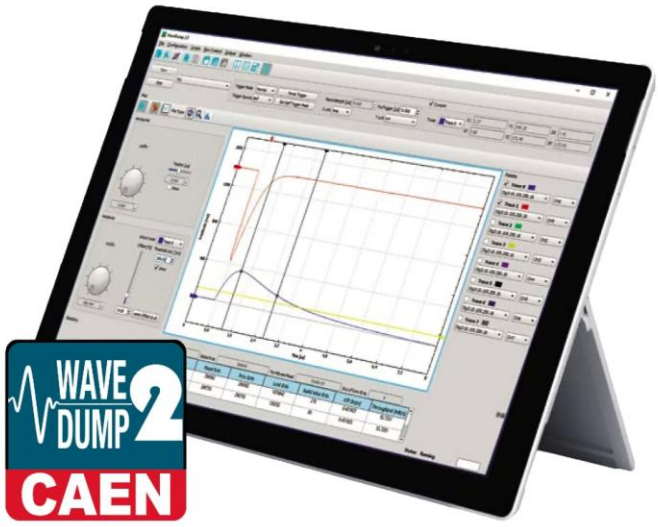
Rev. 7 - April 17th, 2025

WaveDump2

Software Application for Digitizer 2.0 and 1.0 Series



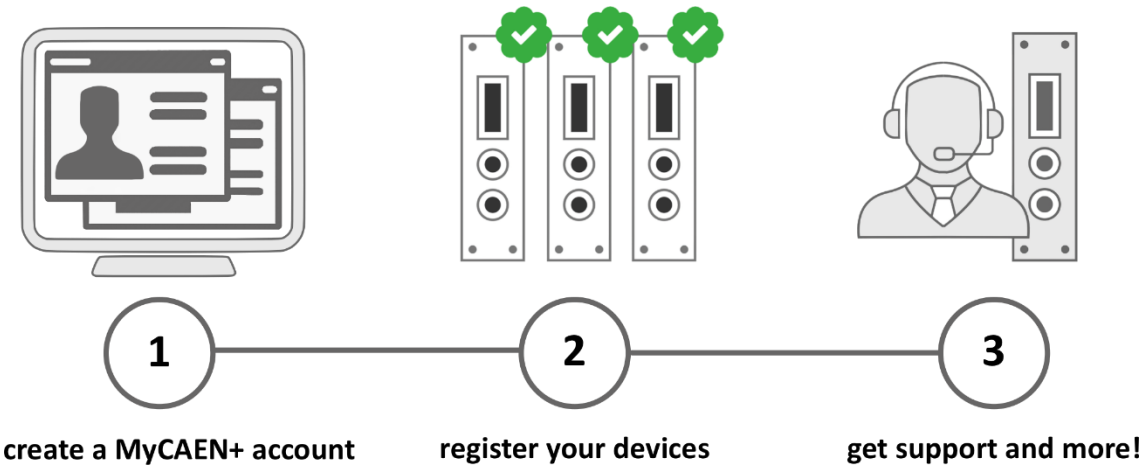
CAEN
Tools for Discovery

User Manual
UM7934

Register your device

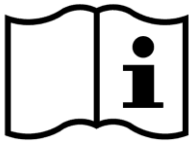
Register your device to your **MyCAEN+** account and get access to our customer services, such as notification for new firmware or software upgrade, tracking service procedures or open a ticket for assistance. **MyCAEN+** accounts have a dedicated support service for their registered products. A set of basic information can be shared with the operator, speeding up the troubleshooting process and improving the efficiency of the support interactions.

MyCAEN+ dashboard is designed to offer you a direct access to all our after sales services. Registration is totally free, to create an account go to https://www.caen.it/become-mycaenplus-user and fill the registration form with your data.



https://www.caen.it/become-mycaenplus-user/

Purpose of this Manual



This document contains the full description of the WaveDump2 software to control the Digitizer 1.0 (DT57XX, N67XX, V/VX17XX) and Digitizer 2.0 (DT27XX, V/VX27XX) series. Reference software revision is v2.1.0. or higher.

Change Document Record

Date	Revision	Changes
July 28th, 2021	00	Initial release
December 6th, 2021	01	Updated the text in the cover page. General review according to rel. 1.2.3 of the software. Major updates: Chap. **21**, Sec. **2.1,** Sec. **2.2**, Chap. **4**, Sec. **9.7**, Sec. **10.3**, Sec. **13.3**, Chap. **19**, **Tab. 11.1**, **Tab. 20.2**. Added Sec. **Manufacturer Contacts**, Sec. **Limitation of Responsibility**, Sec. **16**, Sec. **10.1.7**, Chap. **16**, Chap. **22**
December 15th, 2021	02	Updated Chap. **23**
April 18th, 2023	03	Added Sec. **Limitation of Responsibility**, **Disclaimer**, and **Made in Italy**. Updated Chap. **1**, Chap. **3**, Sec. **9.7**, Sec. **13.4**, Sec. **16.1**, Chap. **19**, Chap. **21**, Sec. **20.2**, Chap. **23**, Chap. **25**.
July 31st, 2023	04	Documented support to 2730 digitizers. Updated Sec. **10.1.6,** Sec. **10.5.6**, Sec. **16.1**, Chap **17**, Chap. **23**.
February 26th, 2024	05	Updated chap. **10.** Added the DAC out description in Sec. **20.1.1**. Added Sec. **23.2** and Sec. **23.2.1**. Added Chap. **24**.
July 25th, 2024	06	Added information on new preliminary support to Digitizer 1.0. Updated Chap. **1**, Chap. **2**, Chap **12**, Sec. **13.3**, Sec. **16.1**, Chap. **17**, Chap. **20**. Added Chap. **26**.
April 17th, 2025	07	Added support to 2751 series of Digitizer 2.0, 720 and 724 series of Digitizer 1.0. Added note on maximum Recordlength value accepted by software at p. **32**. Updated Sec. **20.1.2**. Updated DAC OUT options in **Tab. 20.2**. Updated Sec. **23.2.1**.

Symbols, Abbreviated Terms, and Notations

CPU	Central Processing Unit
ICR	Incoming Counting Rate
MTU	Maximum Transmission Unit

Reference Documents

[RD1] DS7783 – 2740/2745 Digitizers Data Sheet

[RD2] UM7897 – 2740/2745 Digitizers User Manual

[RD3] DS7783 – 2730 Digitizer Data Sheet

[RD4] UM9713 – 2730 Digitizer User Manual

[RD5] DS11720 – 2751 Digitizers Data Sheet

[RD6] UM11514 – 2751 Digitizer User Manual

[RD7] GD9764 – CAEN FELib Library User Guide

[RD8] UM5960 – CoMPASS User Manual

[RD9] AN2086 – Synchronization of CAEN Digitizers in Multiple Board Acquisition Systems

All CAEN documents can be downloaded at:

https://www.caen.it/support-services/documentation-area/

Manufacturer Contacts

CAEN S.p.A.
Via Vetraia, 11 55049 Viareggio (LU) - ITALY
Tel. +39.0584.388.398 Fax +39.0584.388.959
www.caen.it | info@caen.it

Limitation of Responsibility

If the warnings contained in this manual are not followed, CAEN will not be responsible for damage caused by improper use of the device. The manufacturer declines all responsibility for damage resulting from failure to comply with the instructions for the use of the product. The equipment must be used as described in the user manual, with particular regard to the intended use, using only accessories as specified by the manufacturer. No modification or repair can be performed.

Disclaimer

The information contained herein has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies. CAEN spa reserves the right to modify its product specifications without giving any notice; for up-to-date information please visit www.caen.it.

Made in Italy

We remark that all our boards have been designed and assembled in Italy. In a challenging environment where a competitive edge is often obtained at the cost of lower wages and declining working conditions, we proudly acknowledge that all those who participated in the production and distribution process of our devices were reasonably paid and worked in a safe environment (this is true for the boards marked "MADE IN ITALY", while we cannot guarantee for third-party manufactures).

Index

List of Figures

List of Tables

1 Introduction

WaveDump2 has been developed to support the Digitizer 2.0 new generation of CAEN digitizers, including the 2740, 2745, 2730, 2751, and possibly future series.

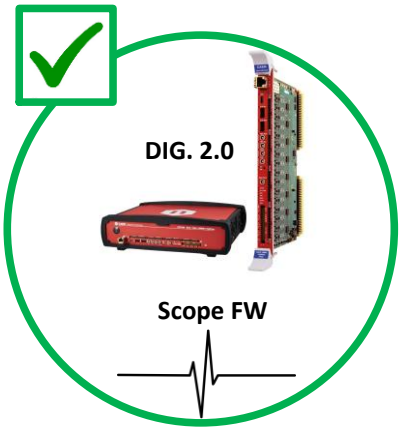
- To use this software, the Digitizer 2.0 must be programmed to run the Scope firmware for waveform recording applications.
- Starting from **revision 2.0.0**, support has been preliminarily extended to pre-existing CAEN Digitizer 1.0 series running the waveform recording firmware (D-Wave): DT57XX, N67XX, V17XX, VX17XX.
- The software does not support the DPP firmware (CoMPASS software must be used in this case **[RD8]**).

WaveDump2 is a C++ software developed upon Qt cross-platform application development framework. Through an advanced and user-friendly configuration GUI, it provides all the necessary tools and functionalities for managing any hardware parameters from the basic ones to the most specific ones (see Chap. **9**). The settings can be conveniently stored into or loaded from a configuration file (see Chap. **21**), or a sequence of operations can be recorded to script files and then loaded to be re-executed (see Chap. **22**).

From a single board to multiple boards and multi-board synchronized systems, data acquisition is managed through a dedicated toolbar and upon different start/stop criteria (see Chap. **20**). Live monitoring of the acquisition statistics can be enabled (see Chap. **19**).

Waveforms are live plotted in a dedicated section emulating an 8-channel digital oscilloscope (see Chap. **13**). This tool allows reviewing the acquired waveforms, fine-tuning the device settings, and/or troubleshooting potential problems. Cursors are available in the oscilloscope to make on-screen measurements, as well as marker lines to indicate the trigger position and the trigger threshold level. Traces can be individually enabled/disabled, and a legend is available to simply identify the displayed signals. The graphical tool offers a zooming control in both vertical and horizontal directions. Basic processing like FFT and samples histogram is provided runtime (see Chap. **13**).

