press `...` to browse.

> **Warning**

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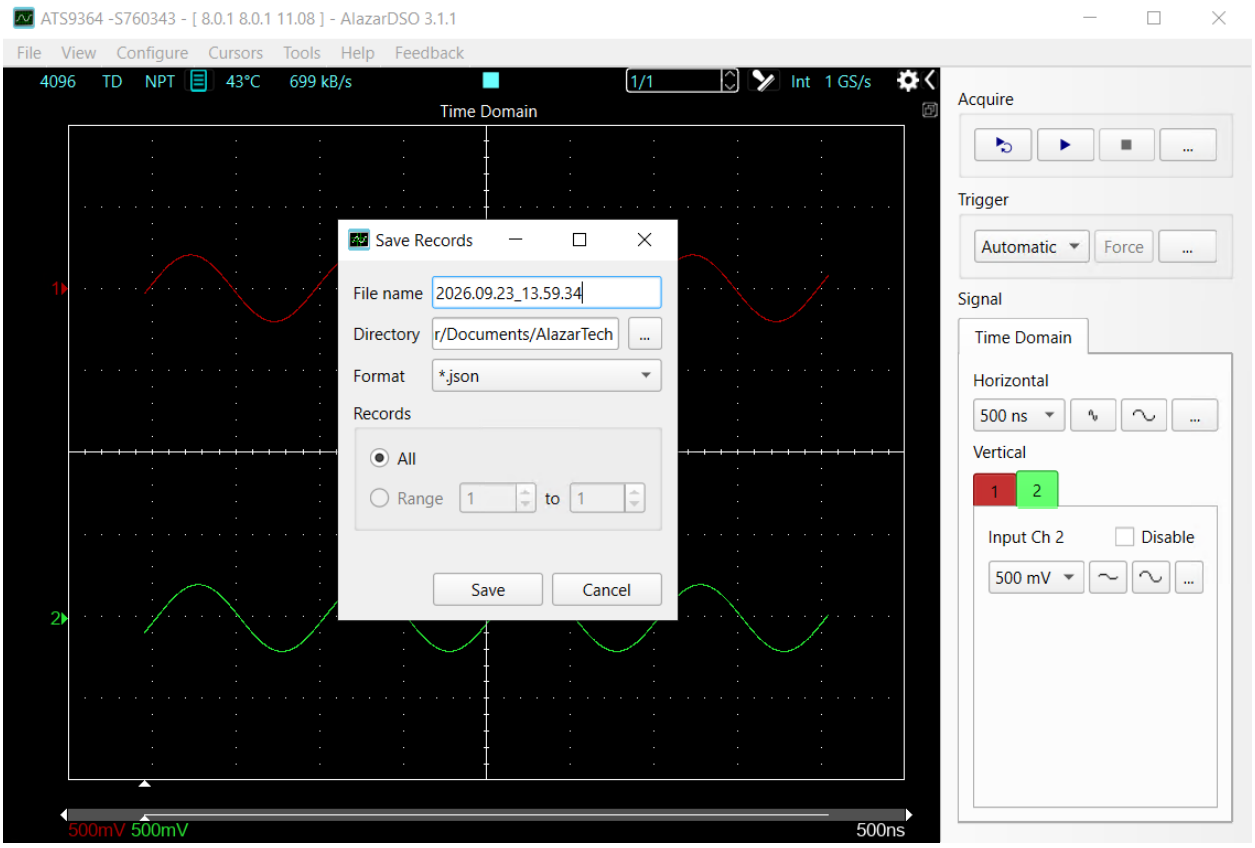


Fig. 17: Save Records window

Cancelling the folder browser clears this field rather than leaving it unchanged. A save with an empty directory writes nothing and still reports success, so check the field after cancelling. **Confirmed.**

Format
Select what to write. See **Formats** below.

Records
Choose **All** to save every record in the frame, or **Range** to save a span. The range runs from 1 to the number of records per channel.

Unavailable for the JSON format, which always saves the whole frame.

Samples
Choose **All samples** to save each record end to end, or **Range** to save a span of samples within each record.

The highest value is the number of valid samples in a record, which on some acquisitions is fewer than the record length; see *Configure Acquire*.

Unavailable for the JSON format.

Note

Typing in either spin box selects **Range** automatically.

Channels
One check box per enabled channel. All are checked when the window opens.

Unavailable for the JSON format, which always saves every channel.

Warning

Clearing **every** check box saves **all** channels rather than none. An empty selection is treated as "no filter". **Confirmed.**

Separate channels into individual files
Write one file per channel instead of combining the channels into one file.

Available for the CSV and MATLAB formats only.

Include metadata header
Write a block of commented lines at the top of each file describing the acquisition that produced it.

Available for the CSV formats only. The MATLAB formats always write their metadata, as a structure inside the file.

Save
Write the files. A progress window appears while they are written, and AlazarDSO reports

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Done when it has finished.

> **Warning**
>
> *Done* is reported whether or not anything was written. A save that fails — because the directory is unwritable, or the data is in a format no writer handles — reports success and produces nothing.
>
> **Confirmed:** a save to a directory under `C:\Windows\System32` reported *Done* and wrote no files, and created no directory.

> **Note**
>
> The progress window can be closed, but **closing it does not cancel the save**. The files are written in full regardless, and *Done* still appears.

Cancel
Close the window without writing anything.

Formats

Entry	Files produced	Notes
`*.json`	One `.json` and one `.bin`	The only format AlazarDSO can read back. Always saves the whole frame.
`*.txt`	One file per record, channel and output	One sample per line, as raw converter codes
`*.bin`	One file per record, channel and output	A bare array of samples, with no header
`*.csv (Volts)`	One file per record, or per record and channel	Time-domain values converted to volts
`*.csv (Samples)`	As above	Raw converter codes
`*.mat (Volts)`	One file, or one per channel	MATLAB Level 5; time-domain values converted to volts
`*.mat (Samples)`	As above	Raw converter codes

Every format is described in detail in *File Formats*.

Note

The **Volts** variants convert **time-domain** values only. Spectra are written as the processed values the transform produced, in both variants.

Choosing a format

JSON when you want to reopen the data in AlazarDSO later. It is the only format **Load Data** accepts.

CSV when the data is going into a spreadsheet, or a script, or any tool that reads text. It carries a time or frequency axis alongside the values, and optionally a full description of the acquisition.

MATLAB when the data is going into MATLAB. Each channel becomes one array of samples by records, with matching axis vectors.

Text or binary when another program needs the raw sample values with nothing around them, and you already know the acquisition settings.

Warning

Opening this window closes |product| when the acquisition produces no time-domain output.

With **On-FPGA FFT** selected and **Raw + FFT** unchecked, **File ▶ Save Data** reports *selected output not in layout* and AlazarDSO terminates. Nothing can be saved first.

Check Raw + FFT before saving. With a time-domain output present the window opens normally and the spectra save as expected.

Warning

Data acquired with 12-bit packing can only be saved as JSON. The JSON format writes the buffers byte for byte and produces the expected `.json` and `.bin` pair. The text, binary, CSV and MATLAB writers produce no files at all, while still reporting *Done*.

Turn 12-bit packing off in *Configure Acquire* before saving in any other format.

Confirmed on an ATS9364.

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CHAPTER

FOUR

DIALOGS

4.1 Board Properties

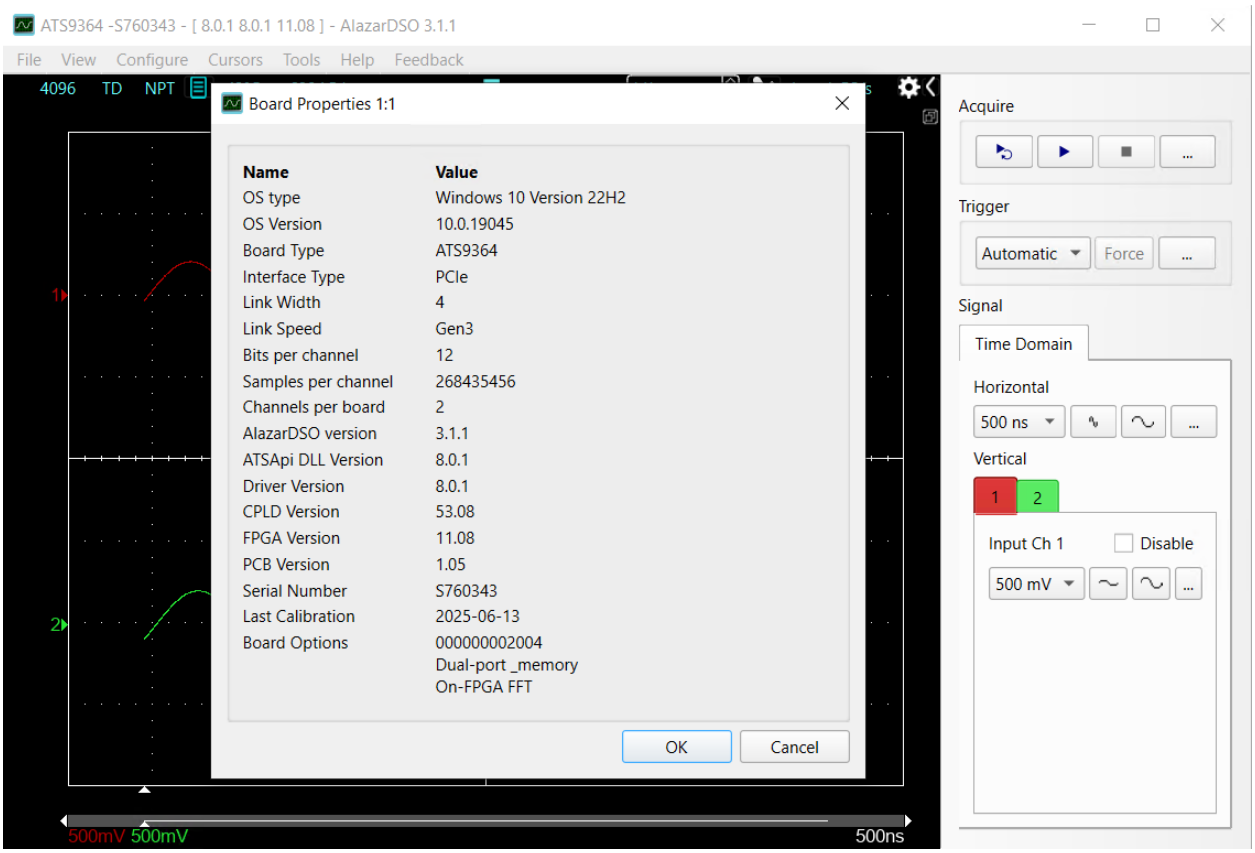


Fig. 1: Board Properties window

Reports the identity, firmware versions and capabilities of one digitizer, along with the software versions in use. Every field is read-only.

Open it from *Configure System* by selecting a board and pressing **Properties...**, or with `F4`.

The title bar identifies the board as **Board Properties** followed by its system and board numbers, for example `Board Properties 1:1`.

Field	Meaning
OS type	The host operating system
OS Version	Its version
Board Type	The digitizer model
Interface Type	The bus the digitizer is attached by
Link Width	The negotiated PCI Express link width
Link Speed	The negotiated PCI Express generation
Bits per channel	The converter's sample resolution
Samples per channel	On-board memory depth, in samples per channel
Channels per board	Number of analog inputs
AlazarDSO version	The version of this application
ATSApi DLL Version	The version of the AlazarTech API library
Driver Version	The version of the device driver
CPLD Version	The digitizer's CPLD version
FPGA Version	The digitizer's FPGA version
PCB Version	The printed circuit board revision
Serial Number	The digitizer's serial number
Last Calibration	The date of the last factory calibration
Board Options	The option code, followed by the installed options one per line

Note

Link Width and **Link Speed** are worth checking when an acquisition reports buffer overruns. A digitizer that has negotiated a narrower link or a lower generation than it supports cannot reach its rated transfer rate. *Bus benchmark* measures what the link actually achieves.

Note

Quote **Board Type**, **Serial Number**, **FPGA Version**, **ATSApi DLL Version** and **Driver Version** when contacting AlazarTech support.

Right-clicking the window offers **Take Screenshot**, which captures the window and opens a preview from which the image can be saved or copied to the clipboard. See *File Formats*.

On a system containing several digitizers, one tab is shown per board.

4.2 Spectrum information

Measures the dynamic performance of a single record: where the fundamental sits, how large its harmonics and worst spur are, and the resulting SFDR, THD, SNR, SINAD and ENOB.

Use it to characterise a digitizer against a known-good sine source, or to see how much of the available resolution a real signal is using.

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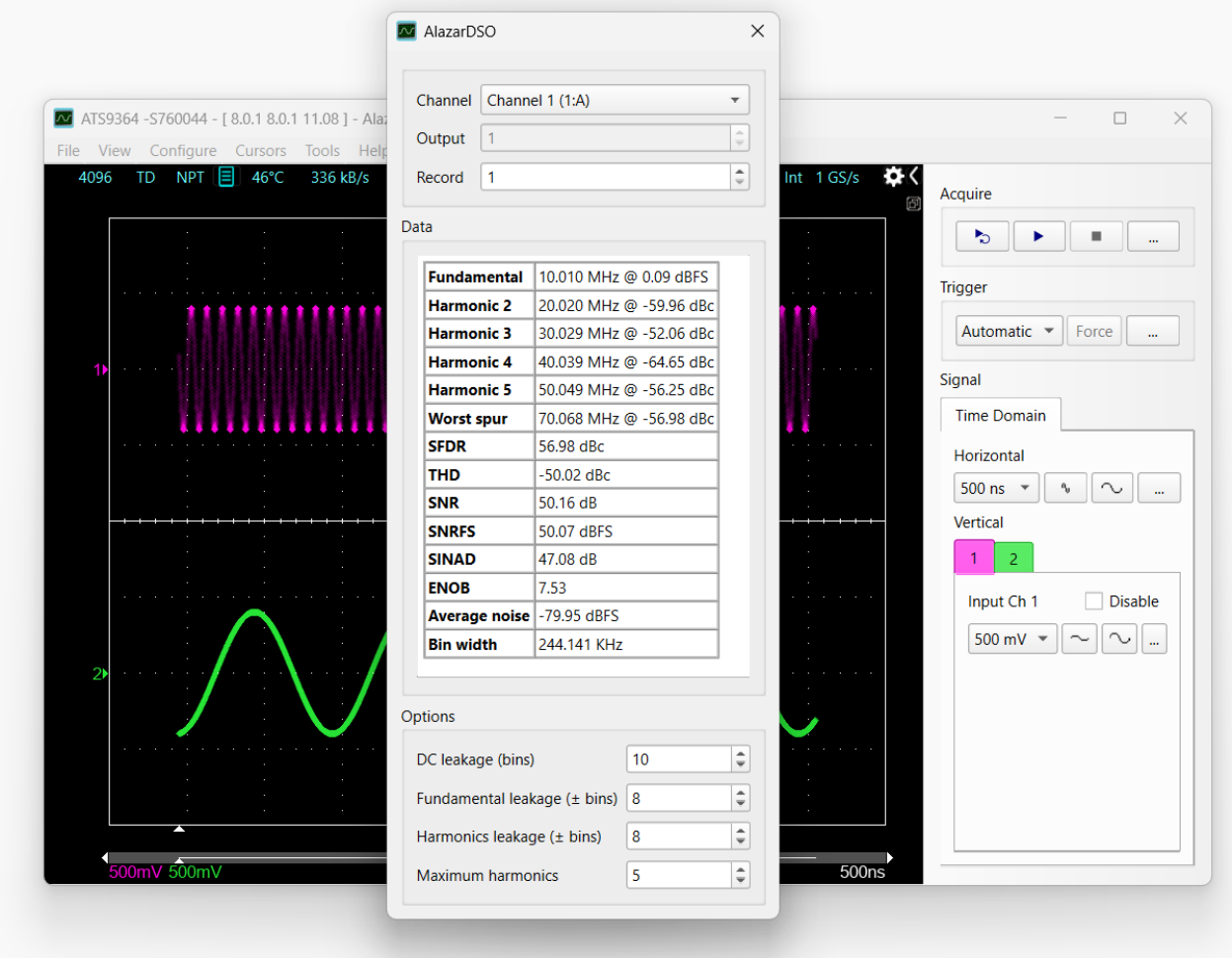


Fig. 2: Spectrum information window

Open it with **Spectrum information** from the **Tools** menu. The window stays open alongside the main window and recalculates every time the display draws a new frame.

New in AlazarDSO 3.1.2.

> **Note**
>
> The measurement is made on **time-domain samples**. It converts the record to volts using the channel's input range, applies a Blackman-Harris window, and transforms the whole record as a single FFT with no averaging. The window and transform length are its own, and are not those configured in *Configure On-FPGA FFT* or *Configure CPU FFT*.
>
> Full scale, 0 dBFS, is the power of a sine filling the channel's input range.

4.2.1 Selecting what to measure

Channel
: Select the channel to measure. Entries read **Channel** *n* followed by the board and input it corresponds to, for example `Channel 1 (1:A)`.

Output
: Select which output of that channel to measure. Available only on digitizers producing more than one output per channel.

Record
: Select which record of the current frame to measure. Available only when the frame holds more than one record.

  This selector and the record selector in the heads-up display follow each other.

  The table updates immediately when the record is changed.

4.2.2 Data

The measurements, as a two-column table.

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Row	Meaning	Units
Fundamental	Frequency and level of the largest component	dBFS
Harmonic 2 . . . n	Frequency and level of each harmonic, relative to the fundamental	dBc
Worst spur	Frequency and level of the largest non-harmonic component	dBc
SFDR	Spurious-free dynamic range	dBc
THD	Total harmonic distortion	dBc
SNR	Signal-to-noise ratio, excluding harmonics	dB
SNRFS	Signal-to-noise ratio referred to full scale	dBFS
SINAD	Signal to noise and distortion	dB
ENOB	Effective number of bits	bits
Average noise	Mean noise floor	dBFS
Average noise	Mean noise floor	dBFS
Bin width	Frequency spanned by one FFT bin	Hz, kHz, MHz or GHz

The number of harmonic rows follows **Maximum harmonics** below.

Instead of the table, the window shows **No signal** when no frame is loaded or the selected record is empty, and **Failed to compute FFT** if the transform could not be performed.

The window works in every acquisition mode, including **On-FPGA FFT** and **ATS-GPU**.

> **Note**
>
> The measurement has been verified against a known source: a 10 MHz sine acquired at 1 GS/s with a 4096-sample record is reported at 10.010 MHz, within half of the 244 kHz bin width.

4.2.3 How the figures are derived

SNR excludes the DC term, the band around the fundamental, and every harmonic up to the **Maximum harmonics** setting. Raising that setting therefore excludes more of the spectrum from the noise measurement.

SFDR ignores those same harmonics, so it reports the largest *non-harmonic* spur. A signal whose largest spur is a harmonic will show a better SFDR than a casual reading of the table suggests.

ENOB is derived from SINAD as `(SINAD - 1.76) / 6.02`, with no correction for a signal below full scale. A signal at half full scale therefore reports roughly one bit fewer than the converter achieves.

4.2.4 Options

These control which bins are excluded from the noise measurement, so that leakage around the DC term and around each tone does not count as noise.

Option	Range	Default	Unit
DC leakage (bins)	0 to 100	10	bins
Fundamental leakage (± bins)	0 to 100	8	bins either side
Harmonics leakage (± bins)	0 to 100	8	bins either side
Maximum harmonics	1 to 20	5	harmonic order

Widen the leakage settings if the window's skirts are being counted as noise, which depresses SNR; narrow them if genuine noise close to a tone is being excluded, which flatters it.

Options are not saved. They return to their defaults when AlazarDSO restarts, but survive closing and reopening the window within a session.

4.3 Power Monitor

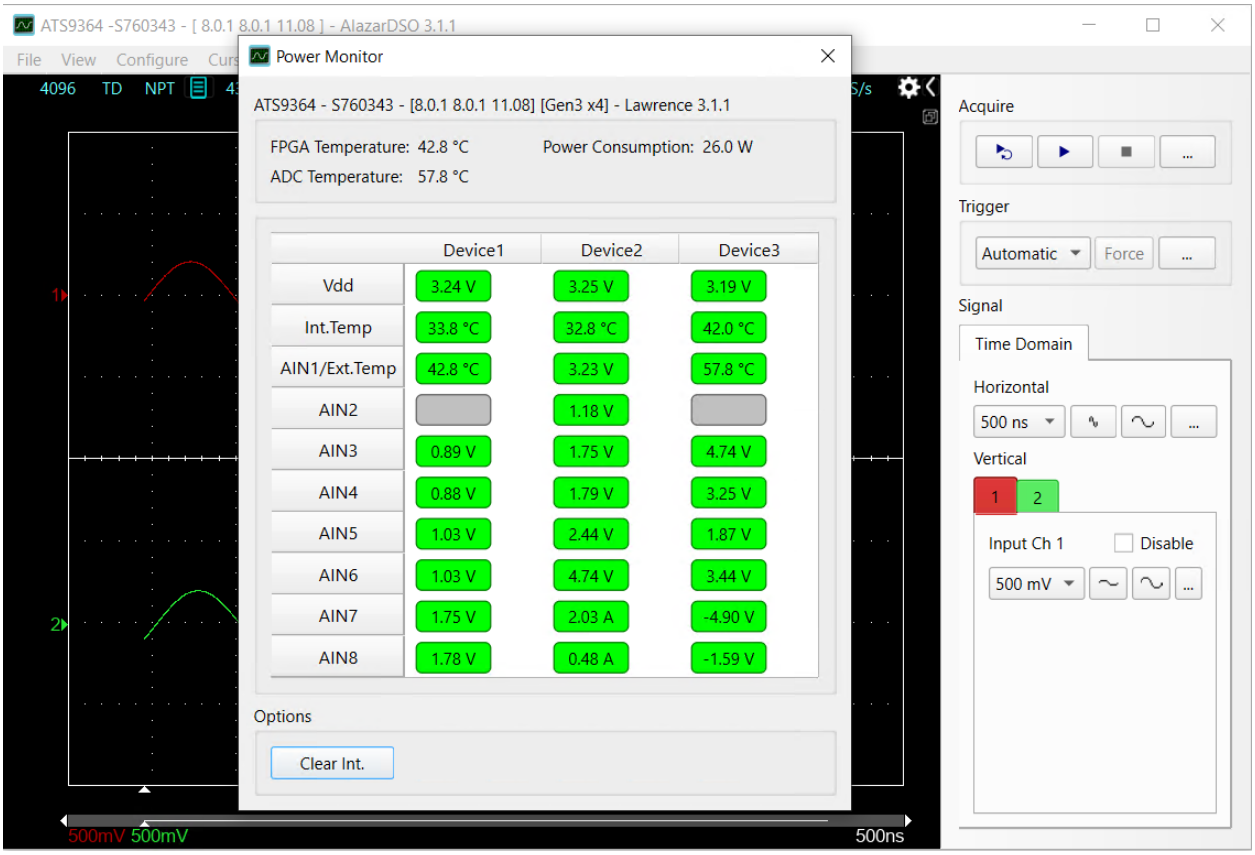


Fig. 3: Power Monitor window

Reports the temperature and supply rail readings from a digitizer's on-board sensors. Open it with **Power monitor** from the **Tools** menu.

Readings refresh every ten seconds while the window is open, and are refreshed once when it opens.

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The heading above the readings identifies the board, its serial number, the software and firmware versions in use, and its negotiated link.

4.3.1 Temperature and power

FPGA Temperature
The temperature of the digitizer's FPGA.

ADC Temperature
The temperature of its analog-to-digital converter.

Power Consumption
The power drawn by the digitizer, calculated from the current on its 3.3 V and 12 V rails.

A reading of `--` means the digitizer does not report that quantity. The tooltip on each says so explicitly.

4.3.2 Supply rails

A table of readings, one row per monitored quantity and one column per monitoring device. Rows are **Vdd**, **Int.Temp**, **AIN1/Ext.Temp**, and **AIN2** through **AIN8**.

Each reading is shown against a coloured background indicating whether it is within its expected range. Hovering over a reading shows its detail.

Clear Int.
Reports the interrupt flags the monitoring devices have latched.

> **Note**
>
> With no digitizer attached — in simulation mode — this window opens with an empty table and no readings.

4.4 ATSApi log

Displays the ATS API log file, for diagnosing communication between AlazarDSO and the digitizer. Open it with **View API log file** from the **Debugging** submenu.

Logging must be enabled first, with **Enable ATS API log**, and AlazarDSO restarted. See *Menu Reference*.

Search
Enter text to find in the log. Press `Enter` or **Next** to search forwards.

Previous, Next
Step between matches.

> **Note**

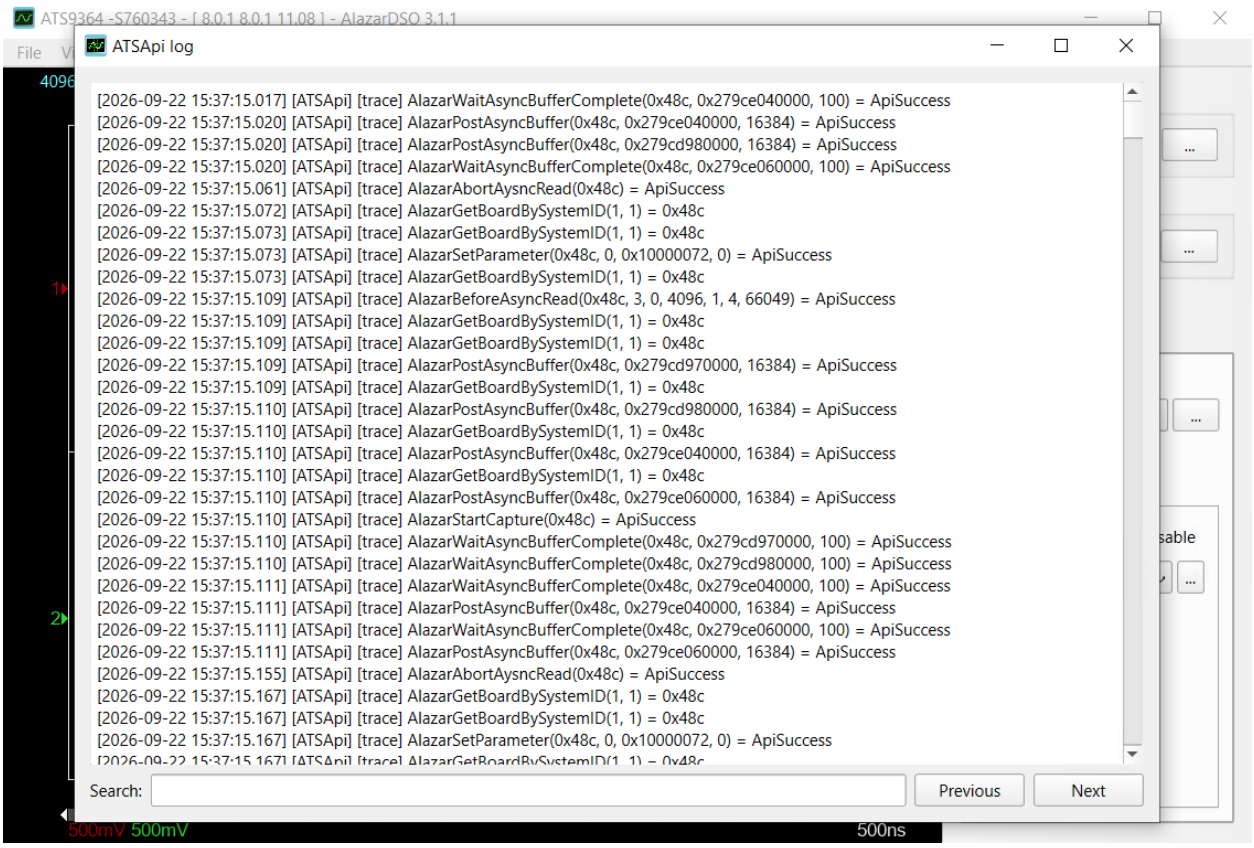


Fig. 4: ATSApi log window

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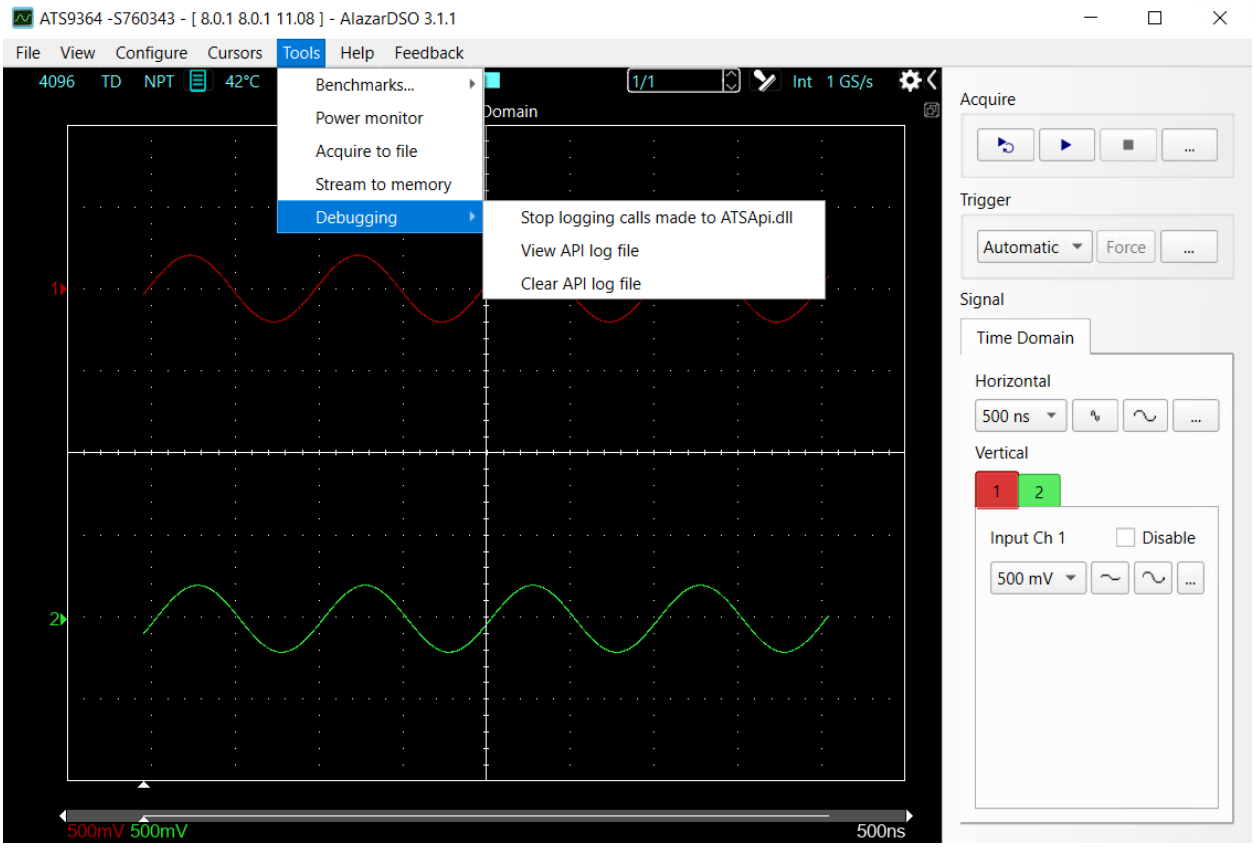


Fig. 5: Enabling the ATS API log from the Debugging submenu

The log is read once when the window opens. It does not follow the file as it grows — close and reopen the window to see newer entries.

4.5 Change Language

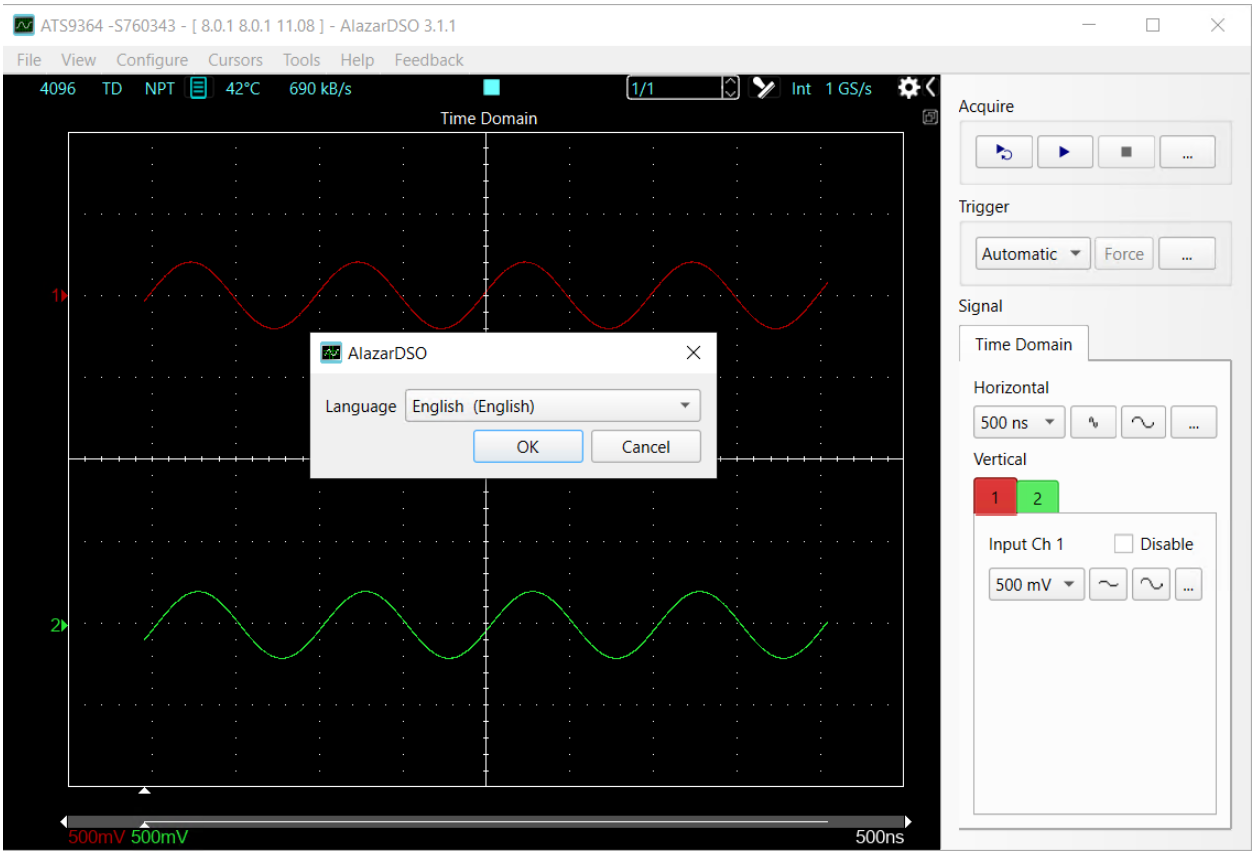


Fig. 6: Change Language dialog box

Selects the language of the user interface. Open it with **Language** from the **Configure** menu, or with `Ctrl+F10`.

AlazarDSO ships in nine languages:

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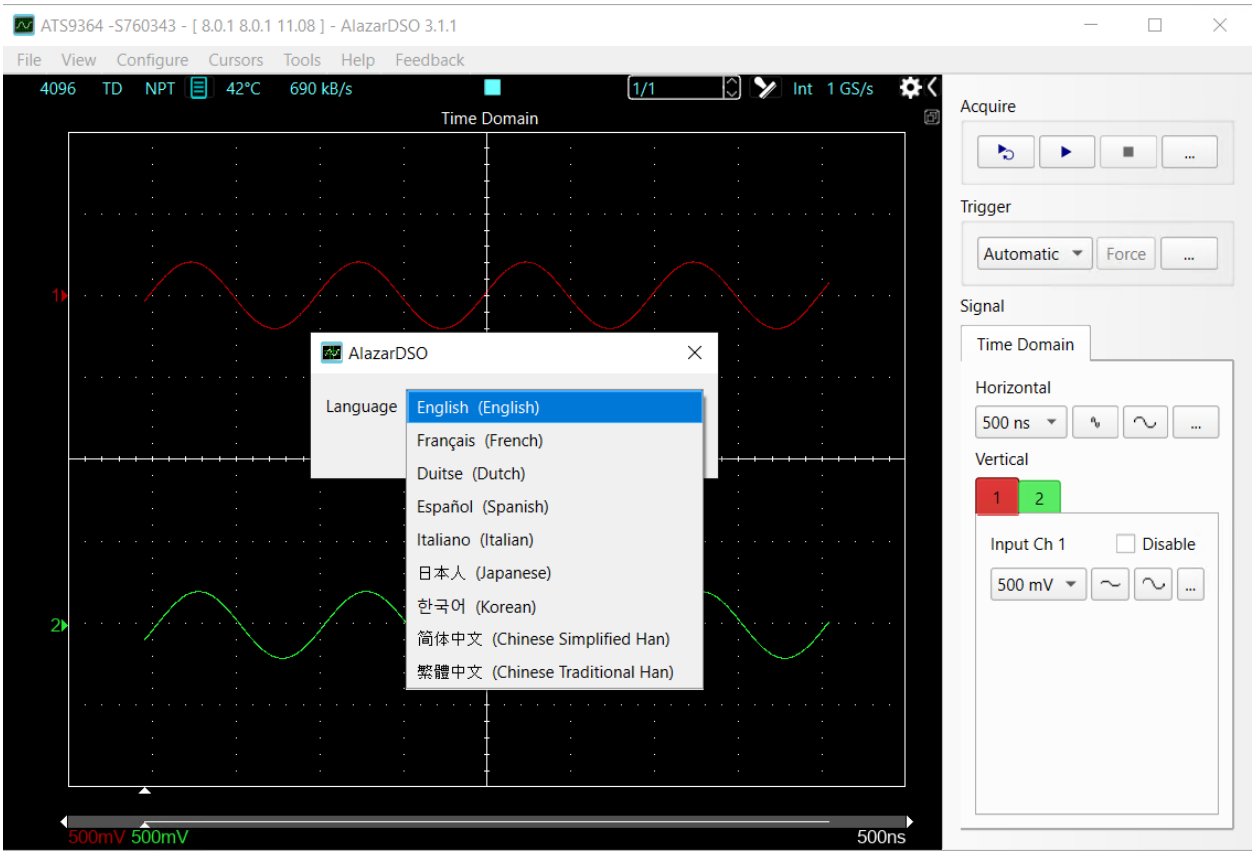


Fig. 7: Choosing a language

Language	Notes
English	The source language, and the default
French	
German	
Spanish	
Italian	
Japanese	
Korean	
Chinese (Simplified)	
Chinese (Traditional)	Traditional characters

Note

A message with no translation is shown in English, so parts of the interface may appear in English depending on the language chosen.

4.6 Acquire To File

Saves a sequence of acquisitions directly to a file. Open it with **Acquire to file** from the **Tools** menu.

File name
: The name of the file to create. AlazarDSO offers the current date and time as a default.

Directory
: Where to create the files. Press `...` to browse.

The dialog box warns that data throughput may be limited while acquiring to file.

Acquiring to file writes a `.json` file describing the acquisition and a `.bin` file holding the sample data, in the same form as the JSON option of *Save Records*. See *File Formats*.

4.7 Save Data

Writes records from the current acquisition to disk. Open it with **Save Data** from the **File** menu.

The controls are described in *Save Records*, and the formats in *File Formats*.

4.8 Load Data

Opens a previously saved acquisition. Open it with **Load Data** from the **File** menu.

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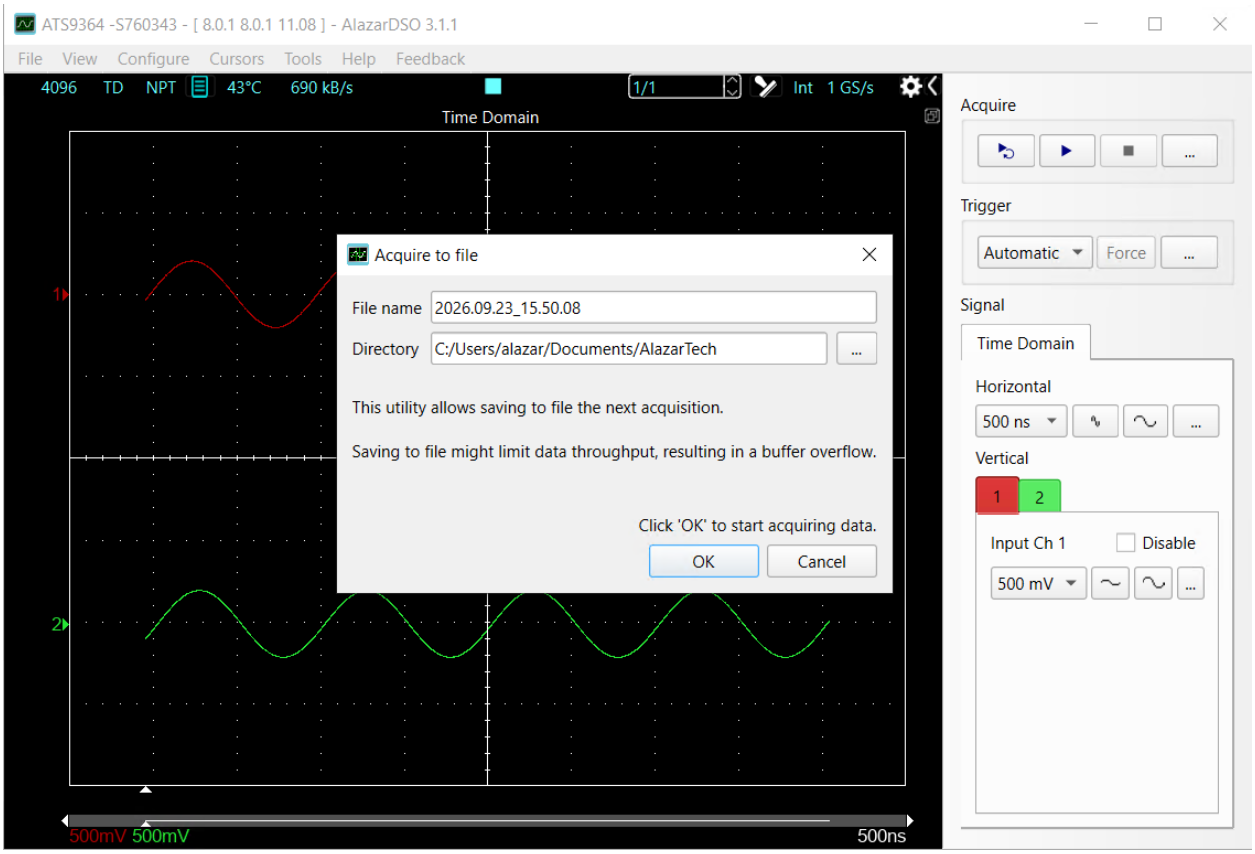