The collected waveform data can be saved to ASCII or binary files for offline analysis (see Chap. **23**).



720	SUPPORTED
724	SUPPORTED
725	SUPPORTED
730	SUPPORTED
740	SUPPORTED
742	NOT SUPPORTED
743	NOT SUPPORTED
751	SUPPORTED
761	NOT SUPPORTED

The following table gives an idea of which features are supported in WaveDump2 and which are not (✓ means "supported"; ✗ stands for "not supported").

Feature	Support	Comments
Acquisition of waveforms with the nominal sampling rate	✓	Digitized waveforms from the target digitizer
Acquisition of waveforms with lower sampling rates	✓	According to the Decimation function, if supported by the firmware.
Waveform processing	✗	Physical quantities extraction (e.g. energy) or data reduction algorithms (e.g. ZLE, DAW)
Single-board management	✓	
Non-synchronized multi-board management	✓	Non-sync (Dig. 2.0) managed Non-sync (Dig. 1.0) managed Non-sync (Dig. 1.0 + Dig. 2.0) managed
Synchronized multi-board management	✓	Sync (Dig. 2.0) managed Sync (Dig. 1.0) managed Sync (Dig 1.0 + Dig. 2.0) **to be done**
Acquisition run upon different start/stop criteria	✓	
Correlation between channels	✗	E.g. coincidences/anti-coincidences
Save/Load configuration files for parameter presets	✓	
Save/Load script files for the preset of sequenced actions	✓	
Live plot of multiple wave traces	✓	Up to 8 traces in the same plot
Live FFT plot of the wave traces	✓	FFT data cannot be saved
Live histogram plot of the wave samples	✓	Samples histogram data cannot be saved
Histogram plot of physical quantities	✗	E.g. energy histograms
Live run statistics of the connected boards	✓	
Waveform recording to files	✓	Binary and text formats supported
Event building	✓	In Sync modes, a unique file including data from multiple boards is saved by event ID and timestamp
Live log of the issued software commands	✓	
Manual control of the device parameters	✓	Advanced tool for expert users
System monitor	✓	Error flags managed

2 Installation

WaveDump2 can run on 64-bit Windows® or Linux® operating systems.

The installation packages and required binary files are available for free download on the CAEN website on the WaveDump2 page (**login required**).

Before installing WaveDump2, perform the following steps:

- **Make sure that your Digitizer is properly installed**.
- **Make sure of a proper cable connection** by USB or Ethernet link between the host PC and the Digitizer.
- **Make sure that the current digitizer firmware is the Scope firmware (Digitizer 2.0) or the waveform recording firmware (Digitizer 1.0)**.

CAEN provides a detailed first installation guide inside the Digitizer User Manual **[RD2] [RD4]**.

WaveDump2 installation package for **Windows** and **Linux is standalone:** it installs all the binary files required to directly use the software.

- **Download** the **WaveDump2 Software** for your OS from the **CAEN website** under the path:

  https://www.caen.it/products/caen-wavedump2/

- **Extract** the files.

Note: Only for Digitizer 1.0, the CAEN FELib and Dig1 libraries must be installed on the host PC:
https://www.caen.it/products/caen-felib-library/

2.1 Windows OS

To install WaveDump2 on Windows OS follow the installation procedure:

- **Double-click** on the **setup executable file** to start the installation.
- **Complete** the **installation wizard** steps.

During the installation, the User can associate or not file extensions for additional software tasks (see Chap. **21 and** Chap. **22**).

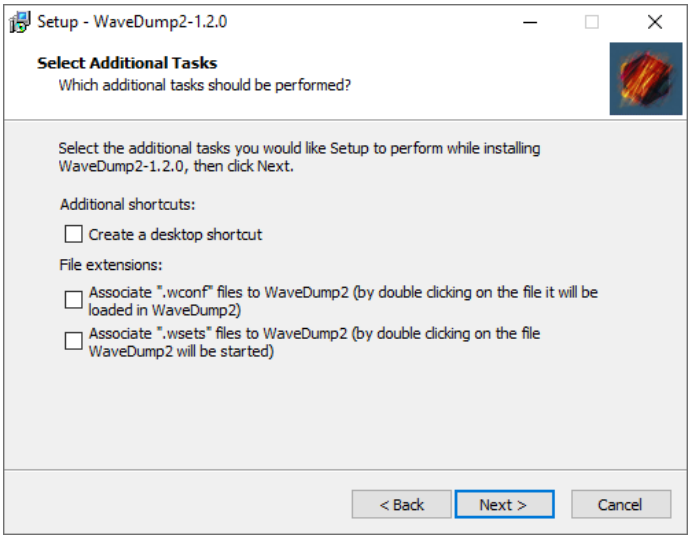


Fig. 2.1: Additional tasks selection during WaveDunp2 installation

By default, the software will be installed at the following destination path:

C:\Program Files\CAEN\WaveDump2

After the installation, a "WaveDump2" folder is also created at:

C:\Users\<USER>

This is the destination for the default *WaveDump2_Config.wconf* file where the current software configuration is saved (see Chap. **21**).

2.2 Linux OS

To install WaveDump2 on Linux OS follow the installation procedure:

- **Open** the **terminal**.
- **Enter** the **WaveDump2** folder.
- **Run** the **install.sh** file **as root** (# sh install.sh).

Do not delete the WaveDump2 folder and do not move it from the original location as the software will need the libraries and plugins located inside this folder to properly run.

After the installation, a "WaveDump2" folder is also created at:

/home/<USER>/WaveDump2

This is the destination for the default *WaveDump2_Config.wconf* file where the current software configuration is saved (see Chap. **21**).

3 Folder Contents

3.1 Windows OS

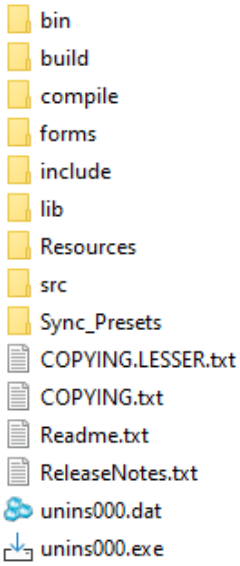


Fig. 3.1: WaveDup2 folder list in Windows OS

Element	Description
bin	Subfolder containing the executable file and all the required binary files
build	Subfolder containing the Visual Studio project
compile	Subfolder containing all the files required to compile
forms	Subfolder containing the GUI forms
include	Subfolder containing all the h files used by the main code
lib	Subfolder containing the CAEN_FELib.lib
resources	Subfolder containing the icons and symbols used in the GUI
src	Subfolder containing the C++ source files
Sync_Presets	Subfolder containing settings and script files ready to use for different cases of multi-board synchronization (see Chap. **26**)
COPYING.LESSER.txt	File containing the Copying GNU Lesser General Public License
COPYING.txt	File containing the Copying GNU General Public License
Readme.txt	File containing the instructions to compile and run the software
ReleaseNotes.txt	File containing the revision history of the software
unins000.dat **unins000.exe**	Uninstall files

Tab. 3.1: Description table of contents

3.2 Linux OS

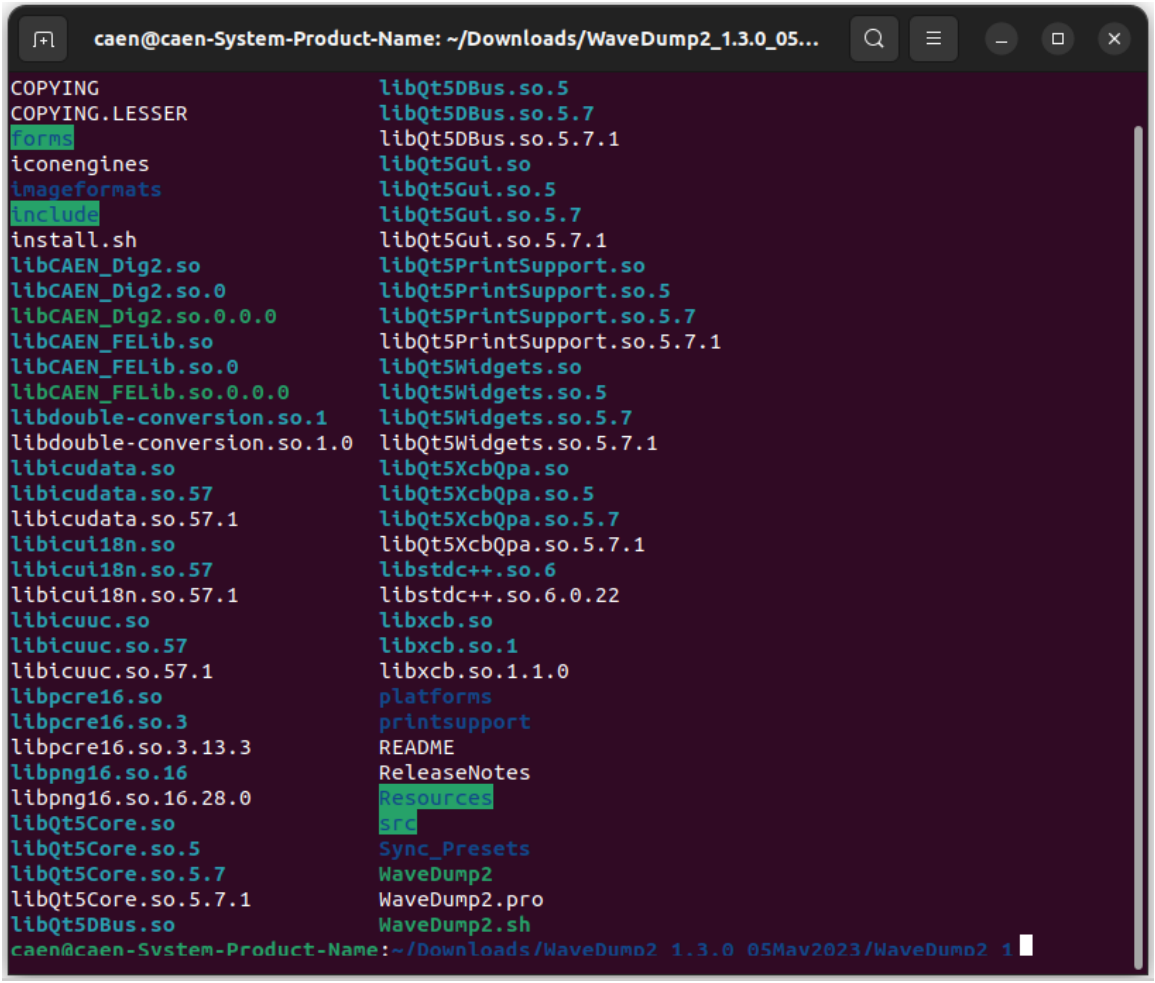


Fig. 3.2: WaveDup2 folder list in Linux OS

4 Uninstallation

4.1 Windows OS

To uninstall WaveDump2 in Windows OS, optionally:

- Run the uninstall executable file in “C:\Program Files\<USER>\”
- Remove by the Windows Control Panel

It is recommended to check in the main folder and in “C:\Users\<USER>\” to manually remove the remaining files or directories if any.