Fig. 8: Acquire To File dialog box

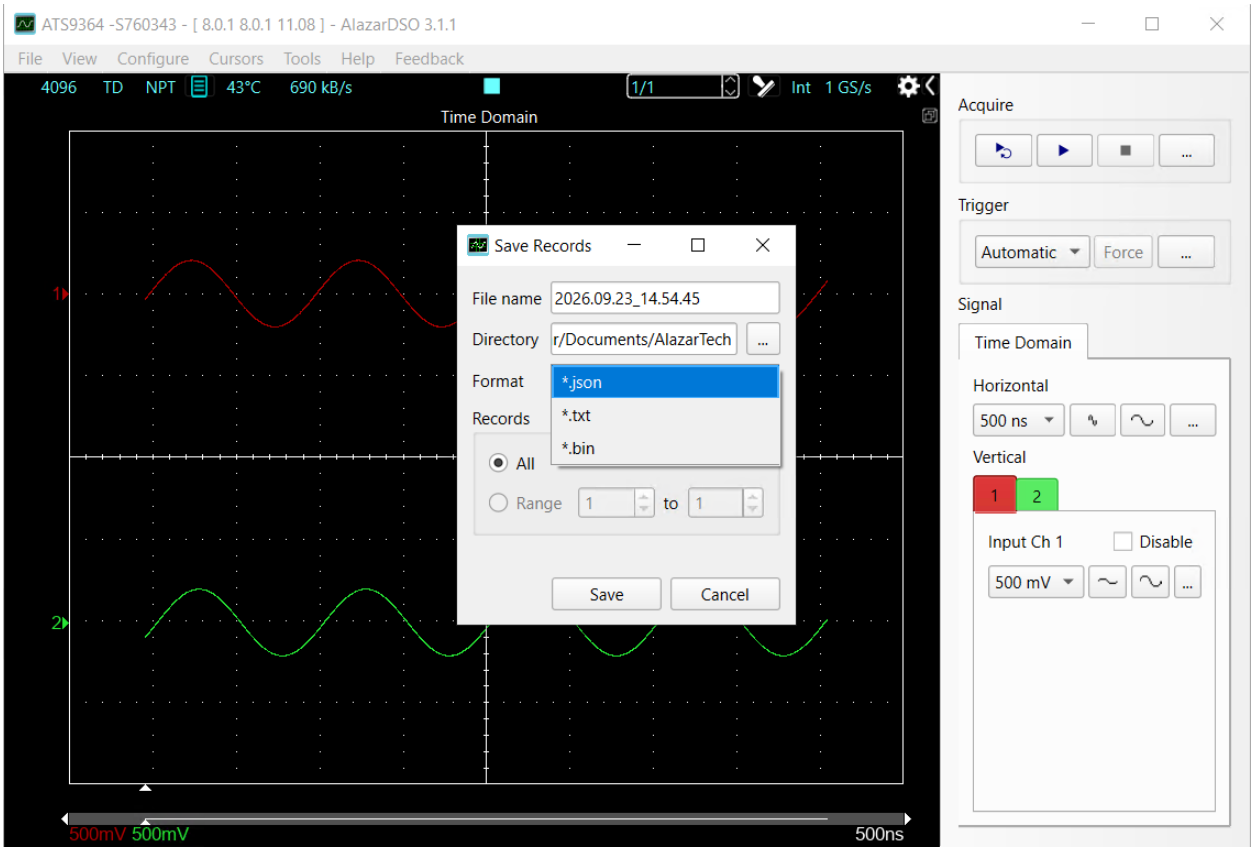


Fig. 9: Save Data window

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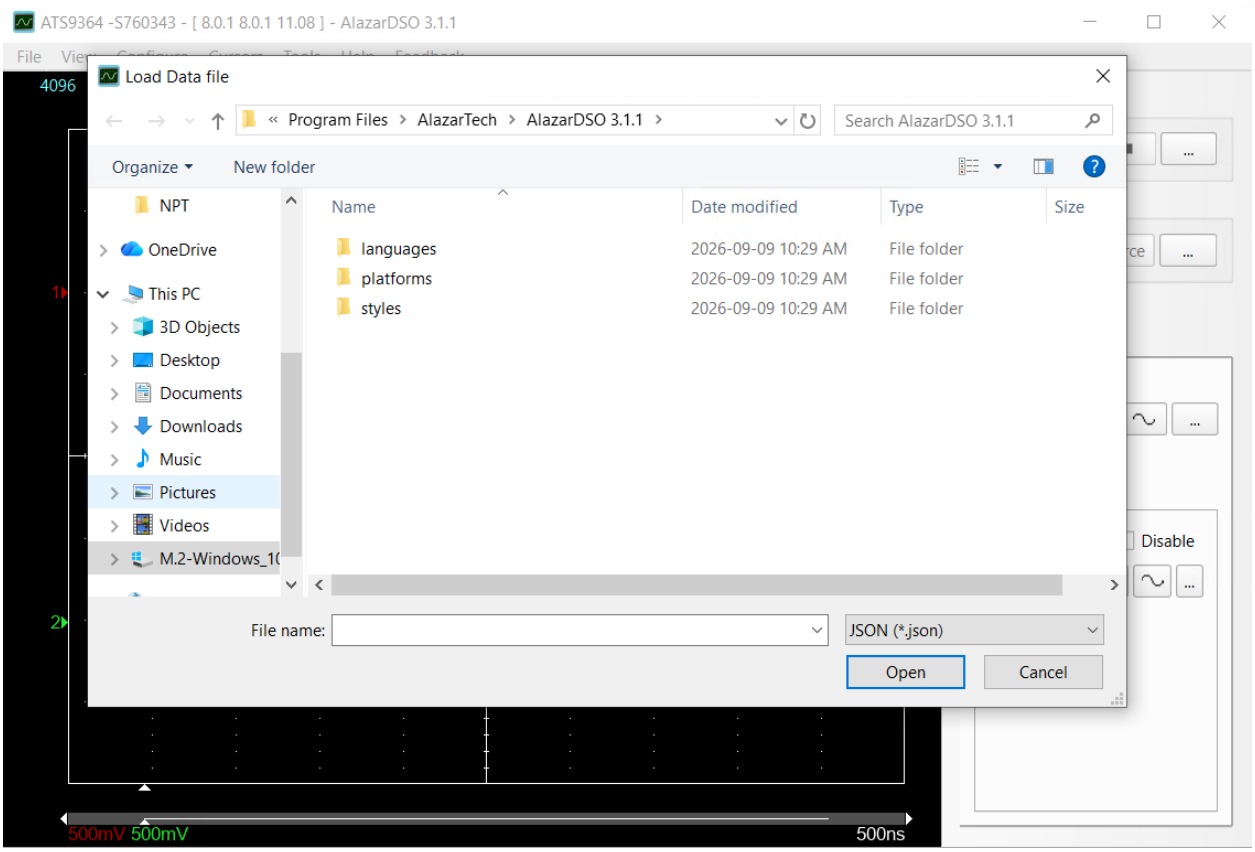


Fig. 10: Load Data window

> **Note**
>
> Opening this window stops any acquisition in progress, whether or not you go on to load a file.

Two file types can be read:

JSON (*.json)
: An acquisition saved by AlazarDSO 3.1.2. The companion `.bin` file must be beside it. Selected by default.

ATB (*.atb)
: A time-domain capture written by AlazarDSO 2.x. **Change the file type to see these files** — the browser shows only JSON until you do.

Loaded records are shown in a window of their own. Most of the configuration menu is hidden while that window has focus, since there is no digitizer to configure — only the FFT windows and **Display...** remain. Cursors, references and screenshots work as they do on live data.

> **Note**
>
> Loaded data cannot be saved again. **Save Data** is unavailable in a loaded-data window, in either format.

4.8.1 Opening an ATB file

Support for reading ATB files was added in AlazarDSO 3.1.2. AlazarDSO **cannot write** them.

Only part of the file is read. AlazarDSO takes the record length, the pre-trigger samples, the sample rate, the record and capture counts, and each channel's enabled state, input range and probe attenuation.

Everything else is assumed:

Setting	Shown as
Input impedance	50 Ω, however the data was captured
Input coupling	DC, however the data was captured
Clock source	Internal
Trigger	Not shown

The file's comment field, trigger settings and per-record timestamps are not read.

> **Warning**
>
> Only files from 2-, 4- and 16-channel digitizers can be opened. A file from a digitizer with any other channel count will not load.

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4.9 About

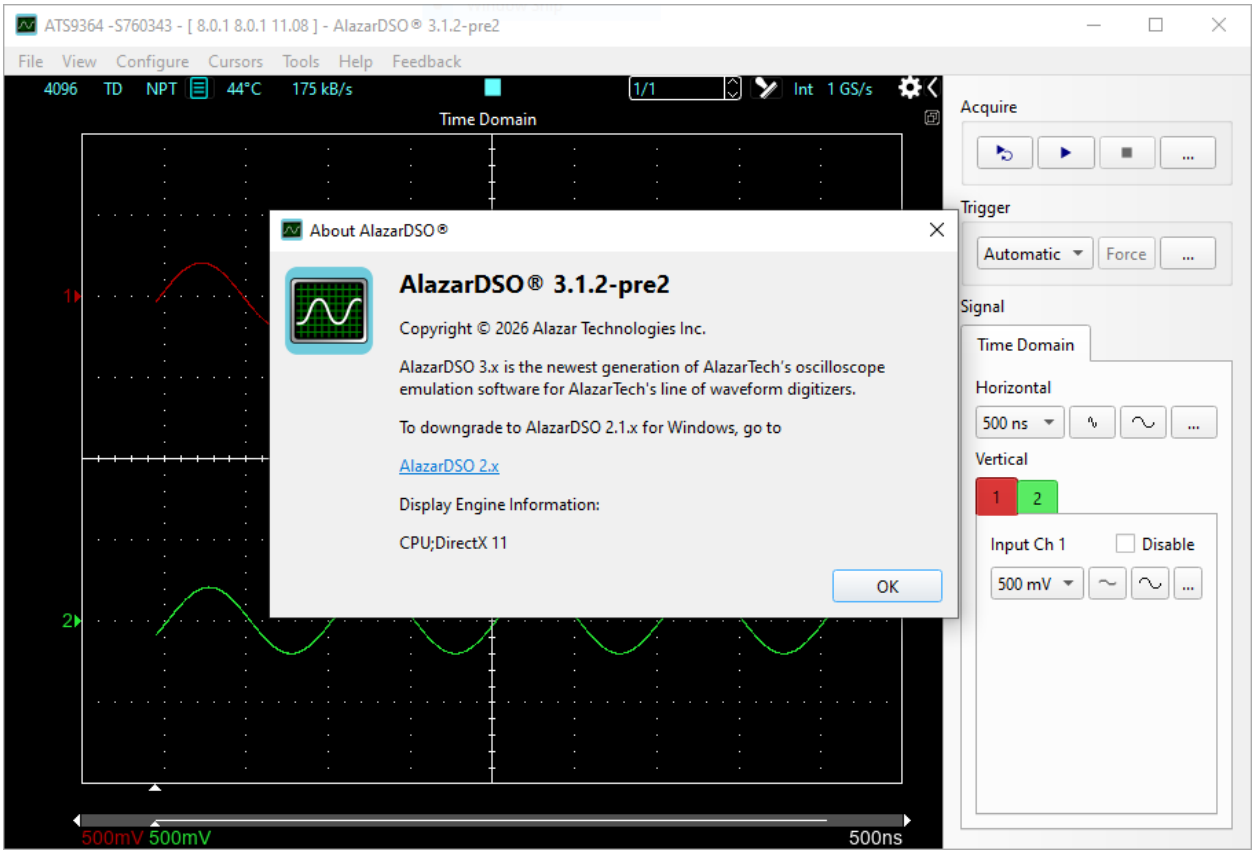


Fig. 11: About dialog box

Shows the AlazarDSO version and copyright information. Open it with **About** from the **Help** menu.

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CHAPTER

FIVE

WIZARDS

AlazarDSO provides five wizards, all reached from the **Tools** menu.

5.1 Common controls

Each wizard page carries some of the following buttons. They are described here once and are not repeated for each page.

Back
: Return to the previous page.

Next
: Continue to the next page.

Cancel
: Abandon the wizard.

Finish
: Close the wizard.

Buttons that do not apply to a page are hidden rather than greyed out, so the set of visible buttons changes as you move through a wizard.

5.2 Stream To Memory

Streams sample data from the digitizer into system memory, optionally writing it to a file afterwards.

Almost every field in this wizard is read-only. It reports the acquisition that the current configuration will produce, and how much memory that will need, rather than asking you to configure it again. Where a setting needs changing, the **...** buttons open the relevant configuration window without leaving the wizard.

5.2.1 Welcome

An explanatory page with no controls.

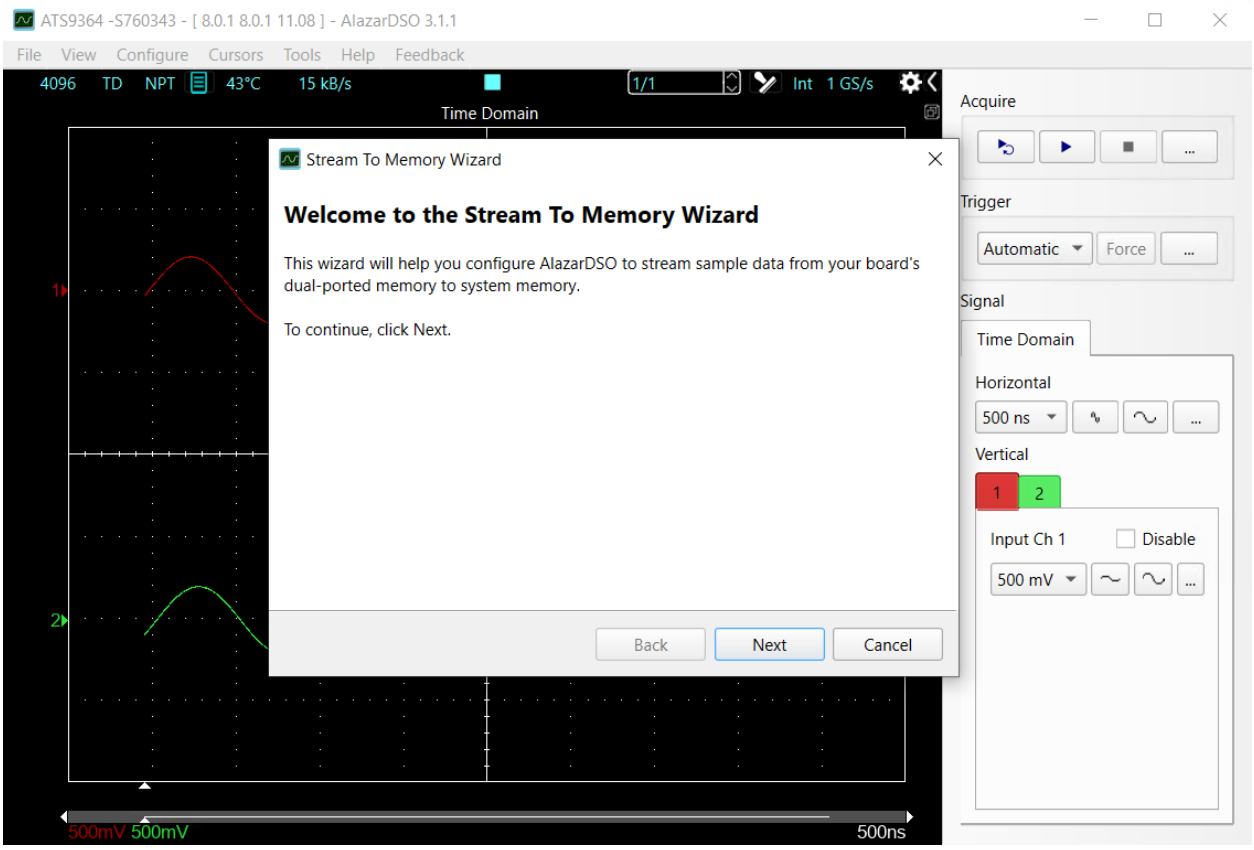


Fig. 1: Stream To Memory Wizard

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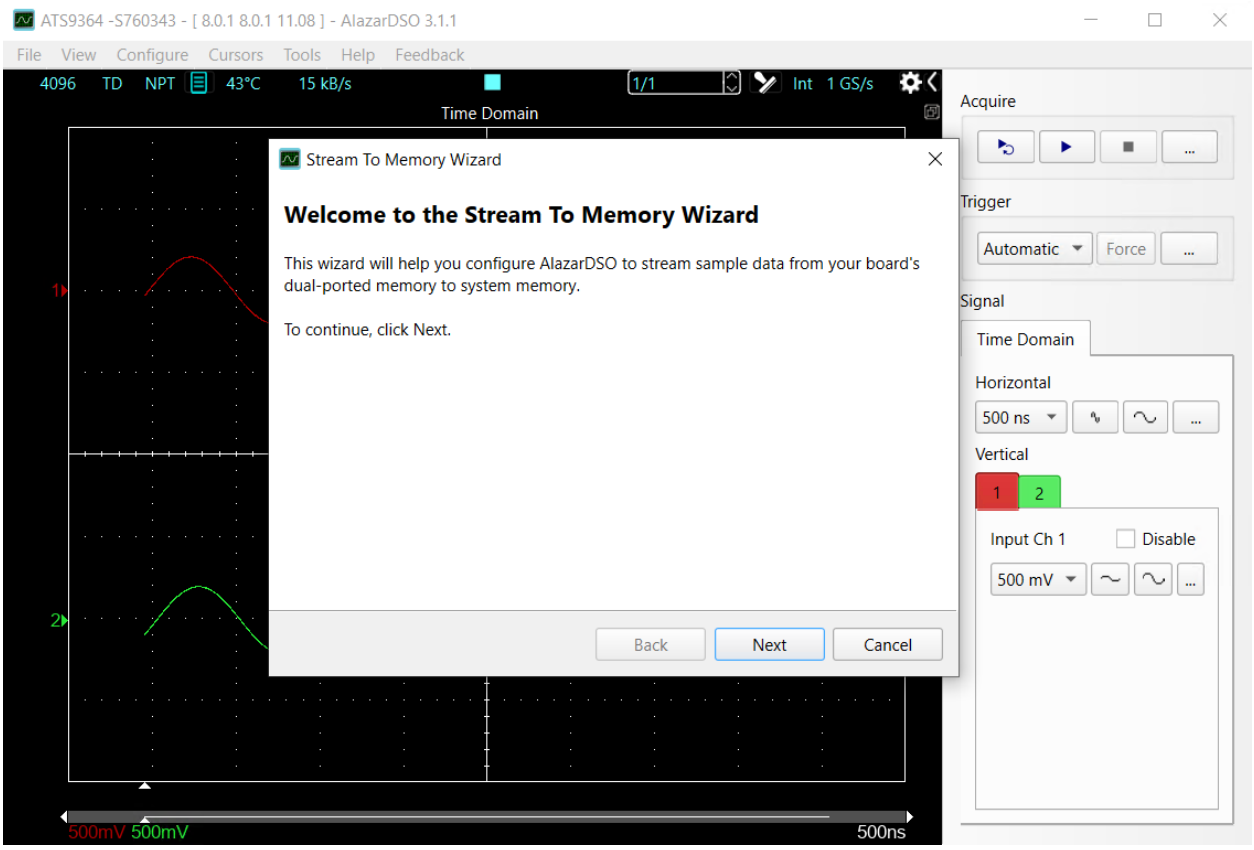


Fig. 2: Stream To Memory, welcome page

5.2.2 Configure acquisition

Reports the acquisition that will be performed. All fields are read-only.

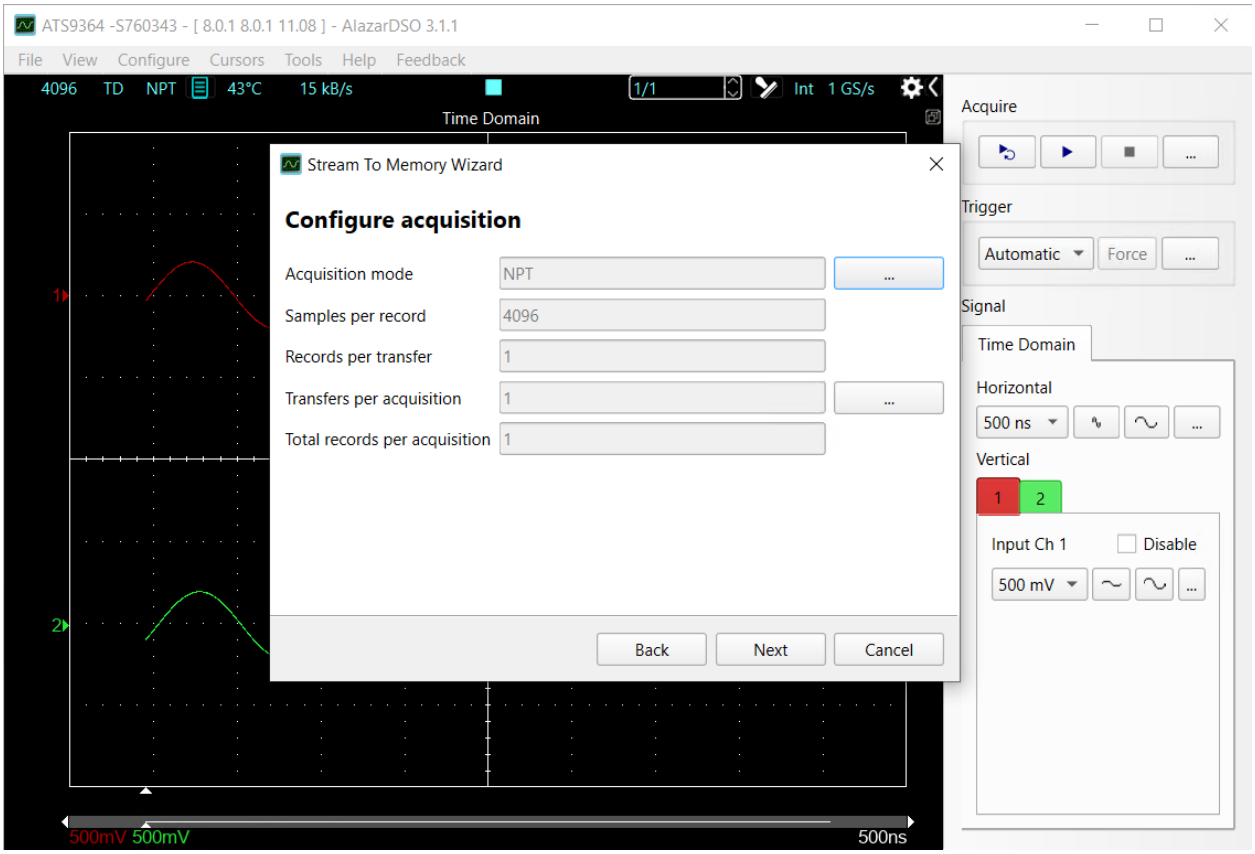


Fig. 3: Stream To Memory, configure acquisition page

Acquisition mode
: The current acquisition mode.

Samples per transfer
: The number of samples in each transfer. In modes that acquire discrete records, this reads **Samples per record**.

Records per transfer
: The number of records in each transfer.

Transfers per acquisition
: The number of transfers the acquisition will perform.

Total samples per channel
: The total the acquisition will produce. In record-based modes this reads **Total records per acquisition**.

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5.2.3 Configure board

Reports the digitizer settings that affect the stream. Each ... button opens the corresponding configuration window; changes made there are reflected here when you return.

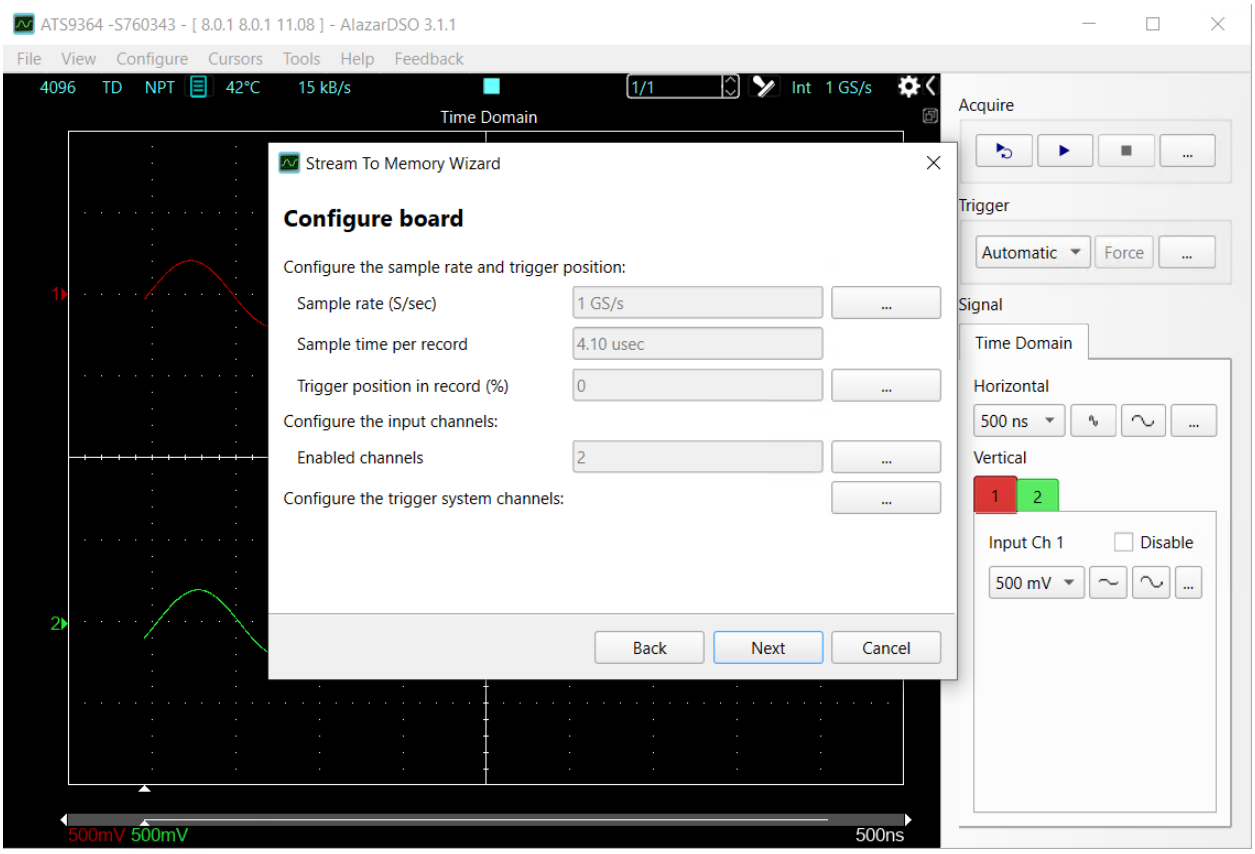


Fig. 4: Stream To Memory, configure board page

Sample rate (S/sec)
: The current sample rate. ... opens *Configure Clock*.

Total sample time
: The duration the acquisition will span. In record-based modes this reads **Sample time per record**.

Trigger position in record (%)
: Where the trigger sits within each record. ... opens *Configure Acquire*.

Enabled channels
: How many input channels are enabled. ... opens *Configure Channels*.

Trigger system
: A summary of the trigger configuration. ... opens *Configure Trigger*.

Note

Streaming to memory requires a finite acquisition. If **Buffers per acquisition** is set to infinite, this page reports *Stream to memory requires finite acquisition.* and will not advance. See *Configure Acquire*.

5.2.4 System memory options

Sets how much system memory the acquisition may use. This page carries the only editable field in the wizard.

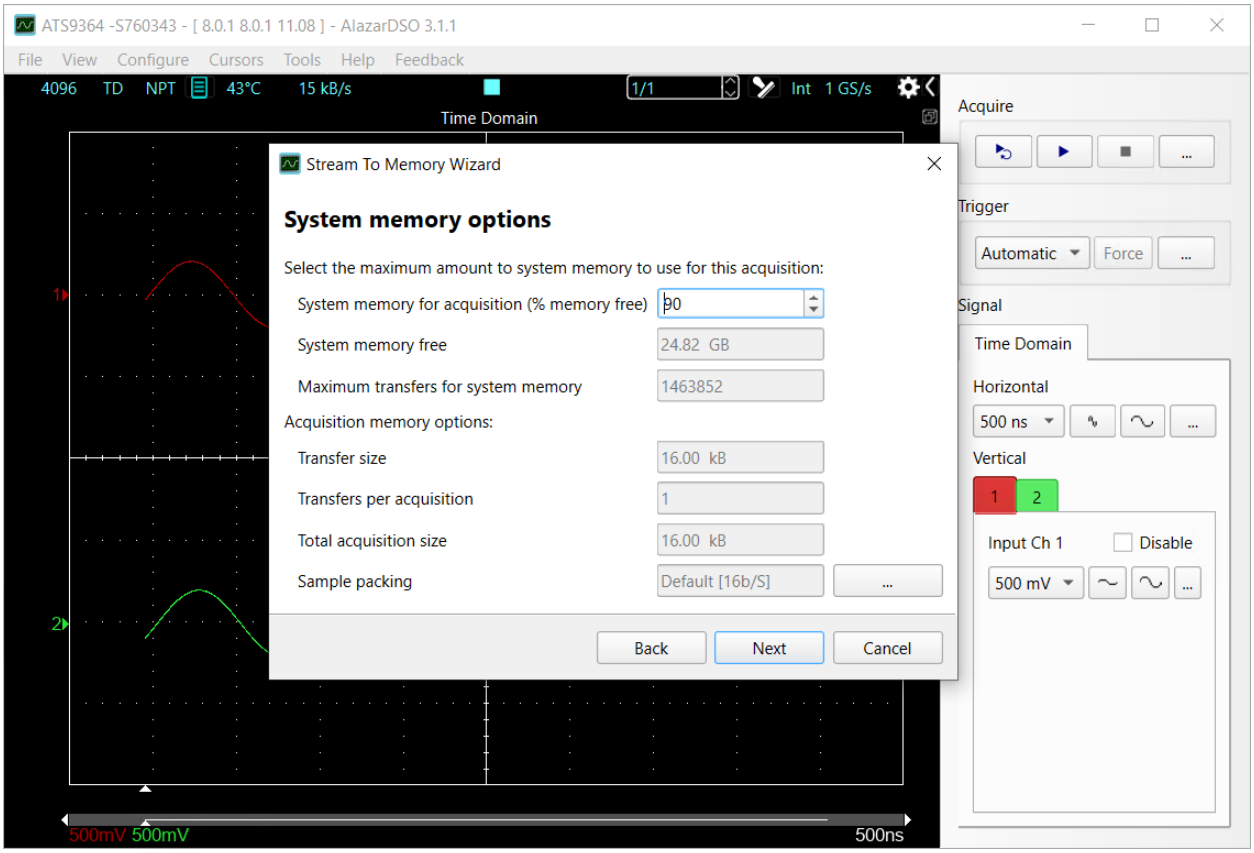


Fig. 5: Stream To Memory, system memory page

System memory for acquisition (% memory free)
: Enter the percentage of currently free system memory to reserve. Accepts 1 to 99; the default is 90.

System memory free
: How much memory is free now.

Maximum transfers for system memory
: How many transfers the reserved memory will hold.

Transfer size, Transfers per acquisition, Total acquisition size, Sample packing
: Read-only summaries of what the acquisition will produce.

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Note

If the acquisition needs more memory than has been reserved, AlazarDSO reports *Insufficient system memory for acquisition*. Either raise the percentage, or reduce the number of transfers in *Configure Acquire*.

5.2.5 Save to file

An optional page. Leave the **Save acquisition to file** group box unchecked to stream to memory without writing anything to disk.

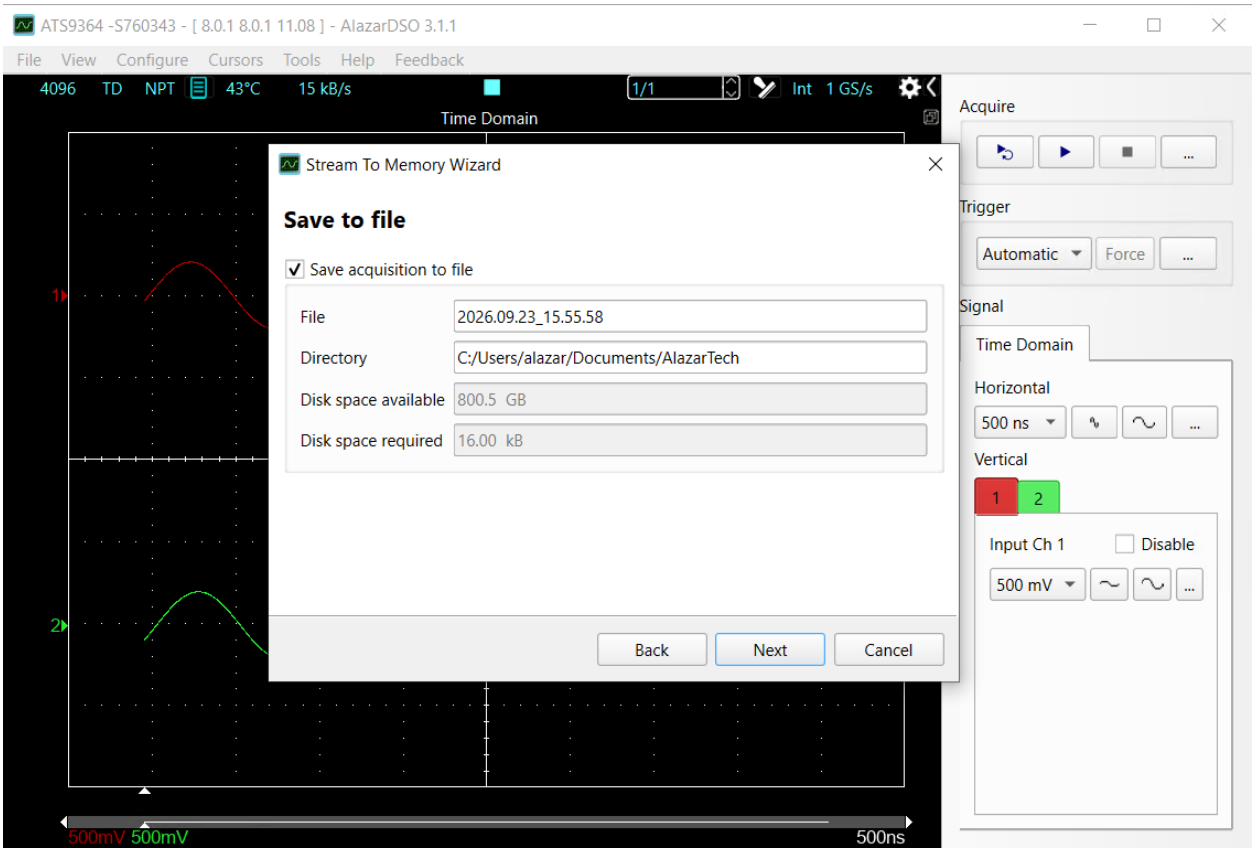


Fig. 6: Stream To Memory, save to file page with saving enabled

File
: The name of the file to create. Defaults to the current date and time.

Directory
: Where to create it. Defaults to `Documents\AlazarTech`.

Disk space available, Disk space required
: Read-only. The wizard will not advance if the acquisition needs more space than the volume has.

5.2.6 Completing the wizard

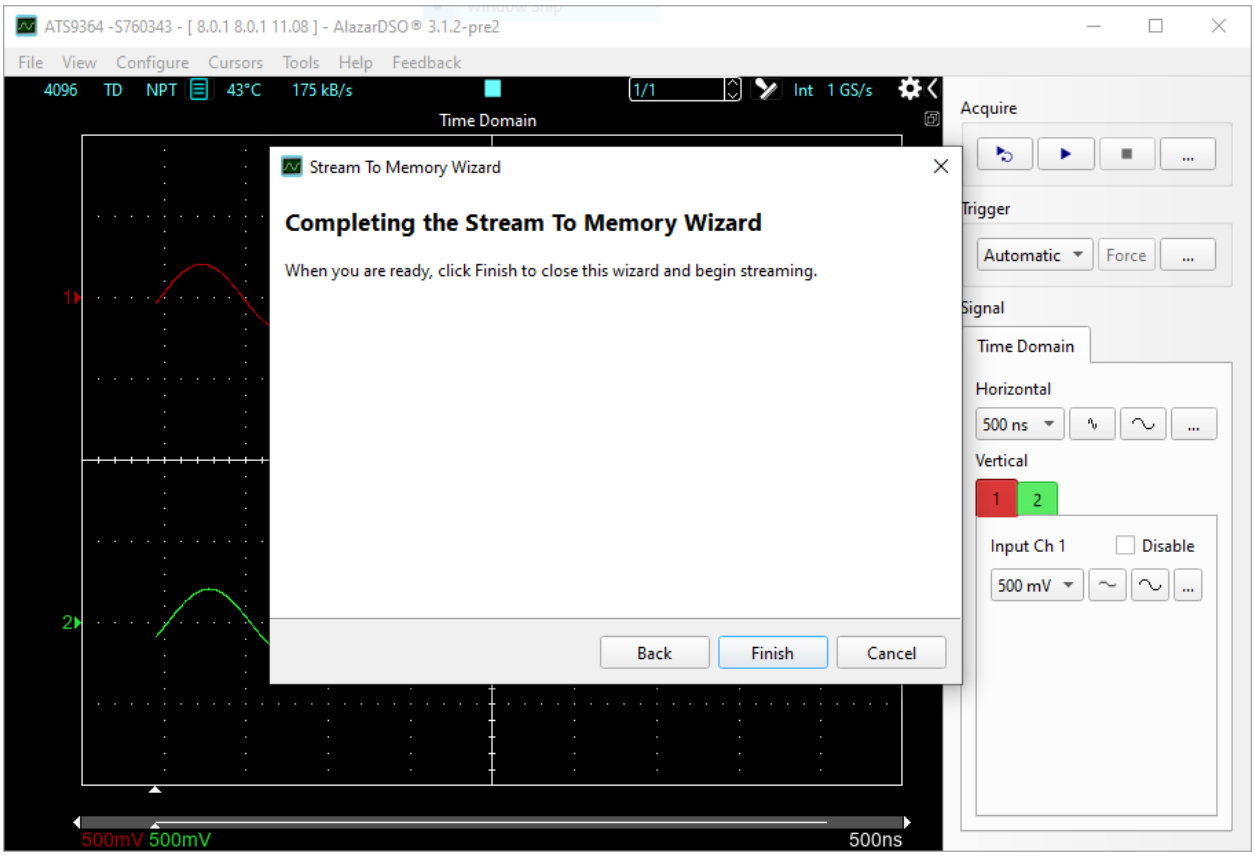


Fig. 7: Stream To Memory, final page

Press **Finish** to close the wizard and begin.

5.3 Benchmark wizards

Three wizards measure sustained throughput: **Bus benchmark**, **Managed Buffers benchmark** and **Disk benchmark**. All three share the same four-page structure, and differ only in their options page.

5.3.1 Common structure

Each benchmark wizard has four pages.

Welcome explains what the benchmark measures and has no controls.

Select benchmark options carries the settings for that particular benchmark. These differ by wizard and are described below.

Performing benchmark shows a progress bar and the current transfer rate, updated about twice a second. The wizard advances by itself when the benchmark completes — there is nothing to press.

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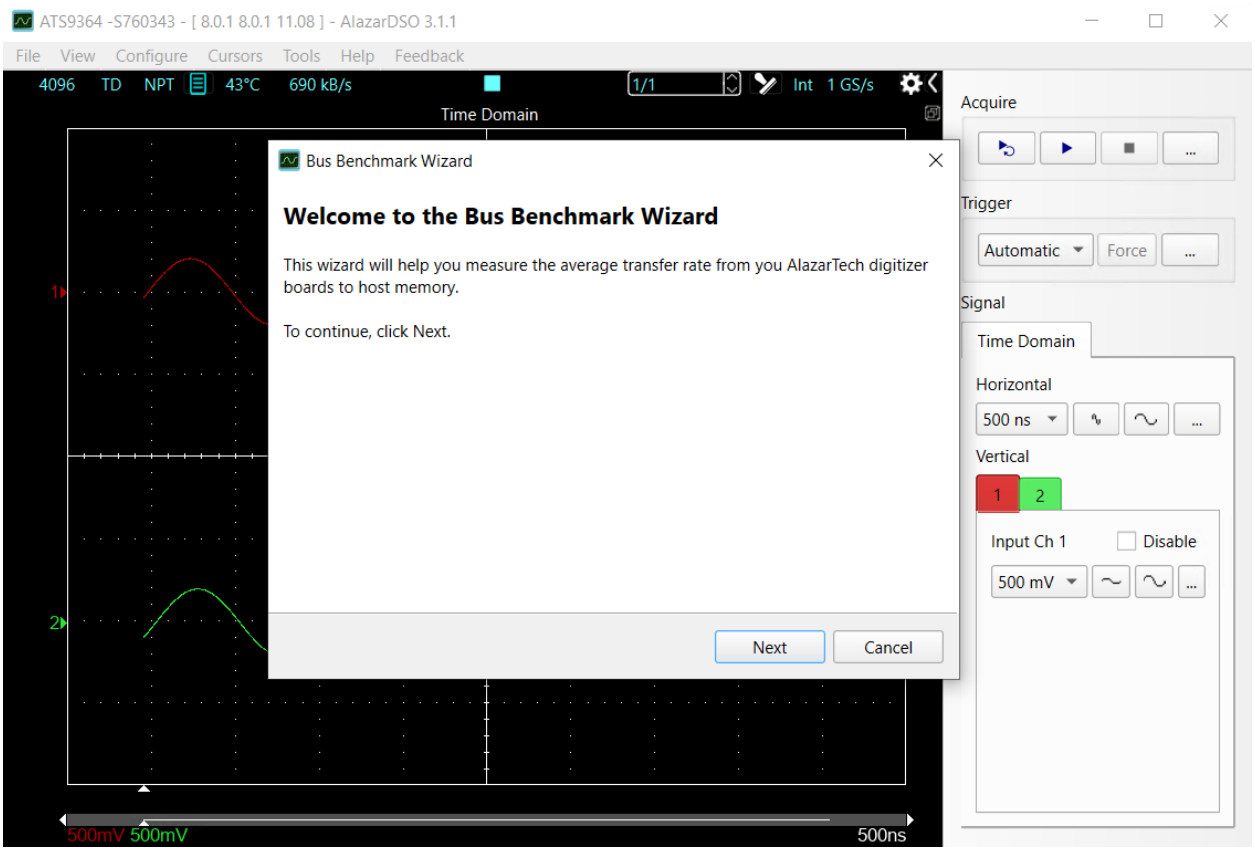


Fig. 8: Benchmark wizard, welcome page — the bus benchmark shown

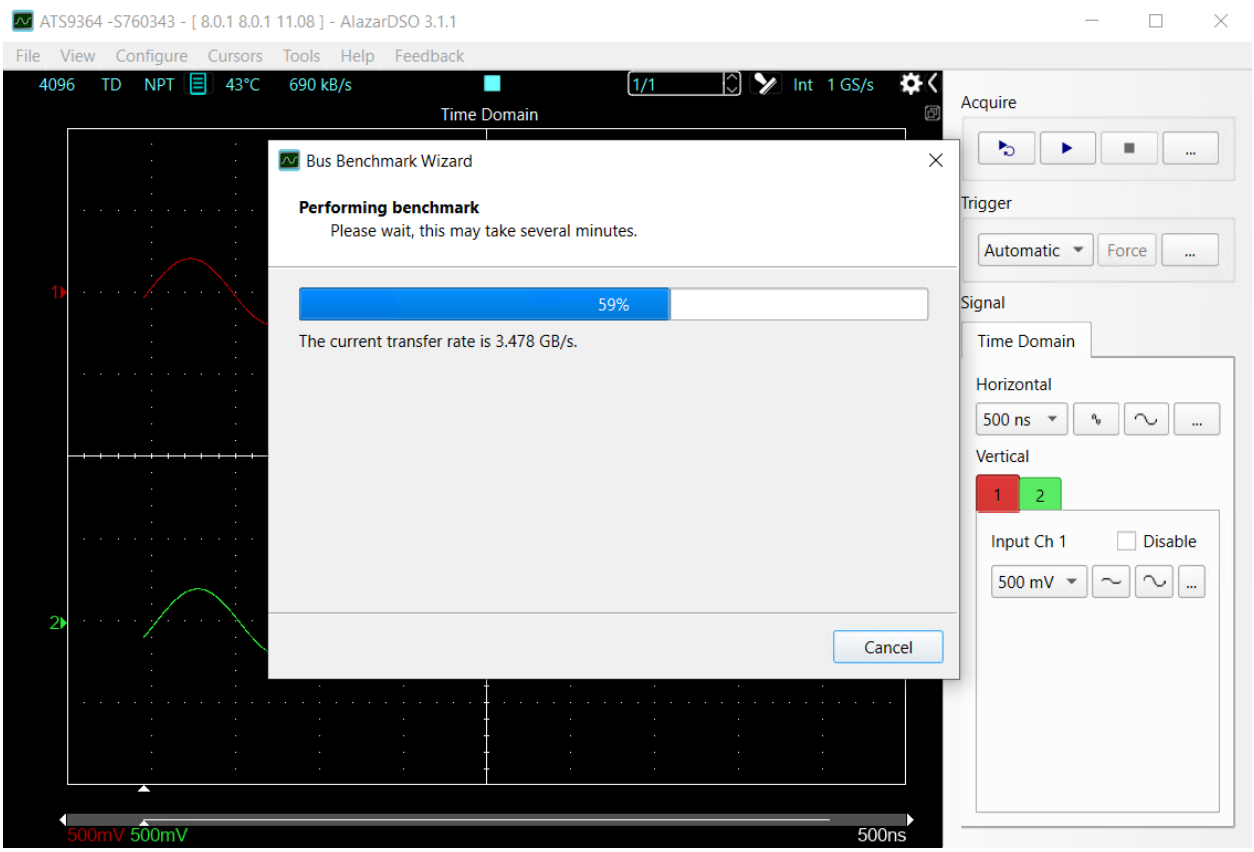


Fig. 9: Benchmark wizard, progress page

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> **Note**
>
> Pressing **Cancel** on this page does not close the wizard. It stops the benchmark and moves to the final page, so the result is still reported.

Completing the Benchmark Wizard reports one of three outcomes: the average transfer rate achieved, that the benchmark was aborted, or the error that stopped it.

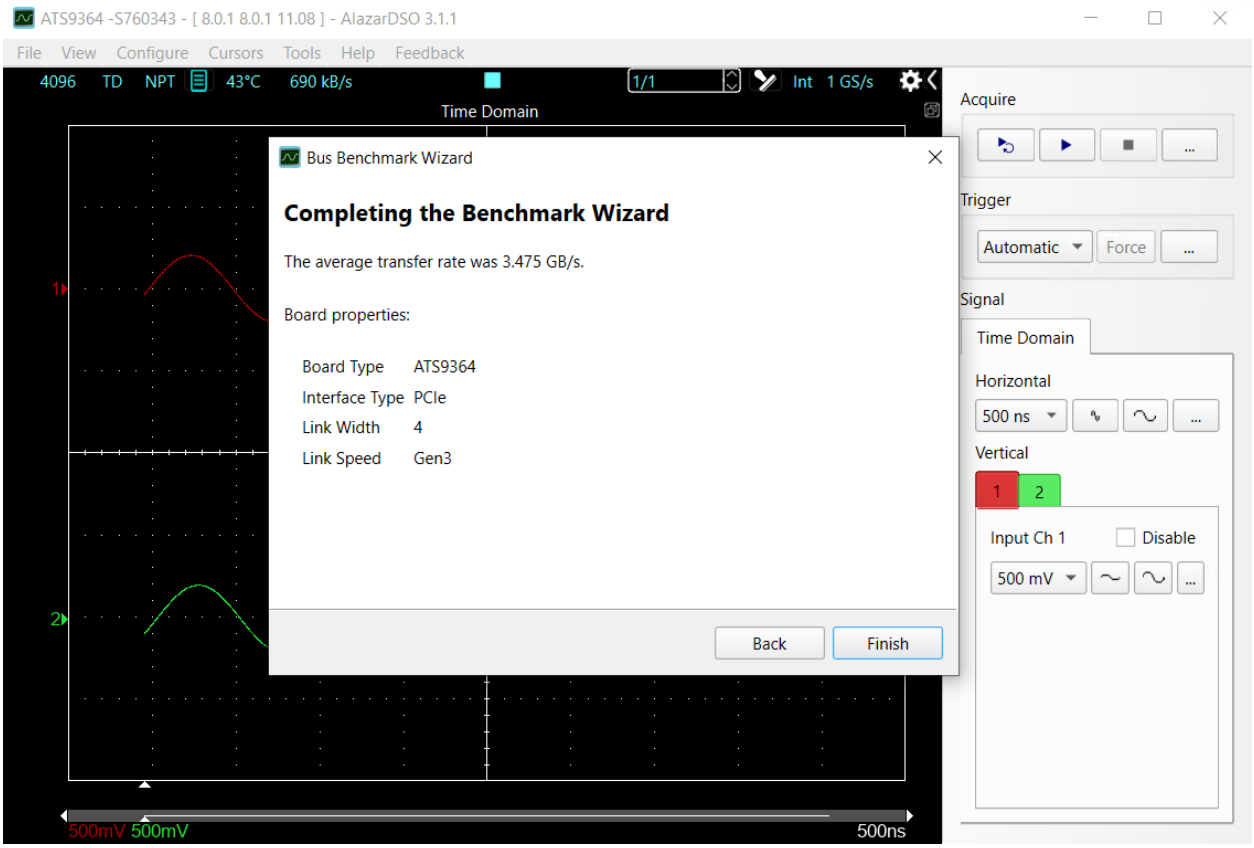


Fig. 10: Benchmark wizard, result page

Beneath the result, the bus and managed-buffer wizards list the properties of each digitizer taking part — board type, interface type, link width and link speed. The disk wizard lists the drive's name, file system, total bytes and available bytes instead.