4.2 Linux OS

To uninstall WaveDump2 in Linux OS:

- Remove the entire WaveDump2 folder.
- Remove (by "sudo rm") the *WaveDump2* file in "/usr/local/bin/"

5 Run WaveDump2

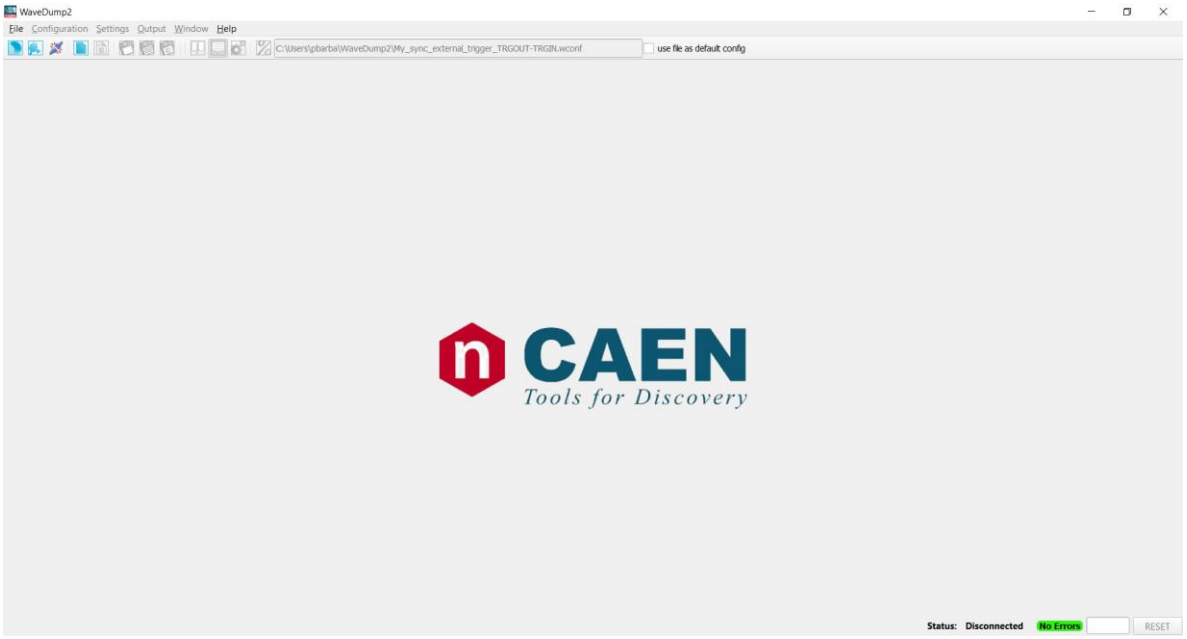


Fig. 5.1: WaveDump2 home screen

5.1 Windows OS

- Run Wavedump2 optionally by:
  - the executable file in the *bin* subfolder;
  - the desktop shortcut;
  - the Start menu.

5.2 Linux OS

- Regardless of which folder you currently are in, type ***WaveDump2*** in the **terminal** to run the software.

6 Device Connection

A new connection with the Digitizer can be established by optionally:

- Clicking the Connect Device button in the Icon bar of the WaveDump2 GUI (see **Fig. 6.1**)
- Selecting *File -> Connect to Device* from the WaveDump2 main menu.

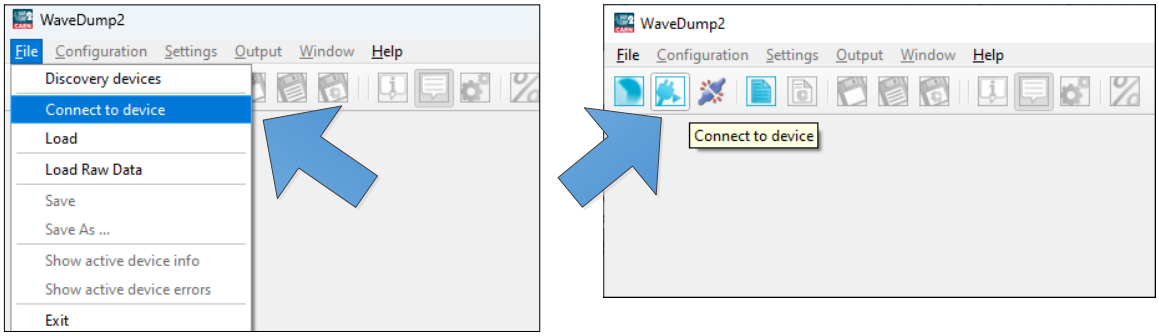


Fig. 6.1: Device connection options

The connection dialog opens showing the connection settings.

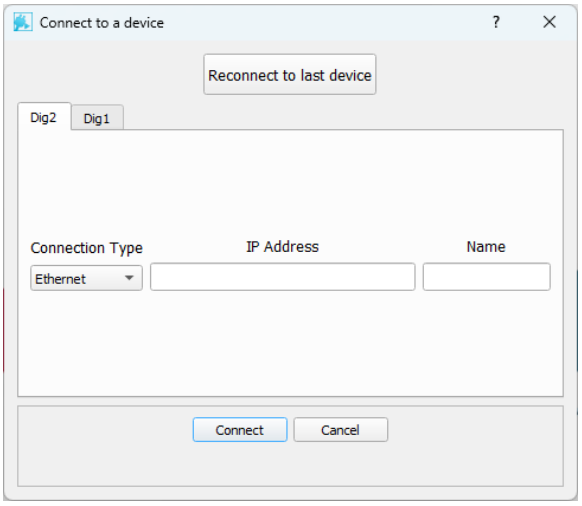


Fig. 6.2: Connection dialog

6.1 Dig2 Connection Settings

The connection parameters to add a Digitizer 2.0 device are described in **Tab. 6.1**.

Setting	Options	Description
Connection Type	Ethernet, USB	The manual selection of the supported connection types settable by the User for a new connection to the device.
IP Address	-	In the case of the Ethernet connection type, the board IP address must be inserted in this section, while for a USB connection the device PID must be inserted instead.
Name	-	The User can optionally provide a device name and it will be used by the software to identify the device.
Reconnect to last device	-	The button can be used to re-establish the last closed connection. By using this function, the last digitizer that had been connected to the software is automatically re-connected. Reconnect will fail in case no previous connection data can be found.
Connect	-	After the other parameters are set, the button allows starting a new connection. If the connection is successfully established, the plot panel and all the software features will become available, and the device name will be visible on the Control panel of the GUI inside a Combobox. This combo box always shows the name of the active device (see Chap. **12**).
Cancel	-	The button allows exiting the connection dialog.

Tab. 6.1: Dig2 connection settings table

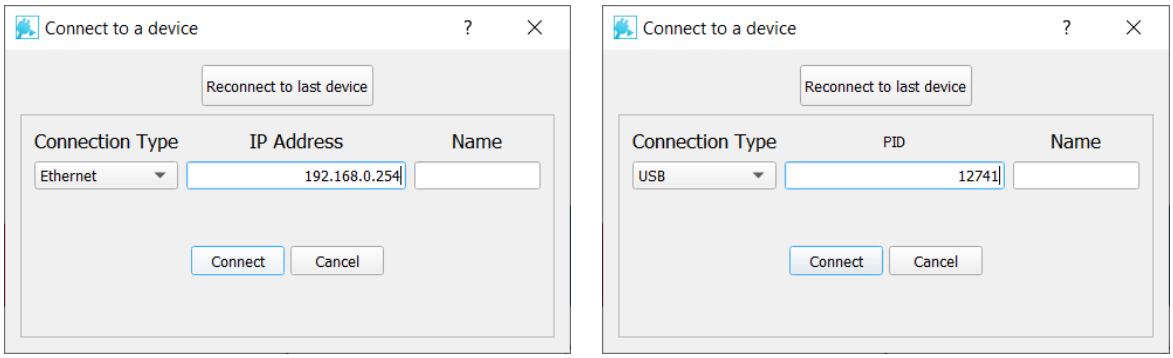


Fig. 6.3: Dig2 connection setting examples

6.2 Dig1 Connection Settings

The connection parameters to add a Digitizer 1.0 device are described in **Tab. 6.2**.

Setting	Options	Description
Connection Type	USB USB-A4818 USB-V4718 Optical Link Ethernet-V4718	The manual selection of the supported connection types settable by the User for a new connection to the device. The "USB" option must be used both for direct USB connection and connection through the V3718 CAEN Bridge (or old V1718). The "Optical Link" option must be used both for direct optical link connection and connection through the V3718 and V4718 CAEN Bridges (or old V2718).
IP Address	Standard dotted-decimal format, with four numbers separated by periods	In the case of the "Ethernet-V4718" connection type, the V4718 IP address must be inserted in this section.
Link Number	0, 1, 2, …	Identifies which USB or Optical link is linked to the host computer when multiple boards/bridges are simultaneously connected.
Conet Node	0, 1, 2, 3, … , 7	Identifies which Optical link is linked to the host computer in the case of a Daisy chain connection.
VME Base Address (0x)	XXXX0000	8-digit hexadecimal VME Base Address identifying the VME Digitizer over the VME bus. Note that "XXXX" is given by the position of the 4 rotary switches on the digitizer motherboard.
PID	YYYYY	In the case of the "USB-A4818" or the "USB-V4718" connection type, the PID is the 5-digit decimal unique product identification number of the A4818 or V4718 respectively.
Name	-	The User can optionally provide a device name and it will be used by the software to identify the device.
Reconnect to last device	-	The button can be used to re-establish the last closed connection. By using this function, the last digitizer that had been connected to the software is automatically re-connected. Reconnect will fail in case no previous connection data can be found.
Connect	-	After the other parameters are set, the button allows starting a new connection. If the connection is successfully established, the plot panel and all the software features will become available, and the device name will be visible on the Control panel of the GUI inside a Combobox. This combo box always shows the name of the active device (see Chap. **12**).
Cancel	-	The button allows exiting the connection dialog.