Note

Link width and link speed are worth checking here. A digitizer negotiating a narrower link or a lower generation than it supports will not reach its rated transfer rate, and this is the quickest place to see that.

5.3.2 Bus benchmark

Measures the average transfer rate from the digitizers to host memory.

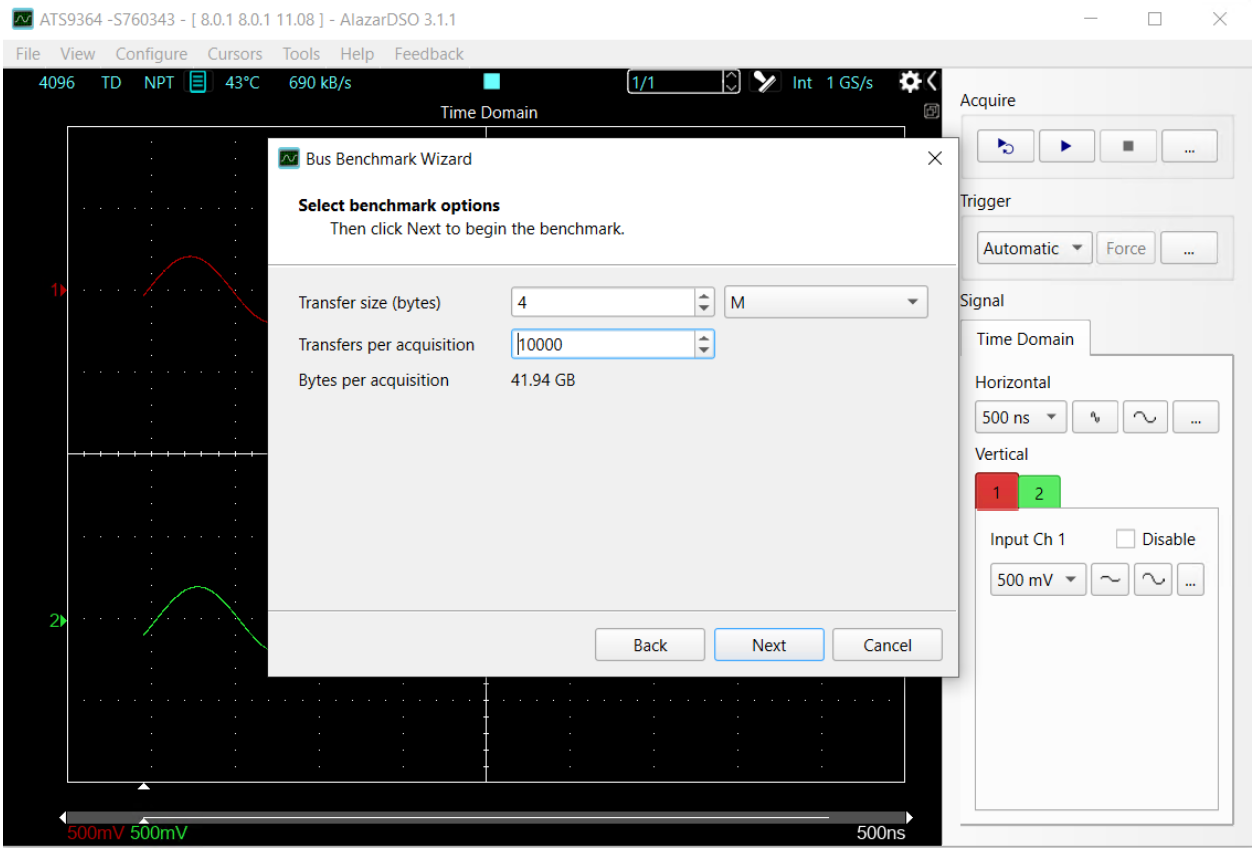


Fig. 11: Bus benchmark options

Transfer size (bytes)
: Enter the size of each transfer, and select **K** or **M** as the unit.

Transfers per acquisition
: Enter how many transfers to perform. Accepts 1 to 1,000,000; the default is 10,000.

Bytes per acquisition
: Read-only. The total the benchmark will transfer.

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5.3.3 Managed Buffers benchmark

Measures transfer rate using the managed-buffer acquisition path, with the DMA options that path offers. Use this to find which combination of options your system sustains best before committing to it for a real acquisition.

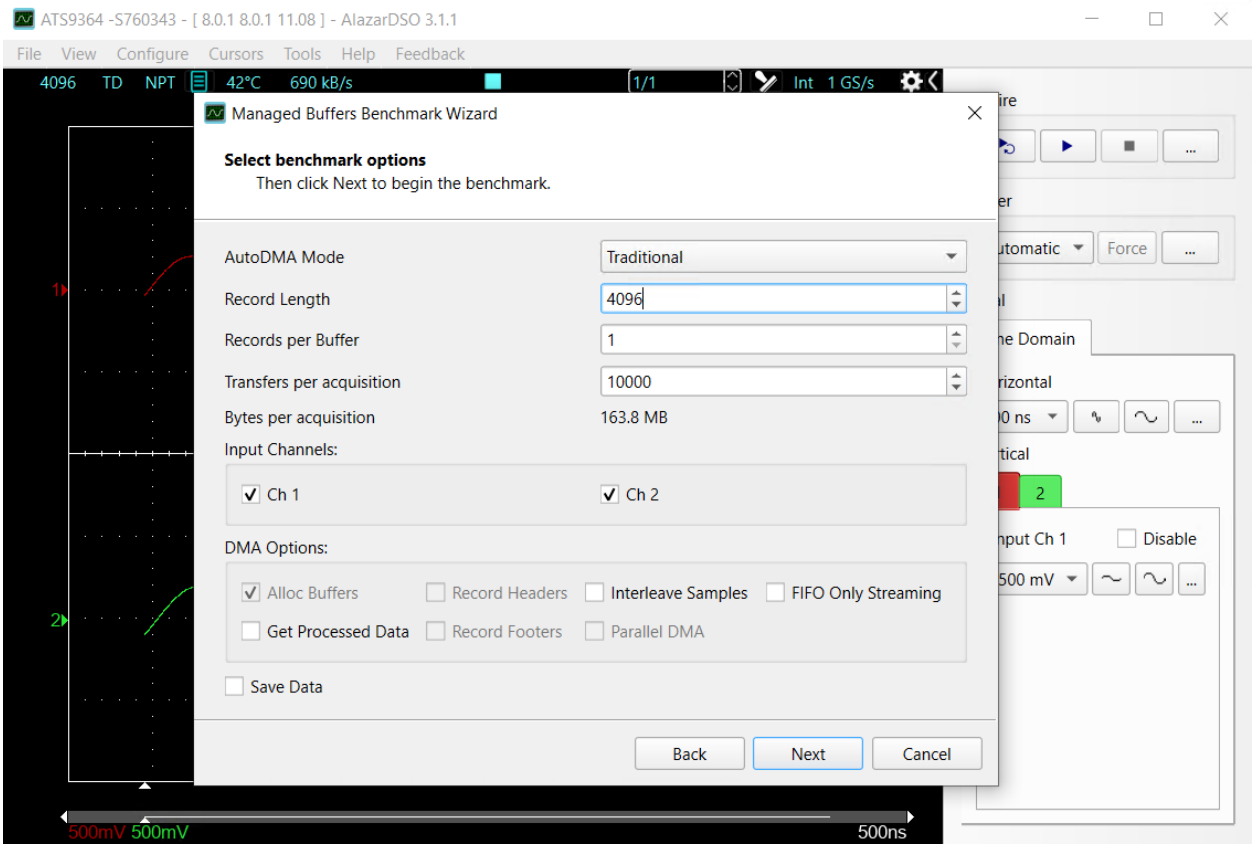


Fig. 12: Managed Buffers benchmark options

AutoDMA Mode
: Select the AutoDMA mode to benchmark.

Record Length, Records per Buffer, Transfers per acquisition
: The acquisition geometry to benchmark.

Bytes per acquisition
: Read-only.

Input Channels
: Select which channels take part. All are selected by default. The number offered depends on the digitizer.

DMA Options
: Select the transfer options to benchmark: **Record Headers**, **Interleave Samples**, **FIFO Only Streaming**, **Get Processed Data**, **Record Footers** and **Parallel DMA**. Options the digitizer does not support are unavailable.

  Record Headers and **Interleave Samples** are mutually exclusive; selecting one clears the

other.

Save Data
Write the benchmark's data to disk as well as transferring it.

5.3.4 Disk benchmark

Measures the sustained write speed of a drive, so you can tell whether it will keep up with a streaming acquisition.

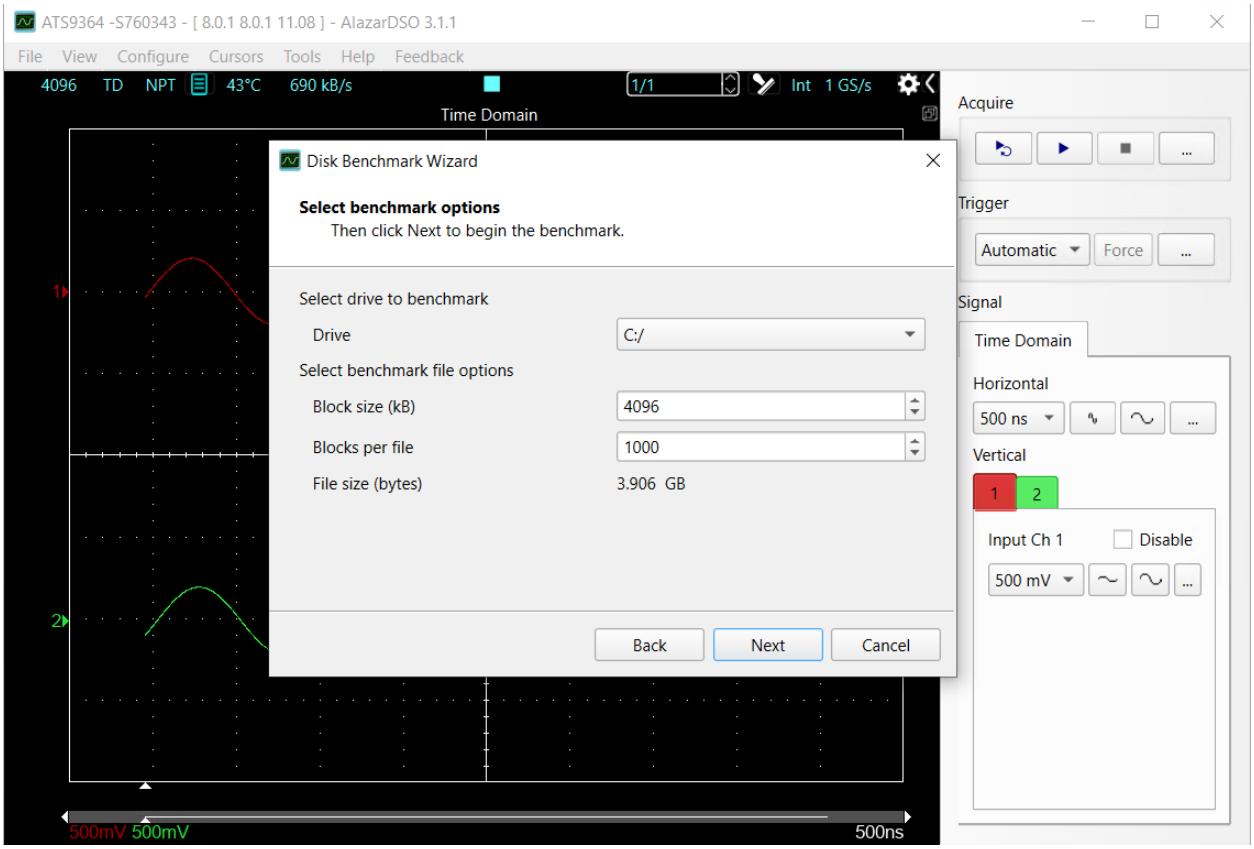


Fig. 13: Disk benchmark options

Drive
Select the drive to benchmark. Only mounted, ready volumes are listed.

Block size (kB)
Enter the size of each write. Accepts 1 to 65,536; the default is 4096.

Blocks per file
Enter how many blocks to write per file. Accepts 1 to 100,000; the default is 1000.

File size (bytes)
Read-only. The size of each file the benchmark will write.

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5.4 ATS Sync Connection

Guides the cabling of the clock and trigger signals between an ATS Sync 4X1G and the digitizers it synchronises, then tests that each connection works.

Open it with **Test** in *Configure System*, which appears once an ATS-Sync system exists.

5.4.1 About ATS Sync

The ATS Sync 4X1G distributes a common clock and trigger to as many as four digitizers so that they sample simultaneously. It also allows triggering to be held off while the digitizers are armed one at a time, which a passive splitter cannot do — without it, some digitizers can trigger while others are still being armed.

The supplied cable carries four clock outputs terminating in SMA connectors, and four trigger outputs terminating in BNC, which connect to each digitizer's external clock and external trigger inputs.

> **Note**
>
> For the digitizers to acquire simultaneously, each must be configured to use the **external clock** and to trigger on the **external trigger** input. Set these in *Configure Clock* and *Configure Trigger* before running this wizard. An external trigger signal must also be supplied to the ATS Sync itself.

> **Note**
>
> PCI Express and Thunderbolt 3 digitizers work with ATS Sync. Older PCI digitizers do not.
>
> Refer to the ATS Sync 4X1G datasheet for its clock frequency limits and for the formula governing internal clock frequencies.

5.4.2 Welcome

Explains what the wizard does. No controls.

5.4.3 How to connect ATS Sync Cables

Shows a table of the connections to make, with a **Connect boards** column and a **Status** column.

Next Step
: Step through the table one connection at a time. AlazarDSO flashes the LED on the digitizer for the current row, so the board named in the table can be identified physically.

On this page the **Next** button is labelled **Skip**, allowing the connection guide to be bypassed when the cabling is already in place.

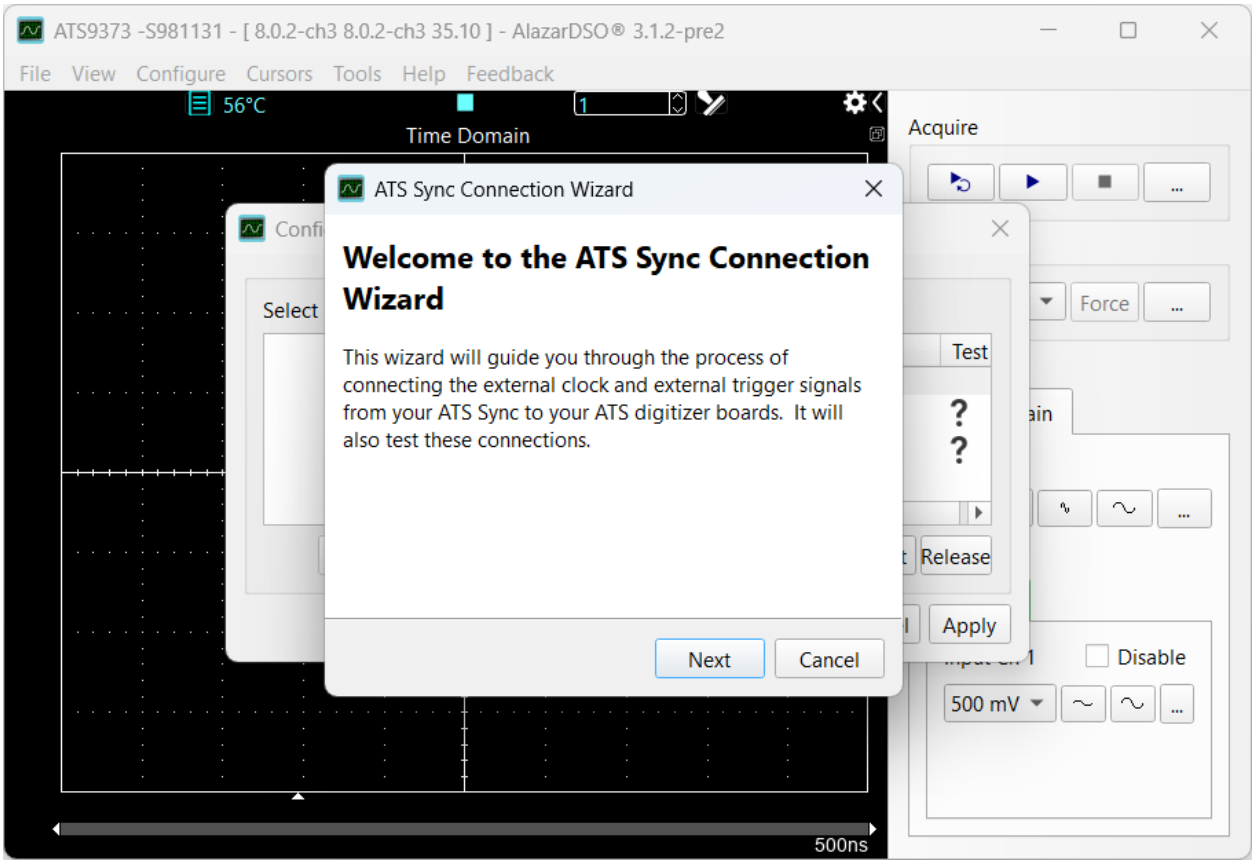


Fig. 14: ATS Sync Connection Wizard, welcome page

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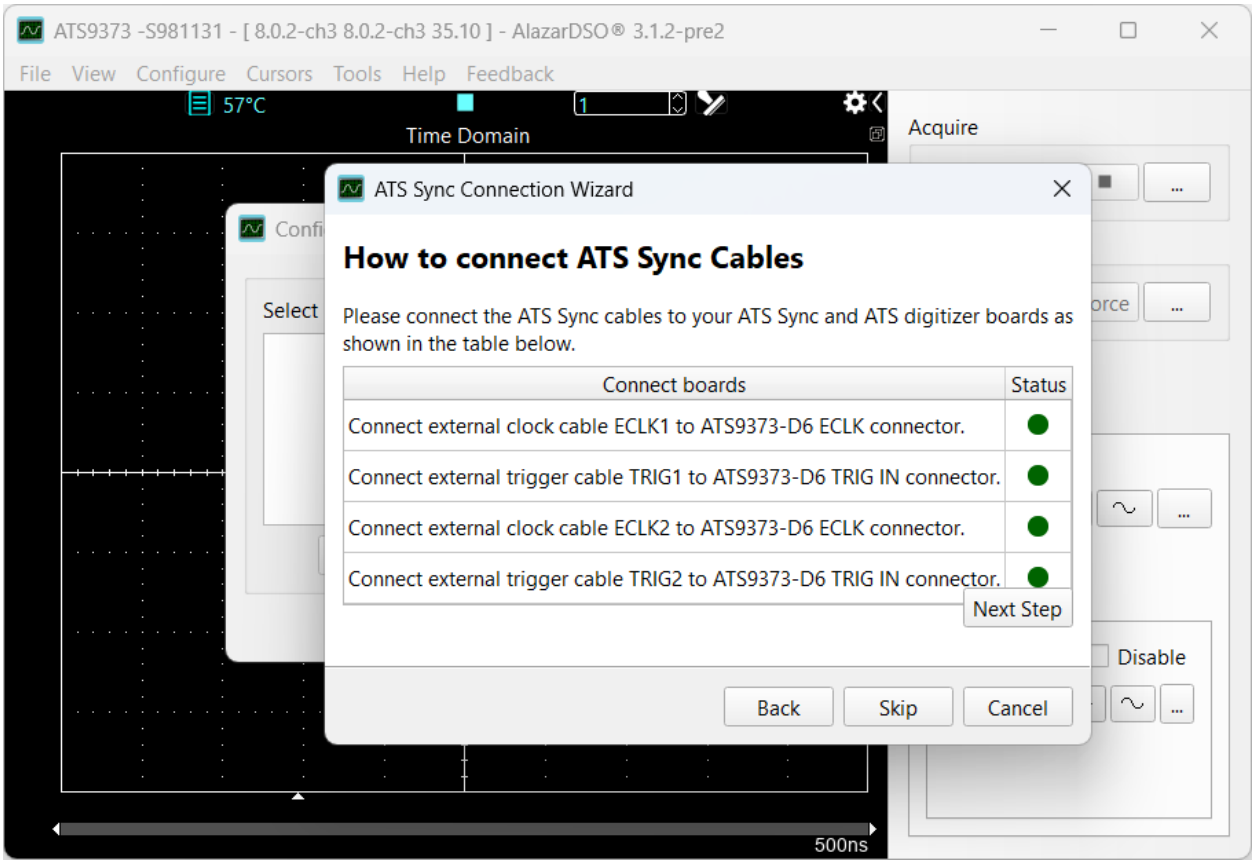