Tab. 6.2: Dig1 connection settings table

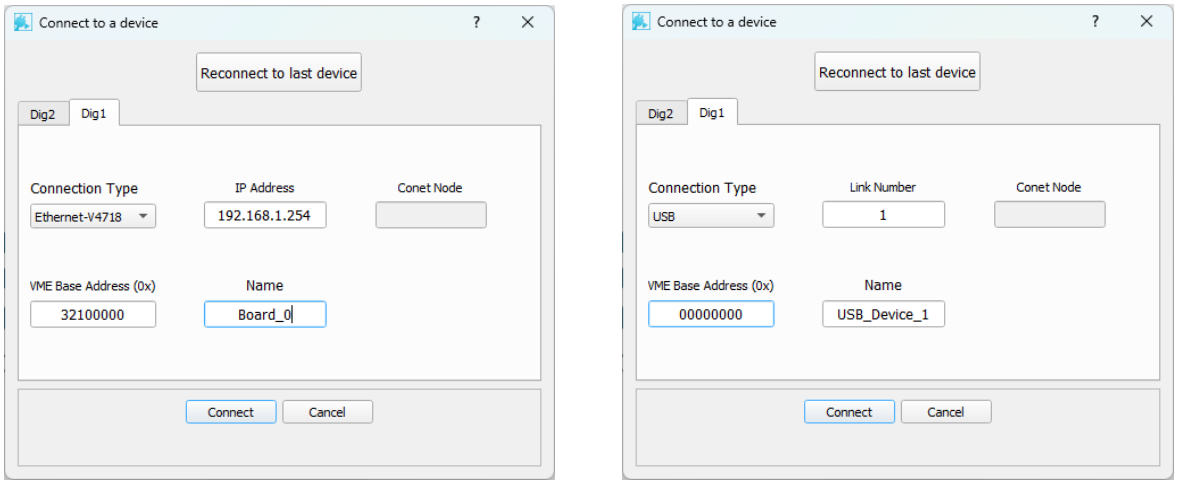


Fig. 6.4: Dig1 connection setting examples

7 Device Disconnection

To disconnect a device:

- Set it as the active device in the Control Panel (see Chap. **12**)
- Click on the Device Disconnect button  in the Icon bar (See Chap. **11**).

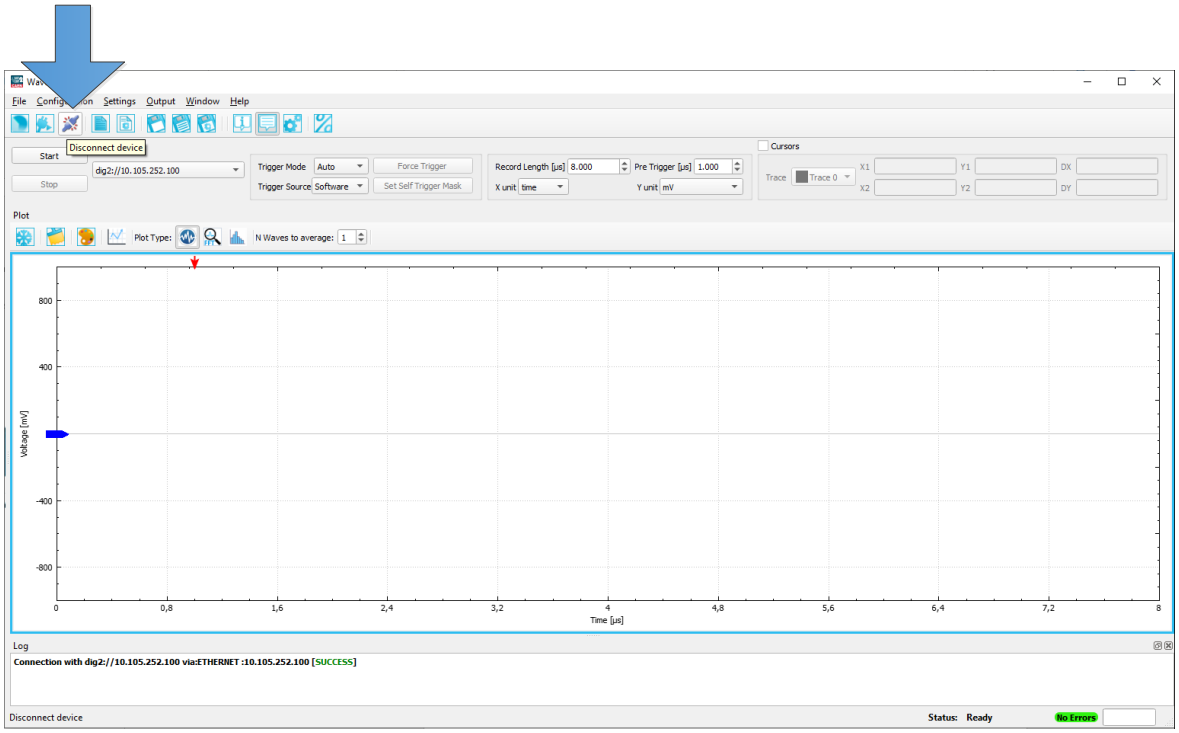


Fig. 7.1: Active device disconnection

8 Exit WaveDump2

To quit the software, two options are available:

- By the Exit function of the File drop-down menu in the Menu bar (see Chap. **10**)
- By the Close key in the Header bar (see Chap. **9**).

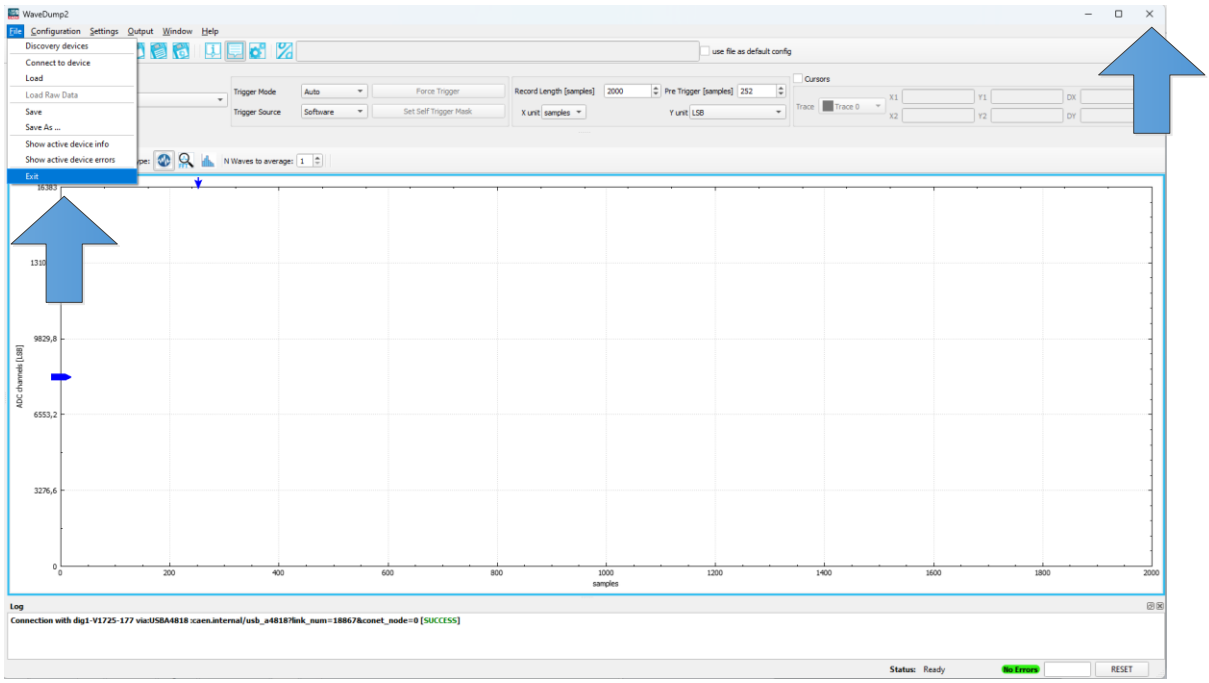


Fig. 8.1: Exit options

9 WaveDump2 Main Frame

The WaveDump2 mainframe is shown in **Fig. 9.1**. One Digitizer has been connected and all the software features are enabled for the User.

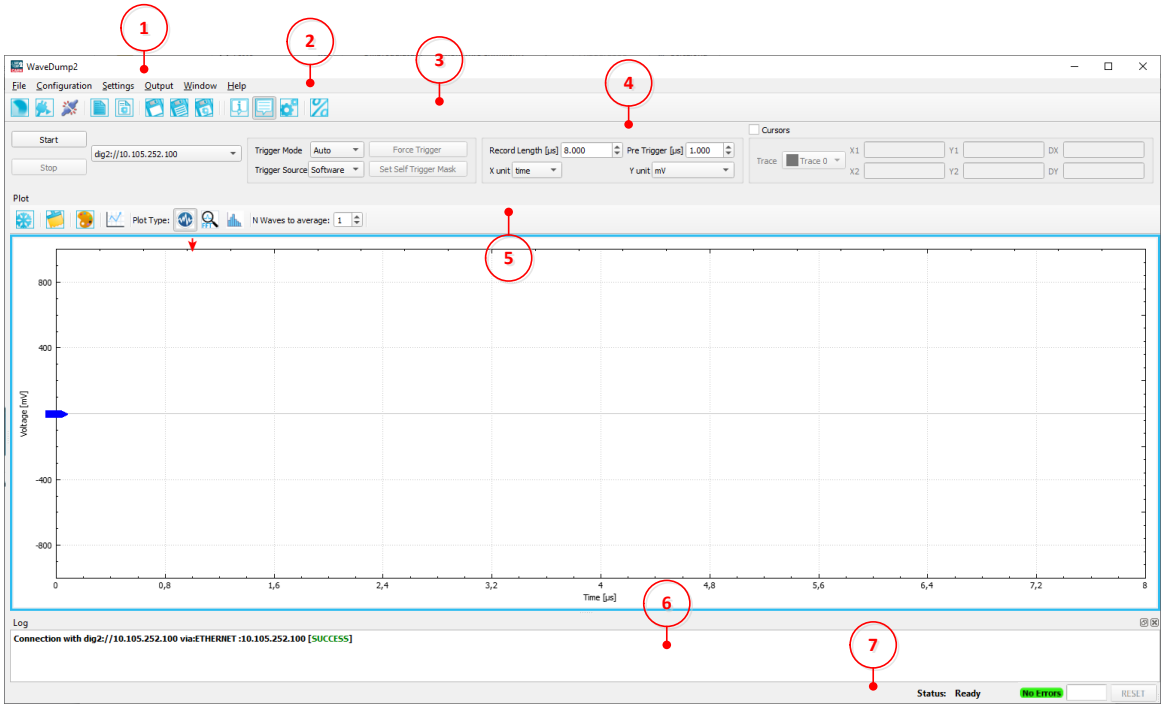


Fig. 9.1: WaveDump2 Mainframe

Starting from the top, the mainframe appears as a set of default sections:

1. *Header Bar*
2. *Menu Bar*
3. *Icon Bar*
4. *Control Panel*
5. *Plot Panel*
6. *Log Panel*
7. *Bottom Bar*

Other sections can be optionally displayed (see Chap. **10** or Chap. **11**).

9.1 Header Bar

This bar shows the software name and logo on the left, while the conventional Windows Minimize, Zoom, and Close keys are available on the right.

9.2 Menu Bar

It is the first level of software functions (see Chap **10**).

This bar includes the following drop-down menu items:

File / Configuration / Settings / Output / Window / Help

9.3 Icon Bar

The bar includes a list of icons for fast access to useful software functions (see Chap. **11**):

Discovery devices / Connect to Device/ Disconnect Device / Load Configuration File / Load Settings File / Save Configuration File / Save Configuration File As/ Start/Stop saving as Settings File/ Show/Hide Device Manager / Show/Hide Log Window / Show/Hide Manual Controller / Show/Hide Statistics.

9.4 Control Panel

The Control Panel includes a set of settings related to the active device (see Chap. **12**):

Start/Stop Acquisition / Active Device Name / Trigger Mode / Trigger Source / Force Trigger / Set Self Trigger Mask / Recordlength / PreTrigger / X Unit / Y Unit / Cursors.

9.5 Plot Panel

This is the central section of the software mainframe including the plot functions (See Chap. **13**):

Freeze / Palette / Graph Tools / Waveform Plot Type / FFT Plot Type / Samples histogram Plot Type / N Waves to Average / Graphic Display Section.

9.6 Log Panel

This section of the mainframe lists any command issued by the software whichever the result, positive or negative (see Chap. **15**).

9.7 Bottom Bar

This bar, at the bottom of the mainframe, echoes the name of the function which is selected by the User on the left side. On the right side, it shows the status of the acquisition and the error flag (see Chap. **16**)

The Bottom Bar also hosts the RESET button:

- It sets all the FPGA registers to the default value and clears the memories.
- It applies to the active device. In case the Active Device combo box is set as ALL (see Chap. **12**), the RESET applies to all the connected devices.
- It cannot be used while an acquisition is running.
- It must be used before starting a new acquisition after the active device exited an overtemperature condition.

10 Menu Bar

Part of the functions in the Menu bar is also available in the Icon bar for faster access and use (see Chap. **11**).

10.1 File

The File drop-down menu includes a set of heterogeneous functions as described in the following sections.

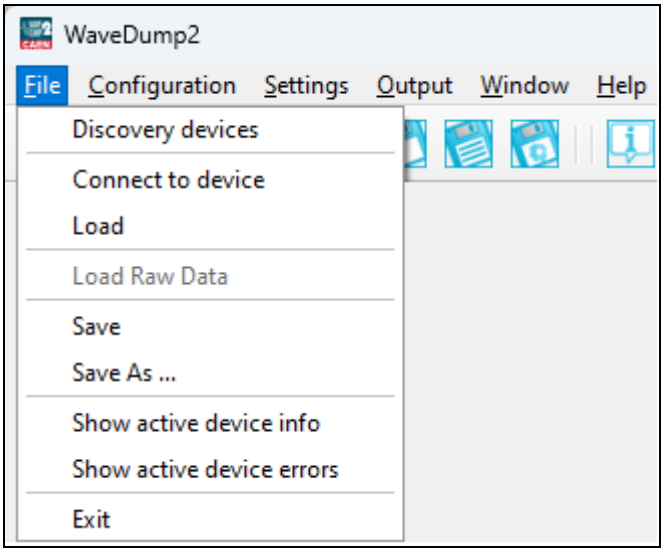


Fig. 10.1: The File functions

10.1.1 Discovery Devices (Not Yet Implemented)

The “Discovery devices” function detects all the available devices currently present on the Ethernet or USB link and allows the User to select which one to connect.

This function is also available in the Icon bar (see Chap. **11**).

10.1.2 Connect to Device

The “Connect to device” function allows connecting a device, according to what is described in Chap. **6**.

This function is also available in the Icon bar (see Chap. **11**).

10.1.3 Load

The “Load” function permits reloading a previously saved WaveDump2 configuration file (*wconf* file). See Chap. **21** for details.

This function is also available in the Icon bar (see Chap. **11**).

10.1.4 Load Raw Data

The “Load Raw Data” function allows importing *wbin* files saved in the Fast Save mode (see Sec. **23.2**). Any connected board must be disconnected to use this function.

10.1.5 Save, Save As

The “Save” and “Save As” functions allow saving the current configuration to a *wconf* file. The “Save As” permits renaming the file and saving it to a different path. If “Save As” has never been used before, the “Save” option works as “Save As”, otherwise it will overwrite the first *wconf* file saved with the updated configuration. See Chap. **21** for additional information. Both functions are also available in the Icon bar (see Chap. **11**).

10.1.6 Show Active Device Info

This function opens a window showing a set of general information retrieved from the active device.

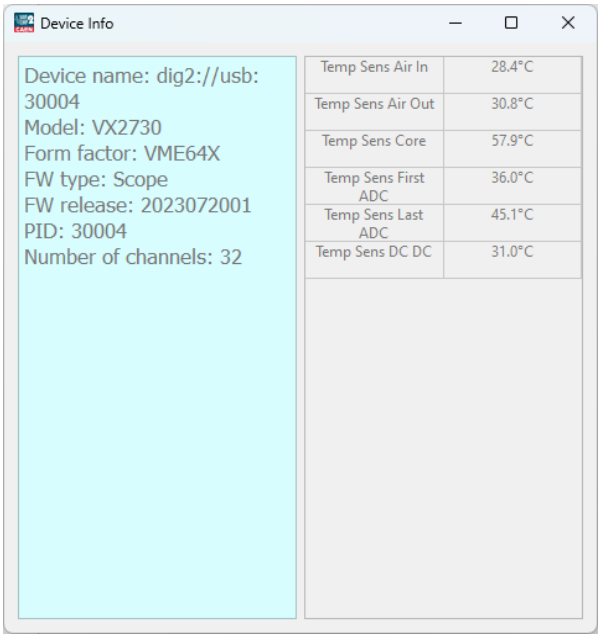


Fig. 10.2: The Active Device Info window

Info	Description
Device name	It is the name of the active device that can be configured by the User at the connection (see Chap. **6**) and is selectable in the Control Panel Combobox (see Chap. **12**).
Model	It is the device model belonging to Digitizer 1.0 or Digitizer 2.0.
Form factor	It is the device form factor: VME64, VME64X, Desktop
FW type	It is the type of currently running firmware: Scope, DPP-PHA, etc.
FW release	It is the release number of the current firmware **[RD2]**
PID	It is the unique Product Identifier of the device **[RD2]**
Number of channels	It is the maximum number of analog input channels supported by the device
Temperature Monitor	The live values of the digitizer onboard sensors (as in the Web Interface for Digitizer 2.0) **[RD1][RD4]**

Tab. 10.1: Active Device Info table

10.1.7 Show Active Device Errors

This function opens a window showing error info from the active device(s) if any (see Sec. **16**).

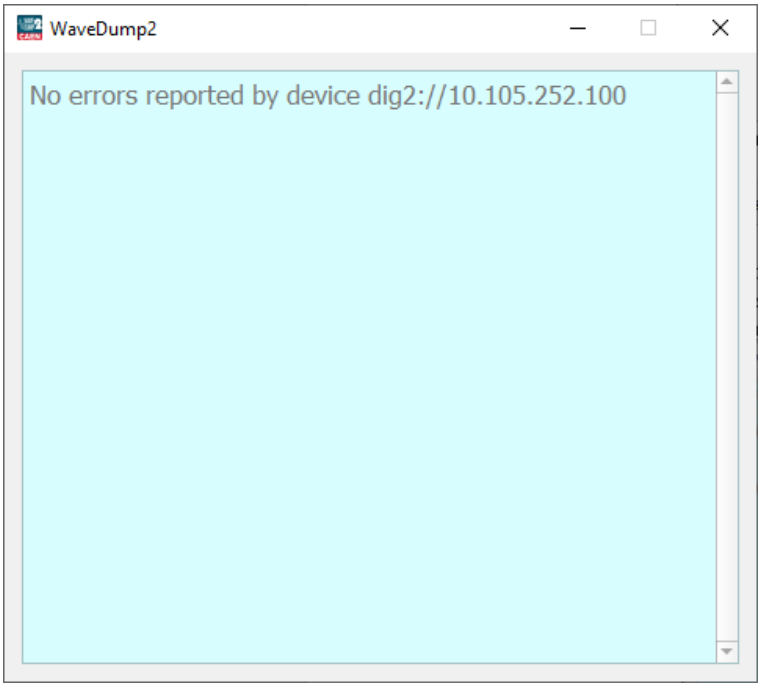


Fig. 10.3: Active device errors window

10.1.8 Exit

This function permits quitting the software.