Fig. 15: Cable connection guide

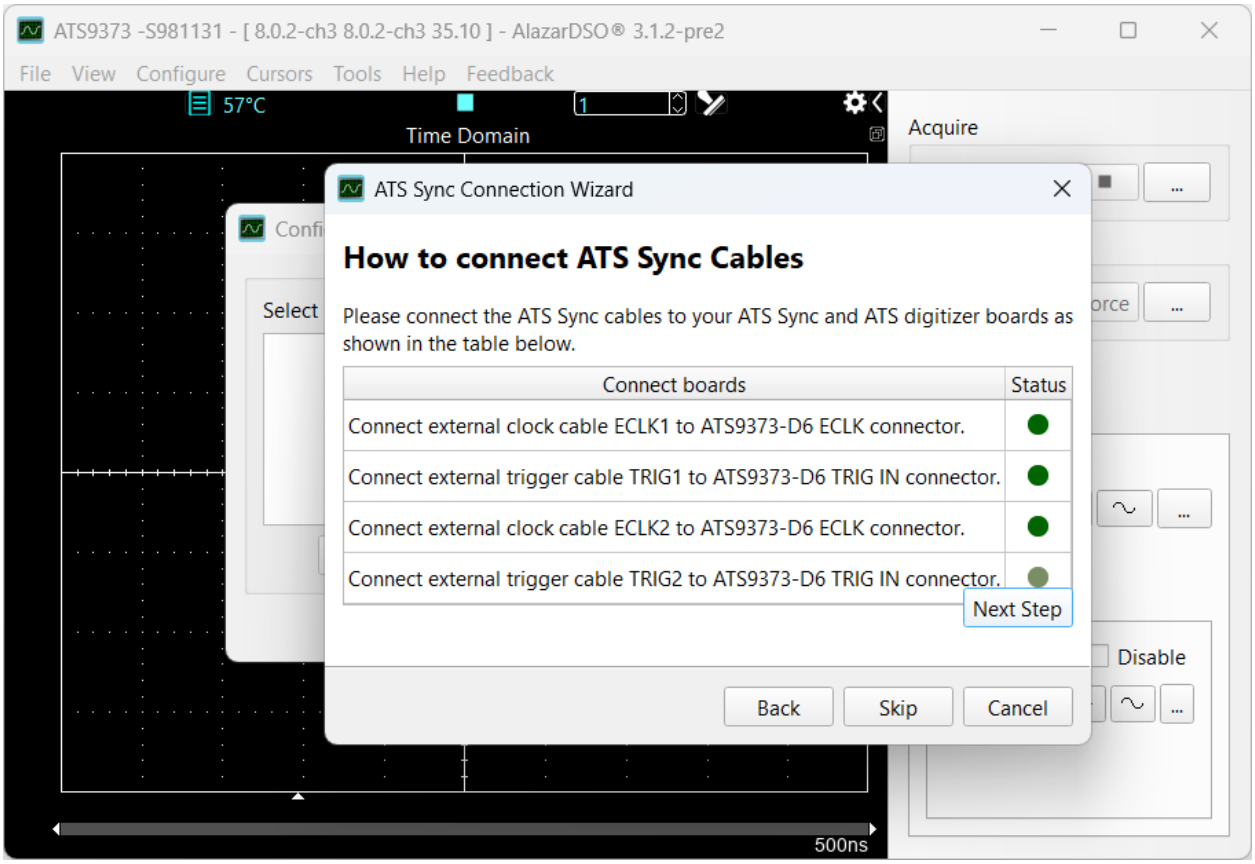


Fig. 16: The final connection step

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5.4.4 Testing connections

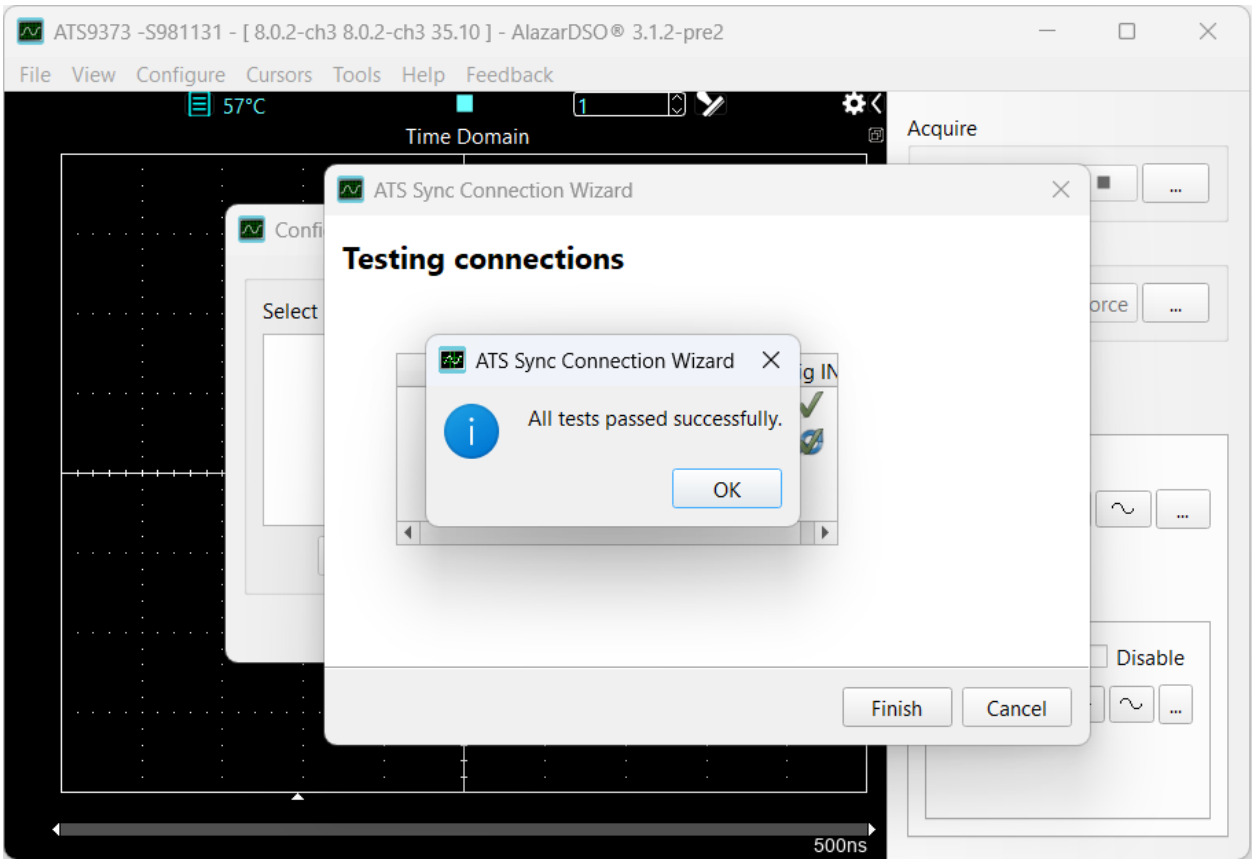


Fig. 17: Connection test results

Tests each digitizer in the system and reports two results per board:

Ext. Clock
: Whether the board receives the clock distributed by the ATS-SyncBoard.

Trig IN
: Whether the board receives the trigger distributed by the ATS-SyncBoard.

A tick in both columns means the board is correctly cabled. Boards are listed by model and system number, for example `ATS9373-D6 (System 1)`.

When every board passes, AlazarDSO reports *All tests passed successfully*. Press **Finish** to close the wizard; the **Test** column in *Configure System* then shows a tick against each board.

If a board fails, check the cable for the column that failed: the **SMA** connector at that digitizer's external clock input for **Ext. Clock**, and the **BNC** connector at its external trigger input for **Trig IN**. Check also that the ATS Sync has power, since it draws none from its USB cable.

Note

The ATS Sync can also be used with digitizers running at *different* sample rates. In that arrange-

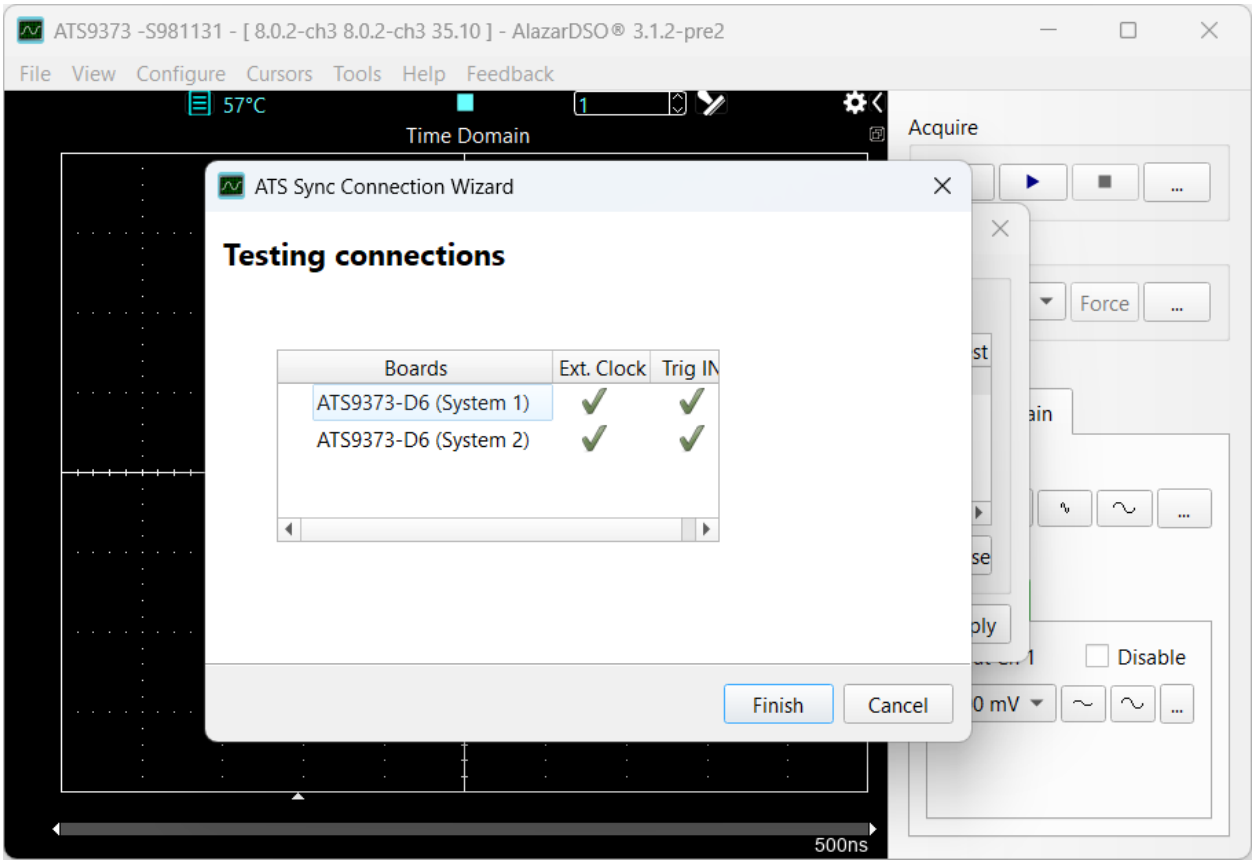


Fig. 18: All tests passed

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ment the clock outputs are deliberately left unconnected and only the trigger is distributed, so the **Ext. Clock** column is expected to fail. Only the trigger is synchronised; the sample clocks are not coherent.

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CHAPTER

SIX

MENU REFERENCE

The main window menu provides access to AlazarDSO functionality that is not available from the settings sidebar or the heads-up display.

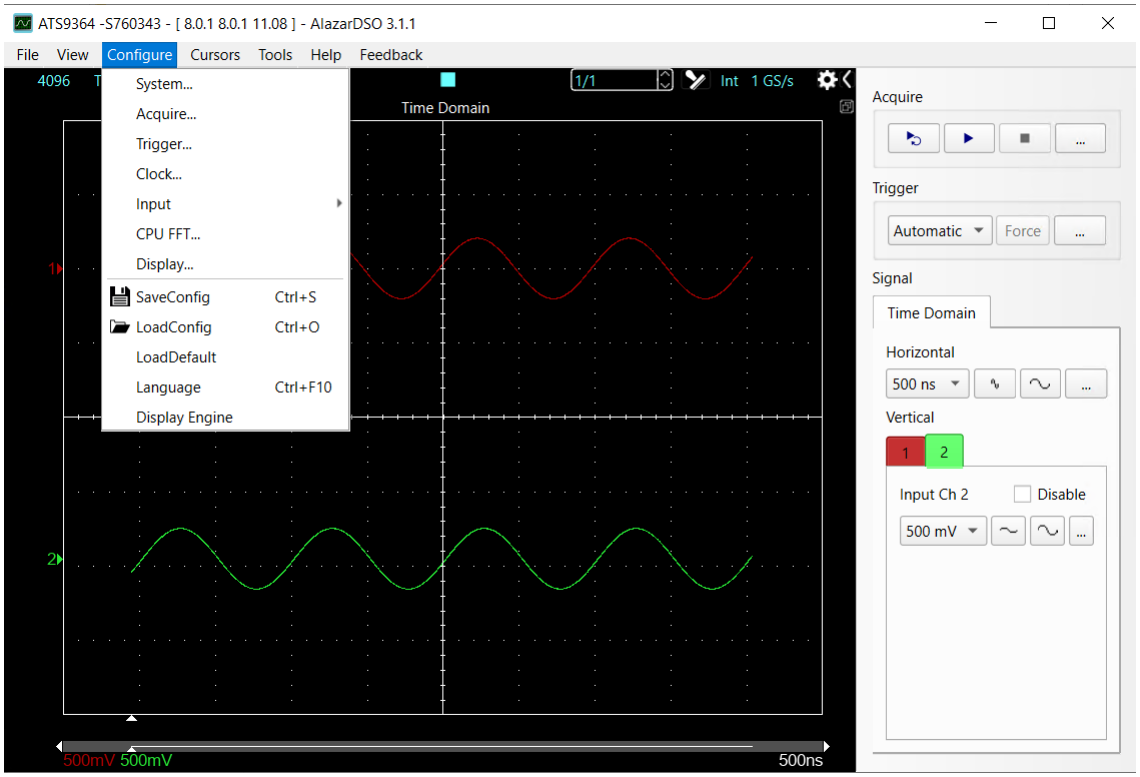


Fig. 1: Main menu

6.1 File

Save Data
: Save the records from the current acquisition to disk. See *Save Records* and *File Formats*.

Load Data
: Load a previously saved acquisition from disk. The loaded records are displayed as reference channels in a separate window.

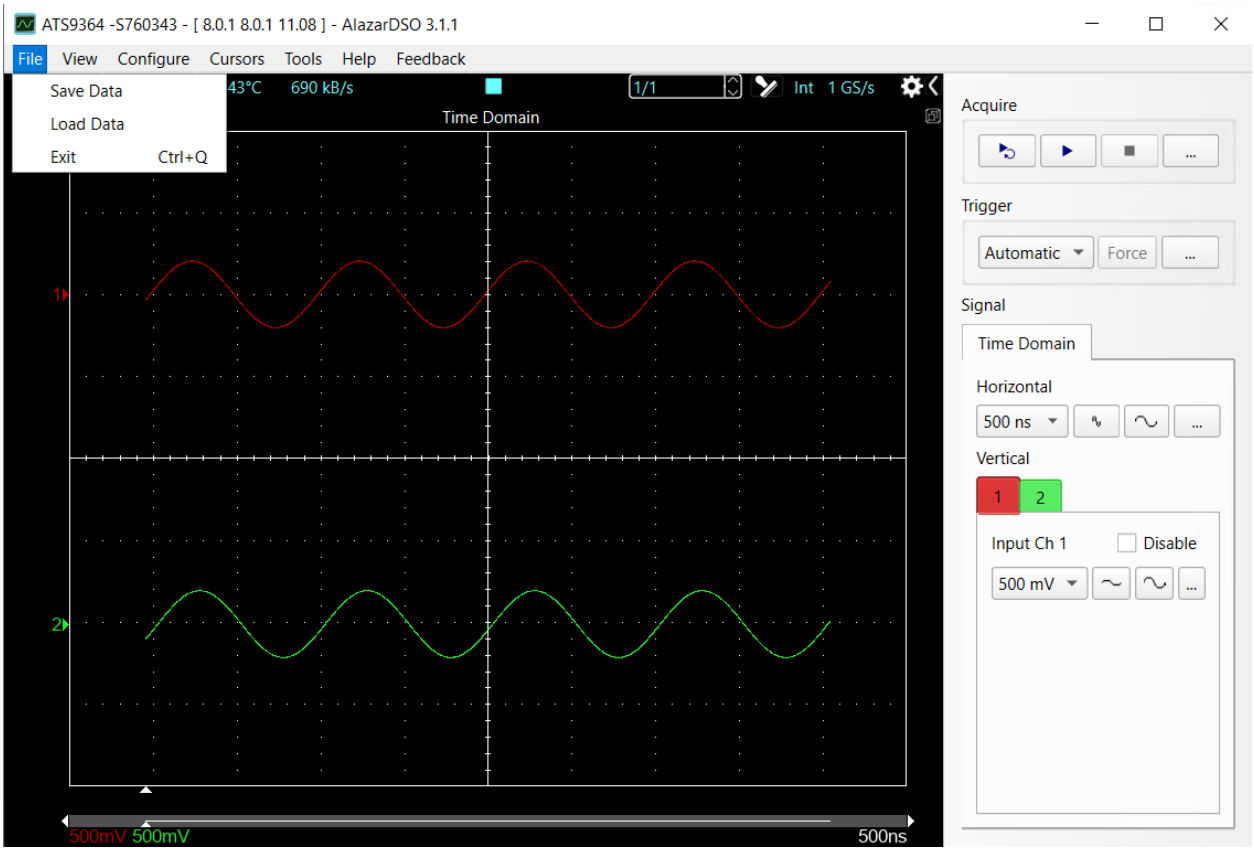


Fig. 2: File menu

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Exit
Close AlazarDSO. Keyboard shortcut: `Ctrl+Q`.

6.2 View

Hide settings sidebar
Hide the settings sidebar to give the display area the full width of the window. Select the item again to show the sidebar.

6.3 Configure

Each item opens a configuration window. See *Configuration Reference* for the controls in each.

System...
Open **Configure System**, which defines the board systems AlazarDSO acquires from, and gives access to board identification and properties.

Acquire...
Open **Configure Acquire**, which sets the acquisition mode, the record and buffer geometry, and the data transfer options.

Trigger...
Open **Configure Trigger**, which sets the trigger engine configuration of a board.

Clock...
Open **Configure Clock**, which sets the sample clock source, sample rate and decimation.

6.3.1 Input

This submenu is rebuilt whenever the channel list changes, so the number of entries depends on the digitizer.

Aux I/O...
Open **Configure AUX I/O**, which sets the function of the auxiliary input/output connector. See *Configure AUX I/O*.

Ch 1..., Ch 2..., and so on
Open **Configure Channels** with the tab for that channel selected. There is one entry per input channel in the active system. See *Configure Channels*.

On-FPGA FFT...
Open **Configure On-FPGA FFT**. This applies when the acquisition mode is **On-FPGA FFT**. See *Configure On-FPGA FFT*.

GPU FFT...
Open **Configure ATS-GPU**. This applies when the acquisition mode is **ATS-GPU**. See *Configure ATS-GPU*.

CPU FFT...
Open the CPU FFT window, which configures the transform calculated by the host processor when acquiring in the time domain. See *Configure CPU FFT*.

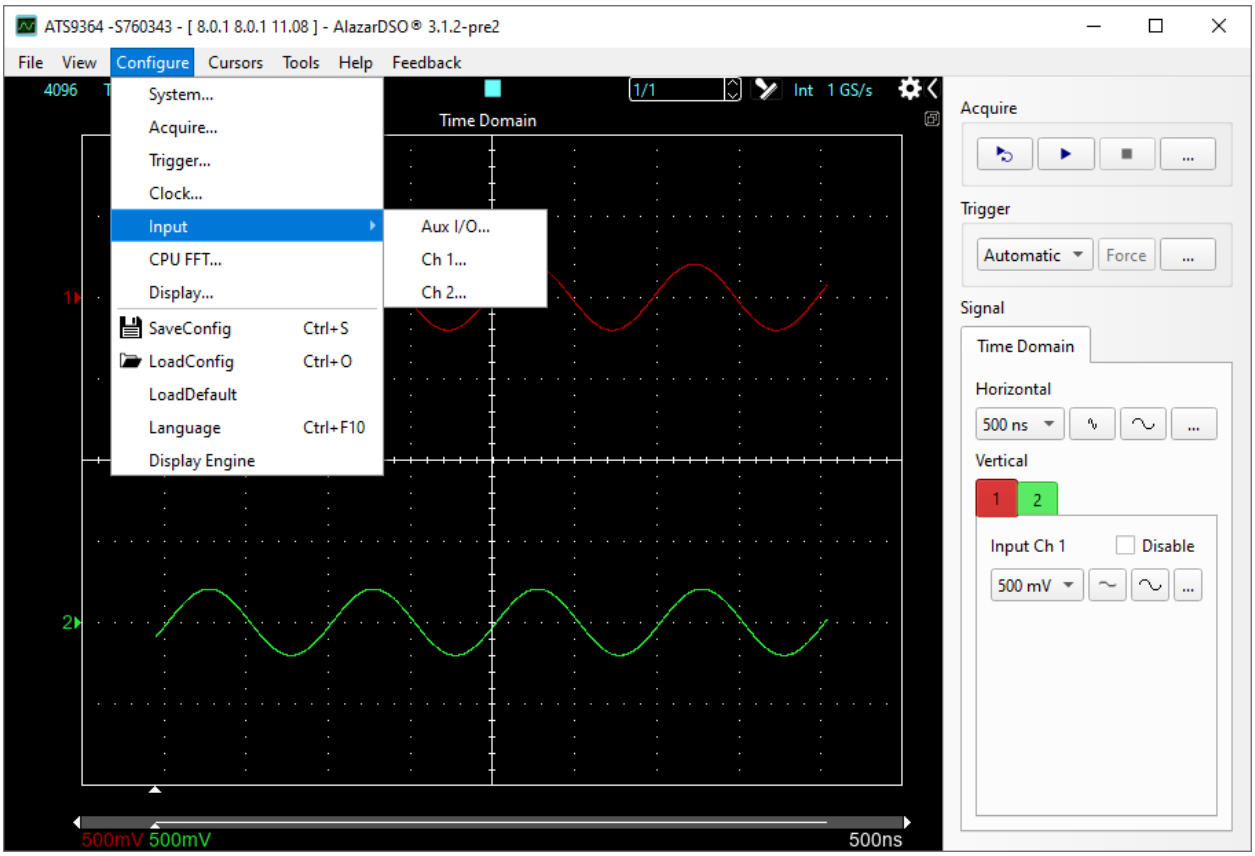


Fig. 3: Input submenu

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Display. . .
Open **Configure Display**, which sets display engine and per-graph options.

SaveConfig
Save the current configuration to a JSON file. Keyboard shortcut: `Ctrl+S`.

LoadConfig
Load a configuration from a JSON file. Keyboard shortcut: `Ctrl+O`.

> **Note**
>
> Configuration files are board-type dependent. A configuration saved from one board type will not load onto a different one. See *Messages*.

LoadDefault
Restore the default configuration.

Language
Open the language selection dialog box. Keyboard shortcut: `Ctrl+F10`.

Display Engine
Open the **Display engine** dialog box, which selects the renderer used to draw waveforms.