10.2 Configuration

By the Configuration drop-down menu, the whole configuration of the connected devices is allowed.

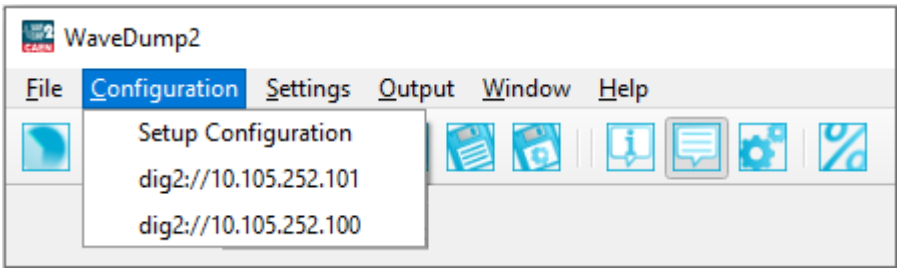


Fig. 10.4: The Configuration functions

10.2.1 Setup Configuration

The "Setup Configuration" function opens the general Configuration GUI (see Chap. **20**), where every connected device can be configured individually in a dedicated tab, or it is possible to apply the same settings to all the connected devices at once in a common tab.

10.2.2 Configuration by Device

Selecting a device from the list of the connected ones, this function opens the related Configuration GUI, where all the settings for that device can be set (see Chap. **20**).

10.3 Settings

The Settings menu manages the *wsets* script files generated upon a precise sequence of operations that have been carried out by the user (see Chap. **22**).

10.3.1 Load

This function loads a script file previously saved by the User.

10.4 Output

By the Output drop-down menu, the data-saving supported by WaveDump2 is managed (see also Chap. **23**). Configure the desired save mode and output file format before enabling the save function.

10.4.1 Save Data

By checking "Save Data", the data saving function is enabled and outputs files will be generated at the start of acquisition according to the settings previously selected in the "Configure" function (see Sec. **10.4.2**).

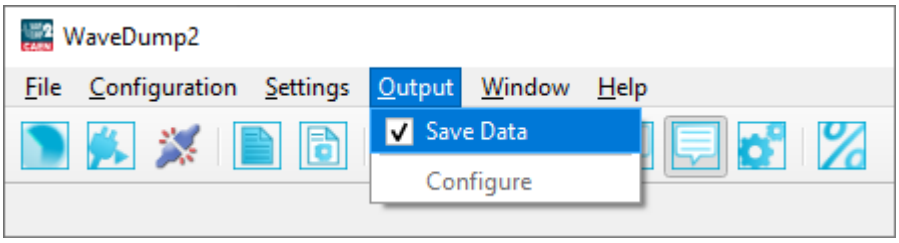


Fig. 10.5: The Save Data function

10.4.2 Configure

The "Configure" function opens the Output Settings dialog box where all the output file options can be configured before checking the Data Save function (see Sec. **10.4.1**). Save modes and output file formats are described in Chap. **23**.

10.5 Window

The Window drop-down menu manages to show/hide the additional function sections in the Wavedump2 mainframe. When selecting the option from the menu, the plot section is resized (see Sec. **9.5**) to host the new appearing panel. Selecting again the same option hides the panel and the plot section resizes back.

Note that all the functions in the Window menu are also available in the Icon bar (see Chap **11**).

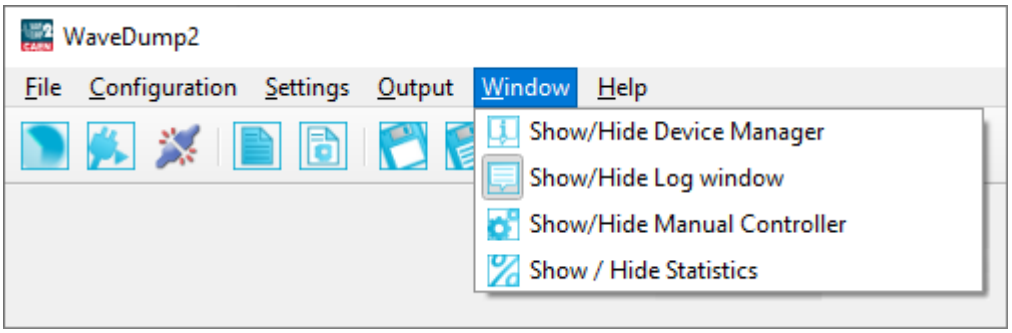


Fig. 10.6: The Window functions

10.5.1 Show/Hide Device Manager

This function shows or hides the Device Manager panel in the WaveDump2 mainframe. See Chap. **14** for more information.

The Device Manager panel is hidden by default.

10.5.2 Show/Hide Log Window

This function shows or hides the Log panel in the WaveDump2 mainframe. See Chap. **14** for more information.

The Log panel is visible by default.

10.5.3 Show/Hide Manual Controller

This function shows or hides the Manual Controller panel in the WaveDump2 mainframe. See Chap. **0** for more information.

The Manual Control panel is hidden by default.

10.5.4 Show/Hide Statistics

This function shows or hides the Statistics panel in the WaveDump2 mainframe. See Chap. **19** for more information.

The Manual Control panel is hidden by default.

10.5.5 Help

Through the Help drop-down menu, it is possible to access the software information (see Sec. **10.5.6**).

10.5.6 About WaveDump2

The “About WaveDump2” function opens the homonymous window (**Fig. 10.7**) with the information described in **Tab. 10.2**.

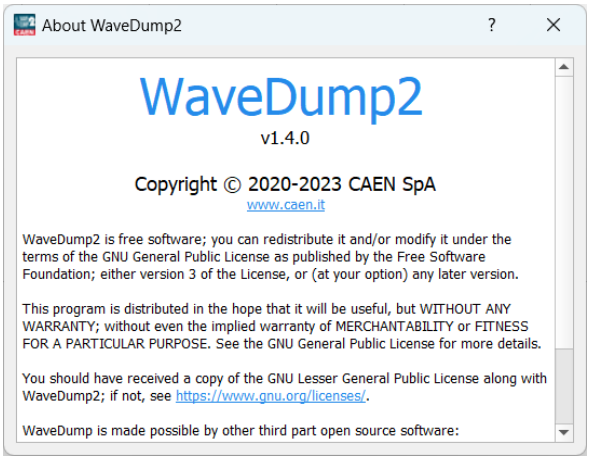


Fig. 10.7: The About WaveDump2 window

Info
The Name of the software
The software release number and Copyright information
The link to the Company's official website

Tab. 10.2: About WaveDump2 window info table

11 Icon Bar

Part of the functions in the Icon bar is also accessible through the Menu bar (see Chap. **10**).

Fig. 11.1: The Icon bar

Icon	Name	Function	Notes
	Discovery devices	Scans the devices available for the connection on the USB and Ethernet links	COMING SOON
	Connect to device	Connects WaveDump2 to a device	Ref.: Chap. **6**
	Disconnect device	Disconnects a device	Ref.: Chap. **7**
	Load configuration file	Loads a previously saved Configuration file	Ref.: Chap. **21**
	Load settings file	Loads a previously saved Settings file	Ref.: Chap. **22**
	Save and Save As configuration file	Save to file (.wconf) the current configuration	Ref.: Chap. **21**
	Start/Stop saving as a setting file	Start/Stop savings to a script file (.wsets) the current settings sequence	Ref. Chap. **22**
	Show/Hide Device Manager	Shows or hides the Device Manager panel	Ref.: Chap. **14**
	Show/Hide Log Window	Shows or hides the Log Window	Ref.: Chap. **15**
	Show/Hide Manual Controller	Shows or hides the Manual Controller panel	Ref.: Chap. **0**
	Show/Hide Statistics	Shows or hides the Statistics panel	Ref.: Chap. **19**

Tab. 11.1: Icon bar description table

12 Control Panel

Just below the Icon bar in the WaveDump2 mainframe, there is the Control panel with a set of general buttons and settings referred to as the active device and plot.

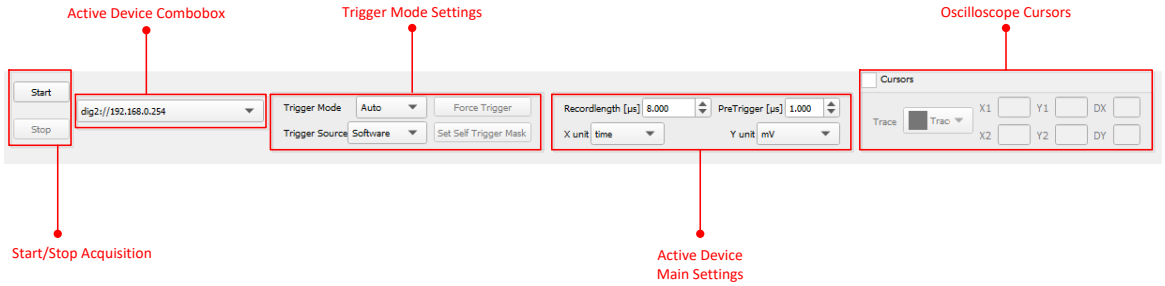


Fig. 12.1: The Control Panel

The panel shows the name of the active device in the "Active Device Combobox". Then, "Recordlength" and "PreTrigger" parameters for the active device can be set here, which affect the plot (see Chap. **13**). The same is for the axis's unit settings ("X unit" and "Y unit").

The Control panel also contains the "Start" and "Stop" acquisition buttons (see Chap. **18**) and allows enabling of the plot cursors (see Chap. **13**).

In case of multiple devices connected, the "Active Device Combobox" contains all the device names (see Chap. **6**), and selecting a new one will set it as the active device. In this case, all the settings are automatically updated and become relative to the new active device.

It is possible to get a list of the main features of the active device by selecting *File → Show active device info* from the Menu bar (see Sec. **10.1.6**).

When more than one device is connected, the combo box also contains the "ALL" option. This option can be selected to start/stop the acquisition for all the devices at the same time, or to apply some settings to all of them. If one or more parameter values are different among the connected devices, the Control panel widgets will be colored in red and will not show any value (see **Fig. 12.2**). When a new value is set, it will be applied to all the connected devices.

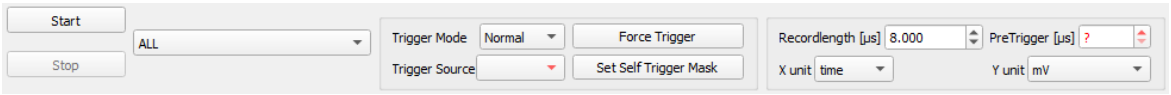


Fig. 12.2: Control panel with the "ALL" option selected; the connected devices have different values for "Trigger Source" and for "PreTrigger"

Together with the "Recordlength" and "PreTrigger" parameters, other active device settings placed in the Control panel are the "Trigger Mode" and "Trigger Source" functions as well as the "Force Trigger" and "Set SelfTrigger Mask" buttons, which are all described in Chap. **18**.

Note: Digitizer 1.0 do have the post-trigger parameter defined in the firmware instead of the pre-trigger. In this case, the pre-trigger that is set here is the difference between the record length and the post-trigger parameter.

13 Plot Panel

The Plot panel occupies the middle of the WaveDump2 mainframe (see **Fig. 9.1**). It provides all the main features and controls of an oscilloscope, and up to 8 traces can be displayed at the same time.

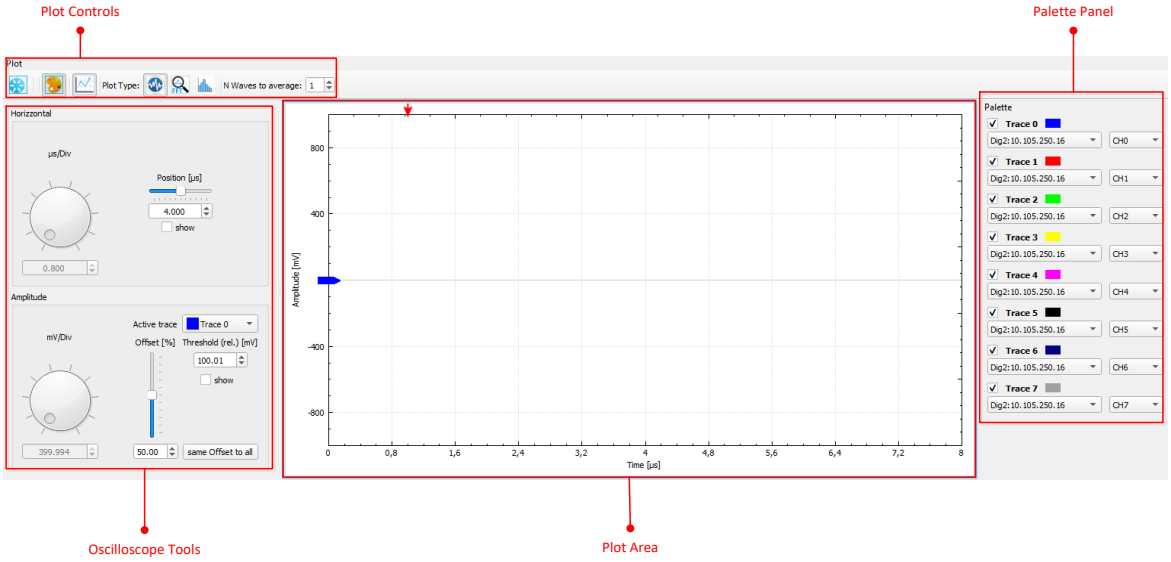
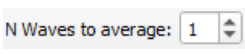


Fig. 13.1: Plot panel section where the "Oscilloscope Tools" and the "Palette Panel" are active.

13.1 Plot Controls

The main controls of the plot are accessible through a set of buttons described in the following table.

Icon	Name	Function	Notes
	Freeze button	This button stops and restarts the automatic replot when data acquisition is active. This option can be useful, for example, to perform measurements on the last acquired waveforms.	Only the plot is affected, while data acquisition goes on in the background.
	Palette button	This button shows/hides the Palette panel	See Sec. **13.2**
	Tools button	This button shows/hides the Oscilloscope Tools panel	See Sec. **13.3**
	Plot type buttons	These three buttons switch from one plot type to another. Allowed plot types are Waveforms, FFT, and Samples Histogram	See Sec. **13.4**
	N waves to average control	This control selects the number of waveforms to be averaged for a single plot. This feature is active only for Waveforms and FFT plot types; a new replot is executed when the specified number of collected waveforms has been reached.	See Sec. **13.4**

Tab. 13.1: Plot buttons description table

Other plot controls are part of the Control panel (see Chap. **12**):

- Recordlength and PreTrigger settings
- Cursor control

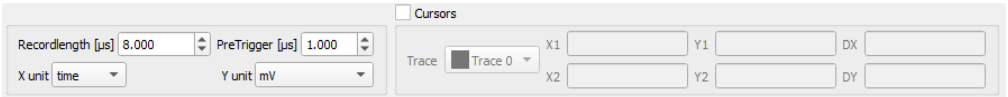


Fig. 13.2: Plot controls included in the Control panel

The "Recordlength" determines the maximum range of the plot x-axis, while the "PreTrigger" value is represented on the plot by a down red arrow indicating the horizontal position of the trigger in the waveform.

Note: The Recordlength parameter is limited by software at the maximum value of 6250000 samples.

The axes units ("X unit" and "Y unit") are set by default to time (µs) for the x-axis and mV for the y-axis, but it is possible to change them to samples and LSB, respectively.

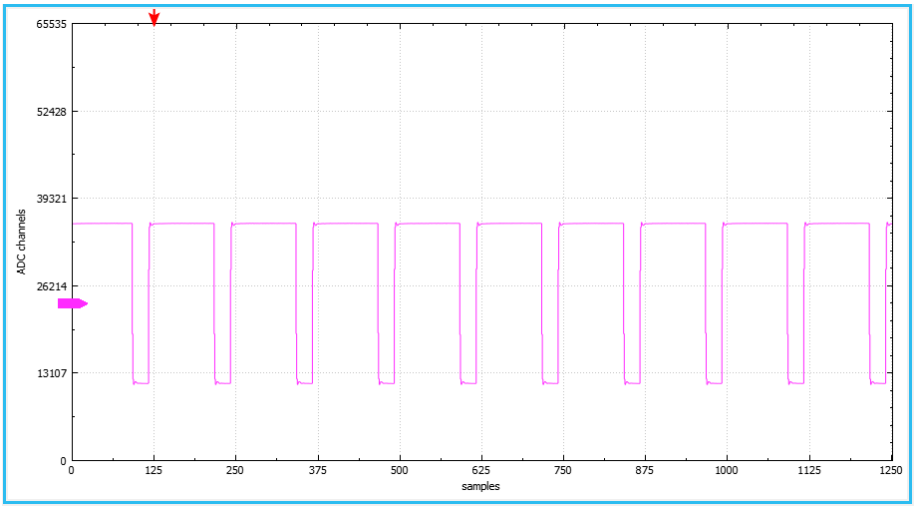


Fig. 13.3: Plot example of a waveform with the default axes units (ADC channels means LSB), "Recordlength" set to 1250 samples, and "PreTrigger" set to 125 samples.

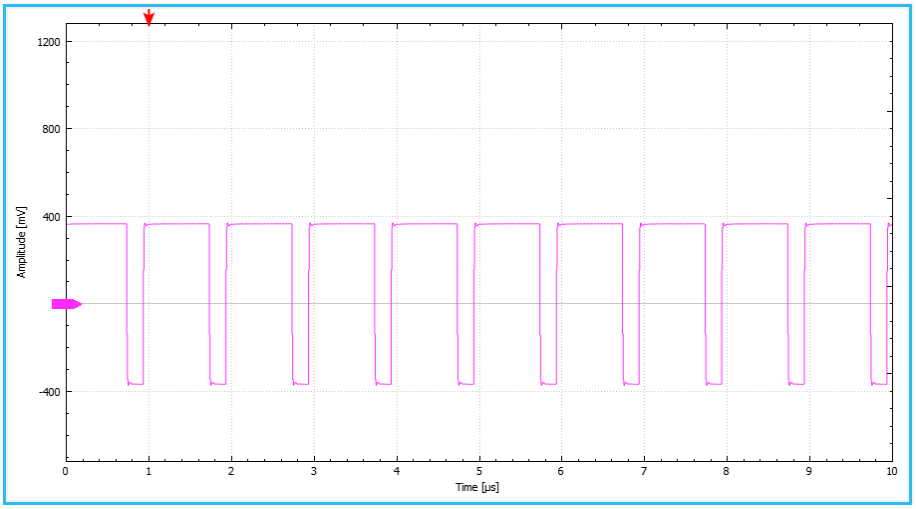


Fig. 13.4: Plot example of the same waveform with the axes units set to mV and Time (µs), "Recordlength" set to 10 µs, and "PreTrigger" set to 1 µs.

By checking or unchecking the "Cursors" checkbox, the oscilloscope cursors can be enabled or disabled, respectively. Once enabled, each of the two cursors can be selected and dragged horizontally to the desired position. The two cursors are associated with the active trace (indicated in the "Cursors" section): they automatically adopt the coordinate axes of the graph and a tracer updates its position to be on the graph data. This means that the horizontal position is controllable by the user, but the value will follow the graph data. X and Y coordinates and horizontal and vertical distances are shown and updated on the dedicated line edits (see **Fig. 13.5**).

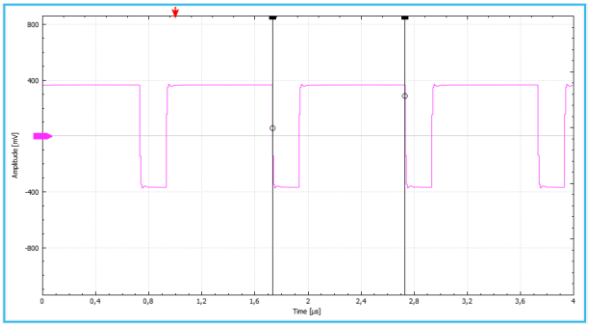


Fig. 13.5: Plot example with cursors enabled (left). The graph coordinates are shown in the corresponding fields as well as the horizontal distance between the cursors and the vertical distance between the cursor tracers (right).