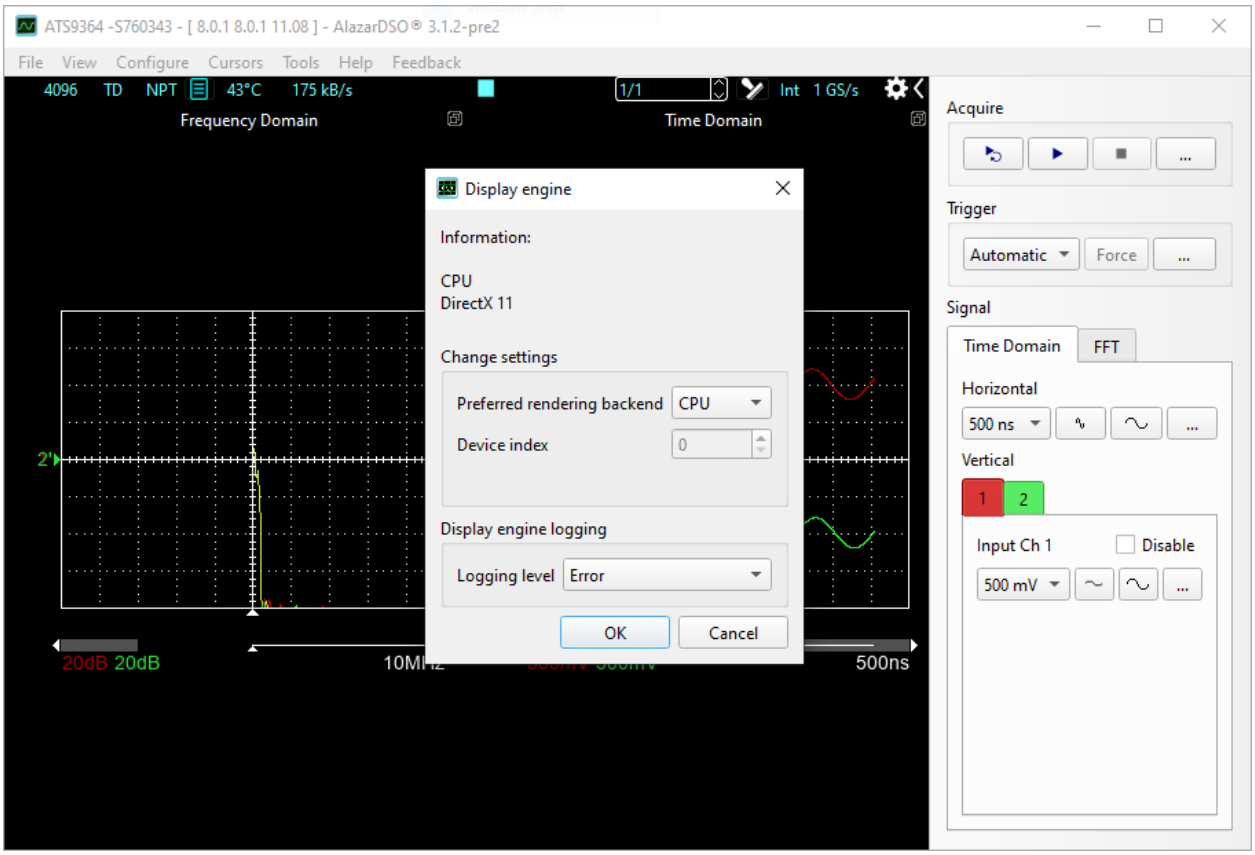


Fig. 4: Display engine dialog box

Preferred rendering backend
Select **CUDA**, **OPENCL** or **CPU**.

Device index
Select which device of the chosen backend to use. This is disabled when the backend is **CPU**. The name of the selected device is shown beneath it.

Logging level
Select **Error**, **Warning** or **Info**.

If the selected backend and device index do not correspond to a device present in the host, AlazarDSO reports that no such device was found and leaves the backend unchanged.

> **Note**
>
> When AlazarDSO is opened on a saved data file, this menu retains only the three FFT entries and **Display...**.

6.4 Cursors

This menu is rebuilt whenever the set of visible graphs changes, and offers vertical and horizontal cursors for each.

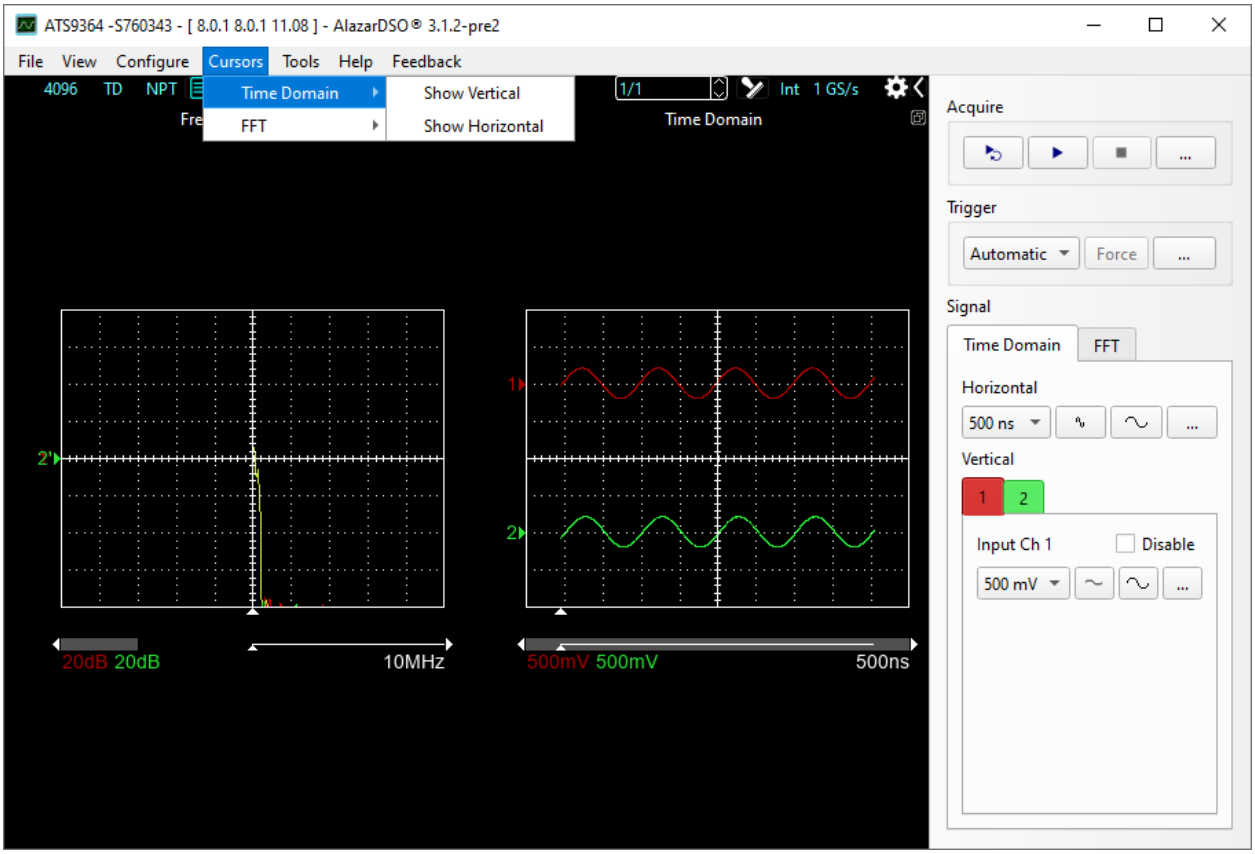


Fig. 5: Cursors menu

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When both the time-domain and FFT graphs are shown, the menu contains one submenu per graph, each holding **Vertical** and **Horizontal**. When only one graph is shown, those two entries appear directly on this menu.

Each entry toggles. Selecting it shows the cursor pair, and the entry then offers to hide them again. Hiding a graph closes any cursors belonging to it.

6.5 Tools

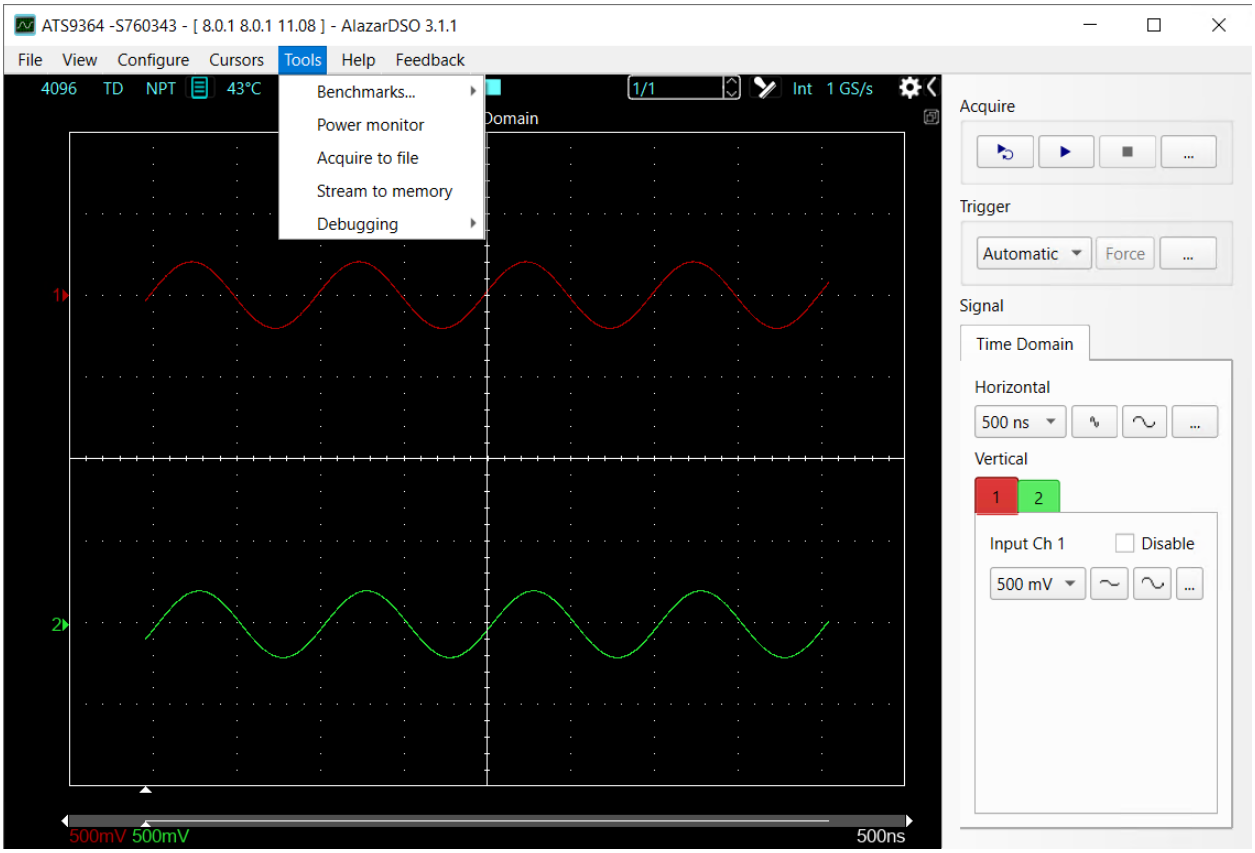


Fig. 6: Tools menu

Power monitor
: Display the **Power Monitor** window, which shows on-board temperature and supply voltage readings. See *Power Monitor*.

Spectrum information
: Display the **Spectrum information** window, which measures the dynamic performance of one record — SFDR, THD, SNR, SINAD and ENOB. See *Spectrum information*.

  New in AlazarDSO 3.1.2.

Acquire to file
: Display the **Acquire To File** dialog box, which saves a sequence of acquisitions to a file.

Stream to memory

Display the **Stream To Memory** wizard, which streams sample data from the dual-ported memory of the digitizer into system memory. See *Stream To Memory*.

6.5.1 Benchmarks

Bus benchmark
Display the **Bus Benchmark** wizard, which measures the sustained transfer rate from the digitizers to host memory. See *Bus benchmark*.

Managed Buffers benchmark
Display the **Managed Buffers Benchmark** wizard. See *Managed Buffers benchmark*.

Disk benchmark
Display the **Disk Benchmark** wizard, which measures the sequential write speed of a drive. See *Disk benchmark*.

6.5.2 Debugging

Enable ATS API log
Enable logging of calls into the ATS API library.

> **Note**
>
> This setting is stored in the Windows registry under `HKEY_CURRENT_USER` as `EnableApiTrace`. It affects every application that uses the ATS API library, not only AlazarDSO, and applications must be restarted for a change to take effect.

View API log file
Display the contents of the ATS API log file.

Clear API log file
Delete the contents of the ATS API log file. This fails if another application currently has the ATS API library loaded.

6.6 Help

About
Display the **About** dialog box, showing the AlazarDSO version and copyright information.

6.7 Feedback

Feedback is a top-level item on the menu bar rather than a menu.

Selecting it displays a message box giving the address to send comments about AlazarDSO to. Nothing is collected or transmitted by the application.

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Note

The **File**, **Tools** and **Help** menus are hidden when AlazarDSO is opened on a saved data file.

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CHAPTER

SEVEN

KEYBOARD SHORTCUTS

`Ctrl+A`	Start or stop acquisition
`Ctrl+S`	Save the current configuration
`Ctrl+O`	Load a configuration
`Ctrl+Q`	Exit AlazarDSO
`Ctrl+F10`	Change the user interface language
`F4`	Display the Board Properties window
`Delete`	Clear all graph displays and discard the current frame

Note

`Delete` has no effect while an acquisition is running. Stop the acquisition first.

Note

AlazarDSO binds no keys for moving between records or for moving cursors. Use the record selector in the heads-up display, and drag cursors with the mouse.

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CHAPTER

EIGHT

NPT FOOTERS

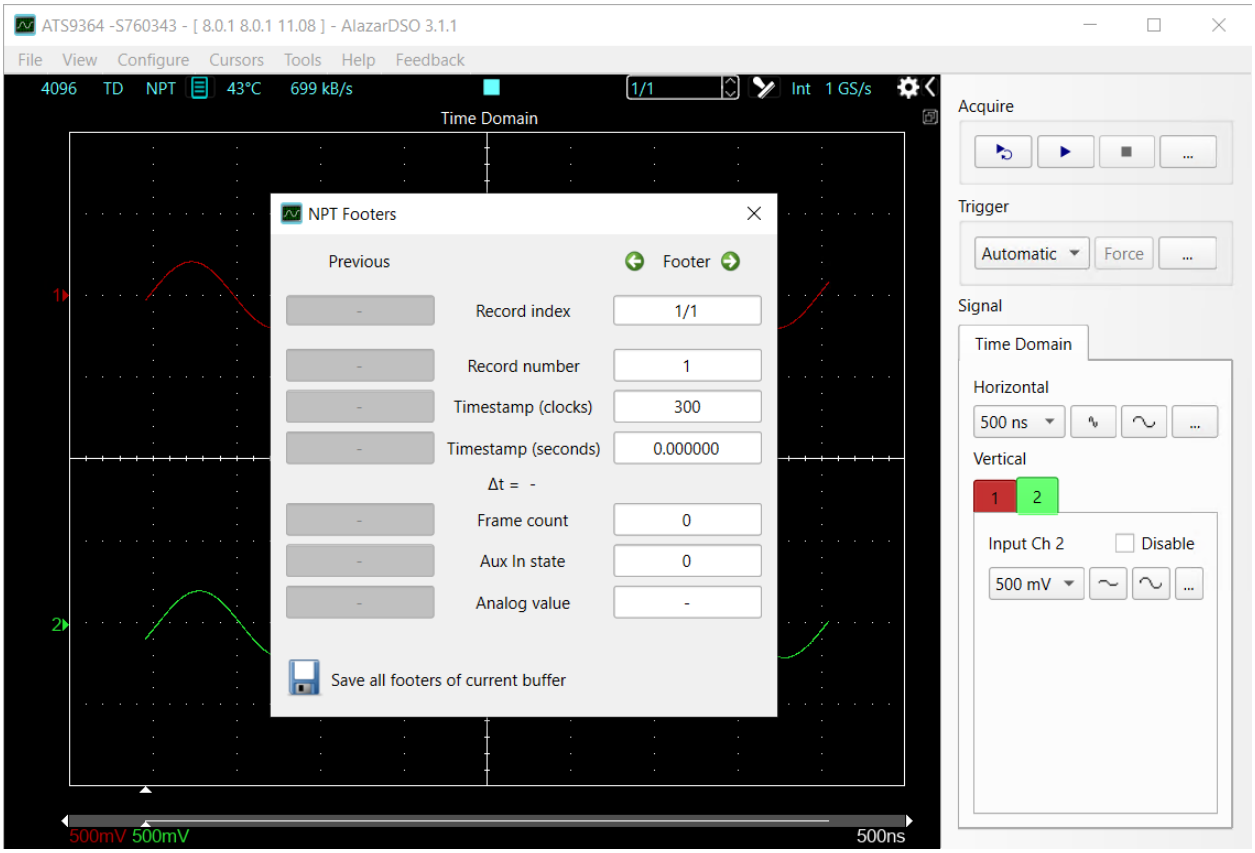


Fig. 1: NPT Footers window

The **NPT Footers** window displays the footer attached to each record when **NPT Footers** is enabled in *Configure Acquire*.

In NPT mode a record carries no header, so per-record metadata — its number, its timestamp, and the state of the auxiliary input at the time of the trigger — is appended as a footer instead.

Open this window with the timestamp button in the heads-up display.

> **Note**
>
> The values shown are meaningful only when **NPT Footers** is enabled in *Configure Acquire*, which is itself board dependent. With footers disabled, or on a digitizer whose firmware does not produce them, the window reports that footers are unavailable.

8.1 Layout

Values are shown in two columns. The **Previous** column holds the footer of the record before the selected one; the **Footer** column holds the selected record's own. Showing both side by side makes it straightforward to confirm that triggers arrived at the expected interval, or to find where a record was missed.

Every field is read-only except **Record index**.

8.2 Fields

Record index
: Enter the record whose footer is displayed, or use the arrow buttons. Records are numbered from 1. A dash is shown when no record is selected.

  This selector and the record selector in the heads-up display follow each other: changing either changes both.

Record number
: The index of the record within the acquisition, as recorded by the digitizer.

Timestamp (clocks)
: The record's timestamp as a count of clock ticks.

Timestamp (seconds)
: The same timestamp converted to seconds.

  > **Note**
  >
  > The timestamp is measured from the start of the acquisition, or from the last timestamp reset. See **Reset timestamp** in *Configure AUX I/O*.

$\Delta t =$
: The interval between the two timestamps displayed, that is, the time elapsed between the previous record and the selected one.

  This is the quickest way to confirm a trigger interval. A value that is a multiple of the expected interval indicates a missed trigger.

Frame count
: The value of the digitizer's frame counter when the record was acquired.

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Unlike **Record number**, which increments once per record, the frame counter advances less often, grouping records into frames.

Aux In state
The state of the AUX I/O connector when the record was acquired. This is meaningful when the connector is configured as an input; see *Configure AUX I/O*.

Analog value
A 12-bit signed value recorded with the record, shown as a converter code rather than a physical quantity.

The value is read from the footer without being shifted down, so it appears **left-justified in 16 bits** — the displayed number is always a multiple of 16. Divide by 16 to recover the 12-bit code.

> **Note**
>
> Only a few digitizer models produce this field. On models that do not, the row is absent.

8.3 Controls

The two arrow buttons step backwards and forwards through the records in the acquisition.

Save all footers of current buffer
Export the footer values for every record in the current buffer to a CSV file.

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CHAPTER

NINE

FILE FORMATS

This chapter describes the files AlazarDSO reads and writes, in enough detail to write a compatible reader.

> **Note**
>
> Sample values are written as **raw converter codes** throughout. AlazarDSO applies no conversion to volts when saving. To convert, use the input range and probe attenuation from the channel configuration; see *Input Channel*.

9.1 Saved records

Records are written from the **Save Records** window; see *Save Records*. Seven formats are offered: `*.json`, `*.txt`, `*.bin`, `*.csv (Volts)`, `*.csv (Samples)`, `*.mat (Volts)` and `*.mat (Samples)`.

The default file name is the current date and time, in the form `yyyy.MM.dd_hh.mm.ss`. The default directory is `Documents\AlazarTech` in the user's profile.

9.1.1 File naming

The text and binary formats write **one file per record, per channel**. Names are built from the name entered in the window:

Contents	File name
Time-domain record	`<name>_TD_Ch<c>_R<n>.<ext>`
Time-domain, multi-output	`<name>_TD_Ch<c>_Out<o>_R<n>.<ext>`
Spectrum	`<name>_DSP_Ch<c>_R<n>.<ext>`
Spectrum, multi-output	`<name>_DSP_Ch<c>_Out<o>_R<n>.<ext>`
NPT footer	`<name>_npt_footer_R<n>.txt`

<n> counts from 1 within each channel, in the order records were saved. It is not the hardware record number carried in the footer. <o> appears only on digitizers producing more than one output per channel.

Where samples from several outputs are interleaved in the acquisition, AlazarDSO separates them when saving, so each file holds contiguous samples for one output.

9.1.2 Text format

A plain text file containing one value per line and nothing else. There is no header.

Contents	One sample per line
Value	Raw converter code, written as a decimal number
Precision	About six significant digits; large and small magnitudes appear in scientific notation
Line endings	CRLF on Windows
Extension	`.txt`

9.1.3 Binary format

A bare array of sample values with no header, no padding between elements, and no terminator. The file length is the sample count multiplied by the size of one element.

> **Warning**
>
> **The binary format is not self-describing.** The element type depends on what was acquired — it may be an 8, 16, 32 or 64-bit integer, signed or unsigned, or a 32 or 64-bit floating point value — and every one of them is written to a `.bin` file with no indication of which was used.
>
> A reader must know the element type in advance, from the acquisition mode, the digitizer's sample resolution, and the FFT output format where one applies. The same caution applies to the text format, which records neither units nor scale.

9.1.4 JSON format

This option writes **two files**: a `.json` file describing the acquisition, and a `.bin` file holding the sample data.

The JSON file contains a single object, `frame_config`. In AlazarDSO 3.1.2 it holds, in this order: `config` — the whole system configuration tree — then `buffer_count`, `board_type` and `boards_in_system`. Two optional members may follow, `dsp_fft_datapath` and `binary_data_file`. The first four are required when reading, in that order.

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> **Warning**
>
> **Opening a ``.json`` that |product| cannot read closes the application.** The file is parsed without a guard, so a file that is damaged, truncated, or written by different software reports an error and then terminates — losing anything else open at the time.

The members are:

`acquisition_config`	Record and buffer geometry
`clock_config`	Sample clock settings
`acquired_buffer_index`	Index of the buffer saved
`channel_configs`	Per-channel input settings
`bytes_per_buffer`	Length in bytes of one buffer in the `.bin`
`buffer_count`	Number of buffers in the `.bin`
`board_type`	Digitizer model
`boards_in_system`	Number of digitizers in the system
`fft_config`	Present only if the frame carried an FFT
`dsp_fft_datapath`	Present only if an FFT datapath was in use
`gpu_config`	Present only for ATS-GPU acquisitions
`cpufft_config`	Present only if a CPU FFT was configured
`binary_data_file`	Name of the companion `.bin` file

The last five members are omitted entirely when they do not apply.

> **Note**
>
> Members must appear in the order above. AlazarDSO reads them sequentially and a file with reordered members will not load.

The companion `.bin` holds `buffer_count` buffers, each exactly `bytes_per_buffer` bytes, written exactly as the digitizer produced them — including any record headers, footers and channel interleaving. Interpreting it requires reconstructing the buffer layout from the configuration in the JSON.

This is the only saved format AlazarDSO can read back. **Load Data** opens the `.json` and expects the `.bin` beside it.

9.1.5 CSV format

A text file of one row per sample, with the axis in the first column and one column per channel. New in AlazarDSO 3.1.2.

Two variants are offered. **Volts** converts time-domain values to volts; **Samples** writes the raw converter codes. Spectra are written as the processed values the transform produced in both variants.

Files

One file per record, per domain:

```
<name>_<D>_R<record><suffix>.csv              channels merged
<name>_<D>_R<record>_<tag><suffix>.csv        channels separated
```

<D> is TD for a time-domain record or DSP for a spectrum. With **Include metadata header** checked, _MD follows it.

<record> is zero-padded to the width of the largest record number in the save, so saving records 1 to 100 gives R001 to R100.

<tag> names the channel, with _Out and the output number appended on digitizers producing more than one output per channel.

<suffix> is _volts or _samples after the format.

> **Note**
>
> A raw-plus-FFT acquisition of *n* records produces *2n* files with channels merged, since the time-domain record and the spectrum are written separately.

Columns

Column	Contents
1	Time(s) for a time-domain record, Freq(Hz) for a spectrum
2 onward	One per channel, in channel then output order. The header is the tag, with (V) appended where the values really are volts

Values after the header are written in scientific notation — nine decimal places on the axis, six on the data — except raw integer codes, which are written as integers. The separator is a comma, the decimal mark is always a full stop regardless of regional settings, and the encoding is ASCII.

Axis values

Time is measured from the trigger, so pre-trigger samples are negative. Frequency runs from zero to half the sample rate across the bins.

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> **Warning**
>
> Both axes are calculated from the **undecimated** sample clock. With a decimation other than 1 the axis values are wrong by that factor.

Metadata header

With **Include metadata header** checked, the file opens with commented lines, each beginning #, giving a key and a value. They describe the acquisition: the board type, acquisition and AutoDMA modes, record length, clock settings, sample rate, and the channels present.

Time-domain files add eight lines per channel describing its input range, offset, impedance, coupling and probe attenuation. Spectrum files instead give the FFT length, output format and bin count.

A reader should skip every line beginning with #, read one header row, then read the data.

> **Note**
>
> The header is intended to let a reader reconstruct the acquisition settings. It does **not** let AlazarDSO reopen the file — **Load Data** accepts JSON and ATB only.

The file opens with `# Alazar DSO CSV` and `# format_version, 2`, then the lines below, each as `# key, value`. Numeric values carry twelve significant digits.

Group	Keys
What this file holds	`domain`, `units`, `merged_channels`, `record_number`
The acquisition	`board_type`, `mode`, `adma_mode`, `pack_mode`, `record_length`, `records_per_buffer`, `pre_trigger_samples`, `sample_interleave`, `parallel_dma`, `npt_footers`
The clock	`clock_type`, `internal_clock_freq_hz`, `external_clock_freq_hz`, `decimation`, `dual_edge_sampling`, `sample_rate_hz`, `samples_per_record`
This file's extent	`sample_offset`, present only when the first sample saved is not sample 0; and `channels`, a space-separated list of the channel tags

Time-domain files then add eight lines per channel tag, giving that channel's input range in volts, offset, impedance, coupling, probe attenuation and enabled state.

Spectrum files instead add `fft_length_samples`, `fft_output_format` and `fft_output_bins`.

9.1.6 MATLAB format

An uncompressed MATLAB Level 5 file. New in AlazarDSO 3.1.2.

As with CSV, **Volts** converts time-domain values and **Samples** writes raw codes, and two variants of the file name distinguish them.

Files

One file per save with channels merged, or one per channel when separated:

```
<name><suffix>.mat                channels merged
<name>_Ch<c><suffix>.mat          channels separated
```

All selected records go into the same file; the record number is not part of the name.

Variables

Variable	Size	Contents
`Ch<c>_volts` or `Ch<c>_samples`	samples × records	One time-domain channel. `double` in the Volts variant, otherwise the digitizer's native type
`Ch<c>_dsp`	bins × records	One channel's spectra, in the type the transform produced
`time_s`	rows × 1	Time axis, present when the file holds time-domain data
`freq_hz`	rows × 1	Frequency axis, present when the file holds spectra
`metadata`	1 × 1 struct	Sample rate, pre-trigger samples, record length, board type, the units, and per-channel input range, offset and probe attenuation

Arrays are column-major, so each record is one contiguous column, in ascending record order.

> **Note**
>
> The record numbers themselves are not stored. After saving a record range, column 1 is the first record of that range rather than record 1.

9.2 ATB files

AlazarDSO 3.1.2 can **read** `.atb` capture files written by AlazarDSO 2.x. It cannot write them.

Open one with **Load Data** from the **File** menu, changing the file type to **ATB (*.atb)**. See *Load Data* for what is read and what is assumed.

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> **Note**
>
> Only time-domain captures are supported, from digitizers with 2, 4 or 16 channels, and from a single board.

9.3 Saved NPT footers

AlazarDSO writes footer data in two different places and two different formats.

9.3.1 Per-record text files

Saving records in any format except JSON also writes one footer file per record, named `<name>_npt_footer_R<n>.txt`. Each contains one field per line:

```
Trigger timestamp: <n>
Record number: <n>
Frame count: <n>
Aux in state: <n>
Analog value: <n>
```

The last line appears only for footer types that carry an analog value.

9.3.2 CSV export

The save button in the **NPT Footers** window writes a CSV file covering **every record in the current buffer**, not only the two records displayed. See *NPT Footers*.

Columns are, in order: `Timestamp (clocks)`, `Record number`, `Frame count`, `Aux In state`, and `Analog value` where the footer type carries one.

All values are raw: timestamps are in sample clock periods, and the analog value is an unconverted code. The seconds conversion shown in the window is not exported, nor is the record index.

An exported file looks like this:

```
Timestamp (clocks),Record number,Frame count,Aux In state,
324,1,0,0,
```

9.4 Configuration files

SaveConfig and **LoadConfig** in the **Configure** menu write and read a JSON file describing the complete instrument configuration.

The file is a tree of nested objects mirroring the configuration structure: host, then systems, then boards, then per-board channel, trigger, clock and AUX I/O settings.

Note

The format carries no version number. A configuration file written by a future release may load incorrectly rather than being rejected.

Warning

A configuration file AlazarDSO cannot read is not reported at startup — the settings silently return to defaults, and the file is overwritten when you next exit. Through **LoadConfig** the same file reports an error and closes the application.

AlazarDSO checks the structure of a configuration against the hardware present when loading it, and refuses a file that does not match:

- **Boards do not match** — the file describes a different number of boards, or boards with different identifiers, than the system currently has.
- **Systems do not match** — the file describes a different arrangement of systems.

Note

These checks compare the *shape* of the configuration, not the digitizer model. A file saved from one model may load onto a different model with the same number of boards and channels, producing settings that are valid in structure but wrong for the hardware.

9.5 Function files

Three features read a function from a file. All three are bare arrays of numbers with **no header of any kind**, little-endian.

Warning

Each file browser offers `*.bin` and `*.txt`, but **every one of these files is read as binary**. A text file is either rejected for being the wrong size or read as meaningless bytes. Do not supply text.

9.5.1 Background subtraction function

Read by **Configure On-FPGA FFT**; see *Configure On-FPGA FFT*.

Element	16-bit signed integer
Element count	Exactly the **record length** in samples
File size	Record length x 2 bytes, checked exactly

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A file of any other size is rejected with *Background subtraction file does not have the right size*; a missing file gives *Invalid Background subtraction file*. Either stops the acquisition.

> **Note**
>
> The required length follows the **record length**, not the FFT length. A background function must be regenerated whenever the record length changes.

The values are subtracted from the record in the time domain, before the transform, so they are in the same units as the samples themselves — converter codes, not a spectrum.

9.5.2 Dispersion compensation function

Read by both **Configure On-FPGA FFT** and **Configure ATS-GPU**, with identical requirements.

Element	Complex number: two 32-bit floats, real then imaginary, 8 bytes per element
Element count	Window length plus padding length — in practice the **FFT length**, since padding is set automatically
File size	FFT length x 8 bytes, checked exactly
Value range	The ATS SDK requires values within -1 to +1. This is **not checked** by AlazarDSO.

Each value is multiplied by the selected window function and supplied as a complex window, so the compensation is applied **on top of** the window rather than instead of it.

9.5.3 Linearization function

Read by **Configure ATS-GPU** when **Linearization function** is selected; see *Configure ATS-GPU*.

Element	32-bit float
Element count	Taken from the file size — no length is expected
File size	**Not checked**

Unlike the other two, this file is accepted at any length. A file of the wrong length is used without complaint and produces wrong results.

AlazarDSO can also write this file. **Generate linearization function from K-clock** captures the k-clock channel, computes a function from it, writes `Linearization.bin` to AlazarDSO's working directory, and fills its path into the **Linearization function** field.

9.6 Screenshots

AlazarDSO can save the contents of a graph, and of the Board Properties window, as an image. Each opens a save dialog box; the preview also offers a button to copy the image to the clipboard.

PNG is the only format offered, and the extension is supplied automatically.

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CHAPTER

TEN

MESSAGES

This chapter lists the messages AlazarDSO displays, what causes each one, and what to do about it.

Messages are grouped by the task in progress when they appear.

10.1 Acquiring

> **Note**
>
> AlazarDSO 3.1.2 no longer reports *All boards must have same enabled channels*. Digitizers in a multi-board system may now have different sets of channels enabled.

This application does not support single port
: The digitizer is a single-ported model, and the requested operation needs dual-ported memory.

  Single-ported boards acquire to on-board memory and transfer afterwards; dual-ported boards transfer while acquiring. Operations that stream continuously require the latter.

  Use a dual-ported digitizer, or choose an acquisition that does not stream.

Select at least 2 channels for parallel DMA
: **Parallel DMA** is enabled in *Configure Acquire* but fewer than two channels are enabled.

  Enable a second channel, or clear **Parallel DMA**.

Select at least 2 channels for interleaved samples
: **Sample interleave** is enabled in *Configure Acquire* but fewer than two channels are enabled. Interleaving alternates samples between two channels and has no meaning with one.

  Enable a second channel, or clear **Sample interleave**.

10.2 Saving and loading data

No buffer to save
: A save was requested with no acquired data to write.

  Acquire data before saving.

Data file cannot be opened. Please make sure that no other process is using it.
AlazarDSO could not open the file for writing.

The file is most often held open by another application. Close anything that has the file open — a text editor, MATLAB, a spreadsheet — and try again. Check also that the destination directory exists and is writable.

File cannot be opened.
AlazarDSO could not open the file for reading.

Check that the file still exists at the path given, that it is readable, and that it is a format AlazarDSO supports. See *File Formats*.

10.3 Configuration files

Configuration file cannot be opened. Please make sure that no other process is using it.
AlazarDSO could not read or write the configuration file.

Close any application holding the file open and try again.

Boards do not match.
The configuration being loaded was saved from a different digitizer model than the one now installed.

Configuration files are board-type dependent. Load a configuration saved from the same model, or start from **LoadDefault** and configure manually.

Systems do not match.
The configuration being loaded describes a different board system than the one currently defined — a different number of digitizers, or a different arrangement of them.

Recreate the board system to match, or start from **LoadDefault**.

FFTs do not match.
The configuration being loaded describes an FFT configuration the current digitizer cannot provide, usually because its firmware lacks the FFT option or implements a different datapath version.

Check **Board Options** in *Board Properties*.

Load default configuration
Confirmation before discarding the current configuration and restoring defaults.

Choose to proceed or cancel. Save the current configuration first if it is worth keeping.

10.4 FFT

FFT Datapath 2 is deprecated
The digitizer's FFT firmware implements datapath version 2, which AlazarDSO no longer supports.

Update the digitizer's firmware. Contact AlazarTech support.

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Unknown FFT Datapath
The digitizer reports an FFT datapath version AlazarDSO does not recognise, usually meaning firmware newer than this release.

Update AlazarDSO, or contact AlazarTech support.

10.5 Stream to memory

Stream to memory requires finite acquisition.
The **Stream To Memory** wizard was started while *Configure Acquire* is set to acquire an infinite number of buffers.

Streaming to memory reserves a fixed block of system memory and must know how much data to expect. Select **Finite:** in **Buffers per acquisition** and enter a count.

Insufficient system memory for acquisition
The acquisition requires more system memory than has been reserved for it.

Reduce the number of transfers per acquisition, or raise the memory limit on the wizard's memory page. Closing other applications frees memory the wizard can then reserve.

Insufficient disk space for acquisition
The volume holding the output directory has less free space than the acquisition will produce.

Reduce the number of transfers, choose a directory on a volume with more free space, or free space on the current one.

10.6 Benchmarks

Select at least 1 channel to run benchmark
A benchmark was started with no channels enabled. A transfer rate cannot be measured without data to transfer.

Enable at least one channel.

10.7 Board systems

Failed to Create ATS Sync system.
AlazarDSO could not create an ATS-Sync system from the selected digitizers.

Check that the boards are connected by ATS-Sync cabling, that each is detected, and that none is in use by another application. See *ATS Sync Connection*.

Failed to release ATS Sync system.
AlazarDSO could not release the ATS-Sync system.

Stop any acquisition in progress and try again.

New system ID does not match expected system ID.
The board system created does not have the identifier AlazarDSO expected.

Release the system and create it again. If it recurs, restart AlazarDSO.

Invalid test status for ATS Sync

The ATS-Sync system test returned a result AlazarDSO could not interpret.

Check cabling and board detection, then test again.

10.8 Clock

AlazarOCTIgnoreBadClock failed with error OCT no trigger detected (ApiOCTNoTriggerDetected)

Ignore Bad Clock is enabled in *Configure Clock*, but no OCT trigger signal is present. The acquisition stops.

Connect the trigger the ignore-bad-clock timing is referenced to, or clear **Ignore Bad Clock**.

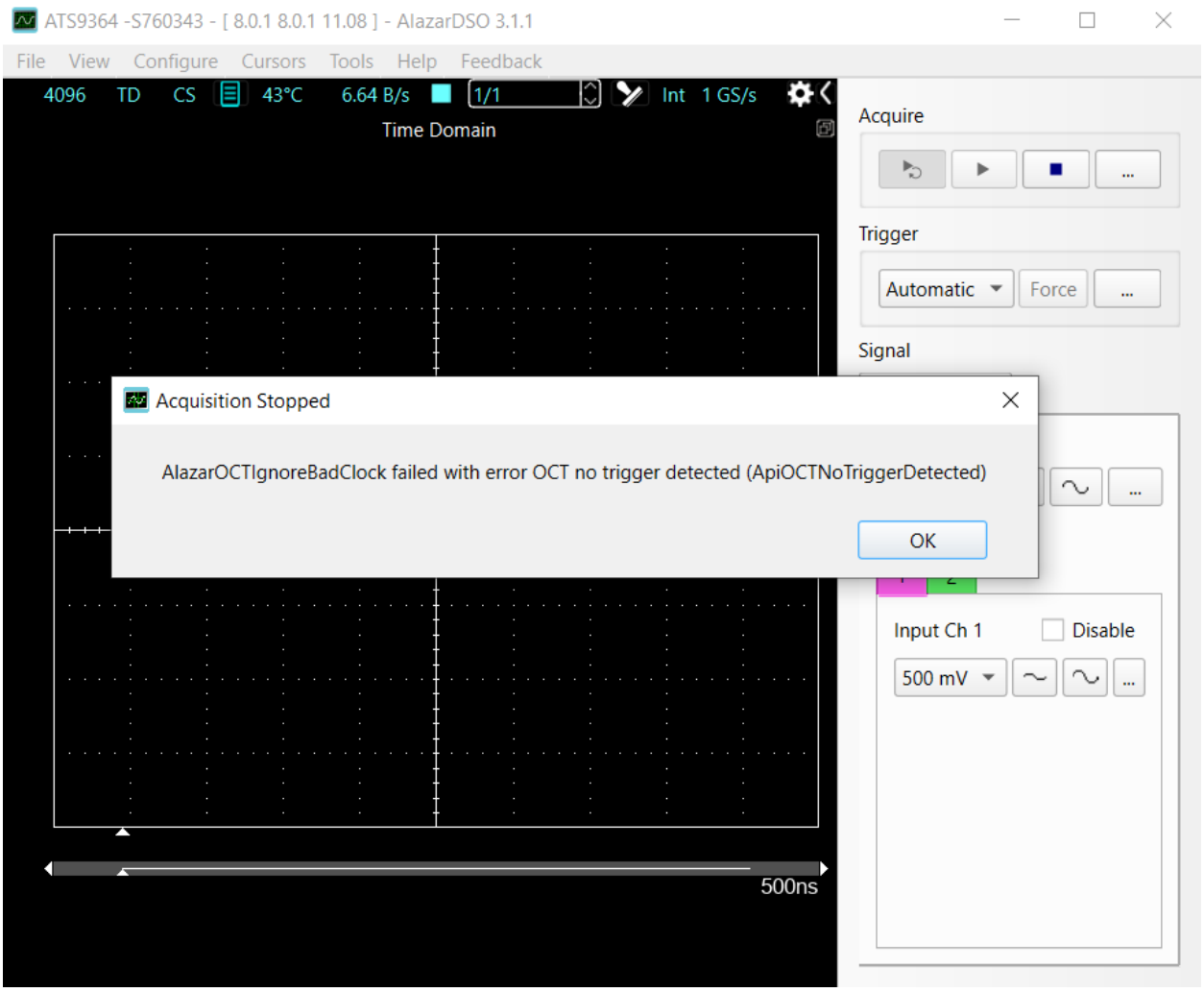


Fig. 1: Acquisition stopped because no OCT trigger was detected

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10.9 Display

Invalid renderer
The selected display engine cannot be used.

Choose a different engine from **Display Engine** in the **Configure** menu. If none works, the host's graphics driver may need updating.

10.10 API log

Failed to clear ATSApi log file. Make sure to close other applications linking to ATSApi library.
The log file is held open by another process.

Close every application using AlazarTech digitizers, then clear the log again.

No logging file path variable found
AlazarDSO could not determine where the ATS API log file is written.

Enable **Enable ATS API log** from the **Debugging** menu first, then restart the application.

10.11 Clock

Error in AlazarSetCaptureClock: ALAZAR_IOCTL_SET_CAPTURE_CLOCK ioctl failed . . . ApiPllNotLocked
The digitizer could not lock to the selected clock source. Seen when an external 10 MHz reference is selected in *Configure Clock* and no valid reference is present at the clock input.

Check that the reference signal is connected, is at the expected frequency, and is within the digitizer's required amplitude range.

10.12 Acquisition

These appear in a box titled **Acquisition Stopped**.

Error in AlazarBeforeAsyncRead: [before_async_read] Error: channel combination is not supported
No channel is enabled. Disabling the last enabled channel stops the acquisition, since the digitizer cannot be asked for nothing.

Enable at least one channel in *Configure Channels* and start again.

10.13 On-FPGA FFT

All three appear in a box titled **Acquisition Stopped**, and the acquisition does not start.

Error in AlazarFFTSetup: Requested channels are not supported
More than one channel is enabled. **The on-FPGA FFT transforms one channel at a time.** Disable the others in *Configure Channels* and start again.

AlazarDSO does not prevent the invalid combination, so this message is the first indication that it will not work.

Error in AlazarWaitAsyncBufferComplete: [dma_transfer_complete] Overlapped buffer overflow
The digitizer filled its on-board memory faster than AlazarDSO could read it.

Reduce the sample rate in *Configure Clock*, reduce **Records per buffer**, or increase **Buffer count** in *Configure Acquire*.

selected output not in layout
Reported in a **Run-Time error** box, after which AlazarDSO closes. **Save your work before opening Save Data in an FFT-only mode** — see *Save Records*.

10.14 Opening a file that cannot be read

> **Warning**
>
> Both messages below are followed by AlazarDSO closing. Save your work before opening a file you are unsure of.

JSON Parsing failed - provided NVP (config) not found
A `.json` file was opened that is not in the form AlazarDSO expects — damaged, truncated, or written by different software.

Error while opening configuration file. Please make sure that configuration file is valid.
As above, for a configuration file opened with **LoadConfig**. Configure the instrument again and save a new configuration file.

10.15 Changing the acquisition system

Changing acquisition system...
Progress shown while AlazarDSO switches to a different board system. Not an error. New in AlazarDSO 3.1.2.

10.16 Starting up

No boards found!
No digitizer was detected. The dialog box offers a list of models so that AlazarDSO can be started in simulation mode, which allows the configuration windows and saved data files to be explored but acquires nothing.

If a digitizer is installed, check that it is seated correctly and that its driver is loaded. See *Getting Started*.

This application does not support single port boards. Please use AlazarDSO version < 3.
The digitizer is of an older, single-ported generation. AlazarDSO requires a dual-ported digitizer.

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Unable to open board system Id 1, board Id 1
: Reported when an acquisition is started in simulation mode. Simulation mode does not acquire data. See *Getting Started*.

Error while loading application translation file
: AlazarDSO could not load the translation for the selected language and will run in English.

  Check that the installation is complete. Reinstalling restores missing translation files.

10.17 Run-Time error

A condition AlazarDSO could not recover from. The dialog box carries the specific cause.

Note the text shown and the operation in progress, then report both to AlazarTech support. If the error recurs at a particular step, note the configuration in use — attaching the saved configuration file is the most useful thing you can provide.

10.18 References

Both appear in an information box titled **Reference signal**.

Channel must be selected for display
: **Set** was pressed for a channel that is not currently drawn. Check the channel under **Plot Channels** in *Configure Display* first.

No data for requested channel
: **Set** was pressed before any data had been acquired for that channel.

10.19 Power monitor

Both appear when **Clear Int.** is pressed in *Power Monitor*.

No interrupts detected.
: No monitored quantity has gone outside its limits.

The following interrupts were cleared:
: Followed by one line per quantity that has, each reading *<name> value exceeds limits.*

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CHAPTER

ELEVEN

SPECIFICATIONS

11.1 Record size and alignment by digitizer

Record lengths and buffer sizes are constrained by the digitizer's memory architecture. AlazarDSO enforces these constraints when validating the values entered in *Configure Acquire*, adjusting them where necessary.

The constraints are:

Minimum record size
: The shortest record the digitizer can acquire, in samples.

Pretrigger alignment
: The number of pre-trigger samples must be a multiple of this value.

Buffer alignment
: The number of samples in a buffer must be a multiple of this value.

Buffer alignment in NPT mode
: The buffer alignment that applies when records are acquired without pre-trigger samples. Where this reads "not supported", the digitizer does not offer NPT acquisition.

All values are in samples.

Board	Min. record	Pretrigger align.	Buffer align.	Buffer align., NPT
ATS310	256	4	16	Not supported
ATS330	256	4	16	Not supported
ATS460	128	16	16	32
ATS660	128	16	16	32
ATS850	256	4	4	Not supported
ATS860	256	32	32	64
ATS9350	256	32	32	32
ATS9351	256	32	32	32
ATS9360	256	128	128	128
ATS9373	256	128	128	128
ATS9416	256	128	128	128
ATS9440	256	32	32	32
ATS9462	256	32	32	32
ATS9625	256	32	32	32
ATS9626	256	32	32	32
ATS9870	256	64	64	64
AXI9870	256	64	64	64

Note

Entering a value that does not satisfy these constraints causes AlazarDSO to adjust it to the next acceptable value. A record length or pre-trigger sample count that differs from what was entered has been rounded for this reason.

11.2 Supported digitizers

AlazarDSO 3.x requires a **dual-ported** digitizer, which in practice means a PCI Express or Thunderbolt model. Most PCI digitizers are single-ported and cannot be used; the ATS460 is an exception, being dual-ported.

Opening AlazarDSO with a single-ported digitizer reports that the application does not support single port boards; see *Messages*.

11.3 Model capabilities

For the capabilities of a particular model — its analog input channels, sample resolution, maximum sample rate, input ranges, impedances, memory options and optional features — see the table at the end of the **ATS-SDK** manual.

The configuration chapter refers to these as board dependent throughout; that table is where to look them up.

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CHAPTER

TWELVE

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