13.2 Palette Panel

The Palette panel can be opened/closed through the “Palette” button (see **Tab. 13.1**) and manages the plot graphs (see **Fig. 13.6**). The traces can be enabled/disabled by checking/unchecking the corresponding checkbox, and the associated color can be changed by clicking the colored square button. For every trace, it is possible to select which input channel of which connected device to associate by the relevant combo box.

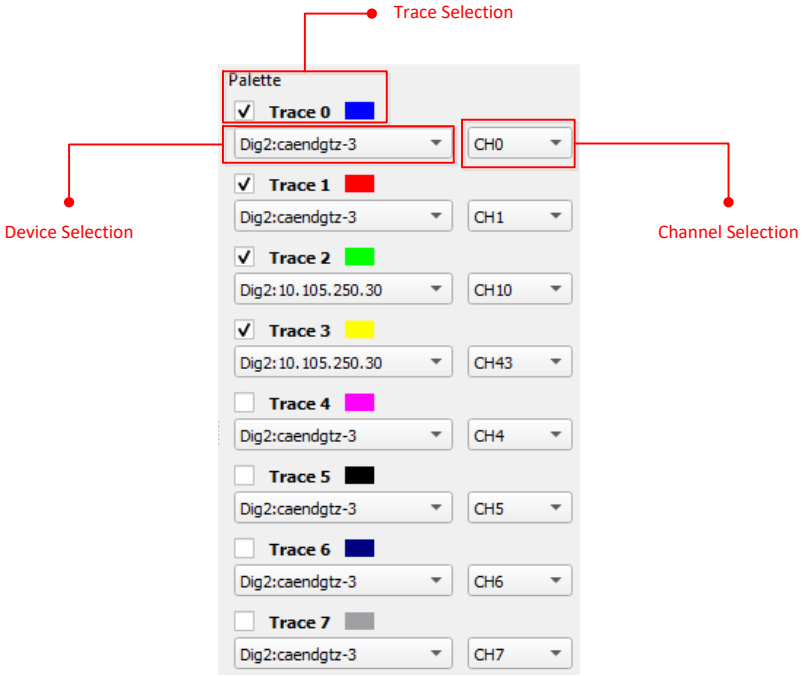


Fig. 13.6: The Palette Panel. Only three traces are enabled. Trace 0 is blue and associated with channel 0 of the device named *Dig2:caendgtz-3*. Trace 1 is red and associated with channel 1 of the same device as Trace 0. Trace 2 is green while Trace 3 is yellow, and they are associated with channel 10 and channel 43 respectively of the device named *Dig2:10.105.250.30*

13.3 Oscilloscope Tools Panel

The Oscilloscope Tools panel can be opened/closed through the “Tools” button (see **Tab. 13.1**). It contains all the controls, horizontal and vertical, like a common oscilloscope (see **Fig. 13.7**):

- Active Trace selection
- Horizontal and vertical zoom (in/out) on the active trace (they are pure software settings)
- Position control on the active trace (it is a pure software setting)
- Channel baseline level adjustment on the active trace (it controls the related hardware setting)
- Trigger threshold setting and visualization on the active trace (it controls the related hardware setting)

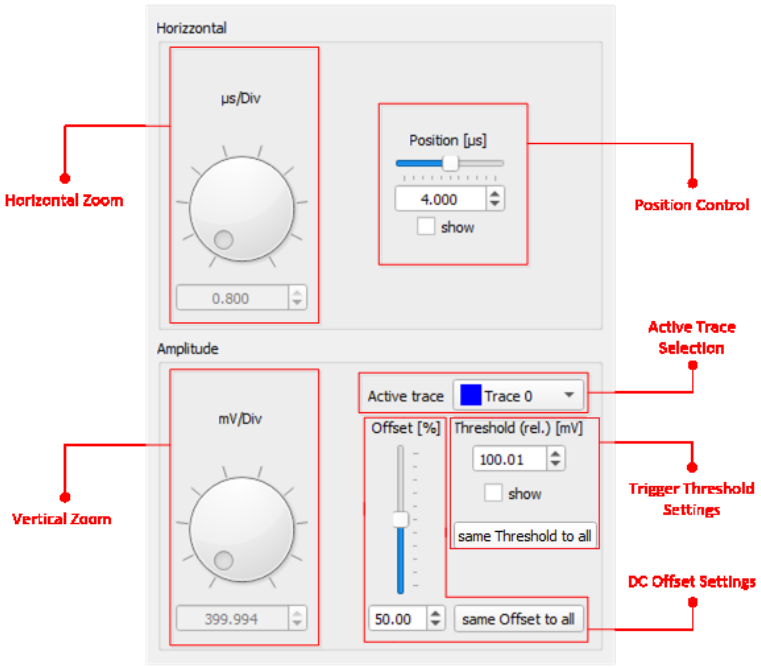


Fig. 13.7: The Oscilloscope Tools panel

The WaveDump2 plot provides a grid of lines that serves as reference marks for measuring the displayed traces. The grid defines ten divisions on the x-axis and five divisions on the y-axis. The length of a single-axis division expressed as µs/Div (or Samples/Div) and mV/Div (or LSB/Div), is shown under the corresponding dial on the Tools panel.

The software zoom in/out can be set through the relevant knob and the value is visualized in the text box below. The effect on the horizontal or vertical axis is to decrease/increase the width of a single-axis division.

For the horizontal axis zooming, the Position control allows the selection of the zoom middle position. The middle position can be set visible on the plot by checking the “show” combo box, then it is identified by a vertical light blue line. The position can be changed by using the corresponding slider or by manually entering the new position value in the text box, possibly fine-tuning by the side up/down arrows (see **Fig. 13.8**).

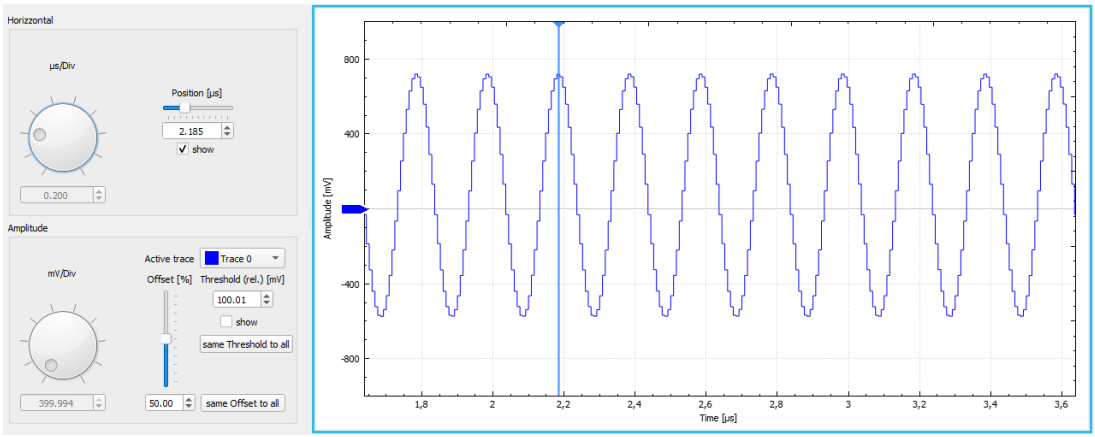


Fig. 13.8: Plot example with a horizontal zoom active. The zoom middle position has been set manually to 2.185 µs and the corresponding vertical line marker is shown. A single x-axis division corresponds to 0.2 µs

The remaining oscilloscope tools control the baseline level (“Offset”) and the trigger threshold (“Threshold”) setting on the active trace, which is selected through the “Active trace” combo box. Using the “same Threshold to all” button, it is possible to set the same threshold to all the channels of the same connected device that are associated to the plot traces.

The trigger threshold in an absolute value (i.e. referred to the zero of the ADC scale) for Digitizer 1.0, while it is relative to the baseline level in the case of the Digitizer 2.0 (i.e. it can be negative or positive).

The baseline of the active trace is expressed as a percentage of the input range and can be adjusted using the vertical slider or manually entering a new value in the relevant text box. It is possible to apply the same baseline settings to all the enabled traces at once by the “same offset to all” button.

When the Y unit is set on [LSB], the scale is absolute, and the baseline of each enabled trace moves to the correspondent percentage value set for the DC Offset parameter in the GUI. When the Y unit is set on [mV], the scale is relative in the sense that the zero of the Y-axis coincides with the baseline of the channel of the active trace, and all other signals are displayed with respect to it.

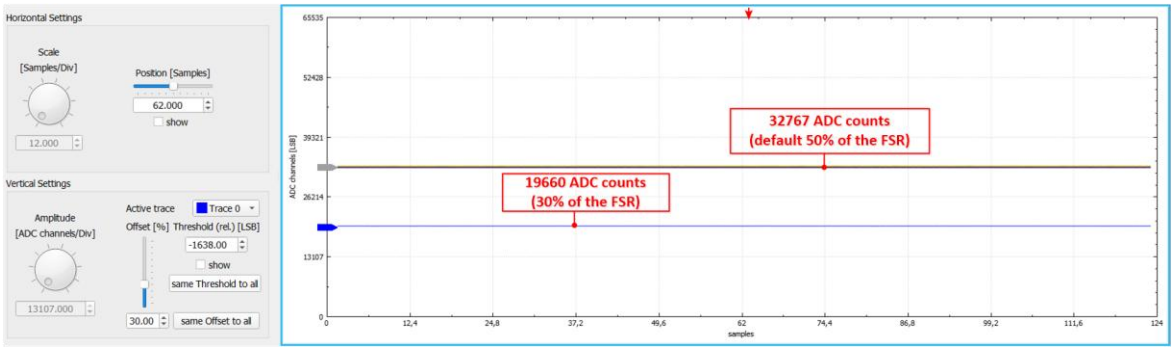


Fig. 13.9: Plot example with the Y-axis unit expressed LSB and Offset parameter for active Trace 0 set on 30%.

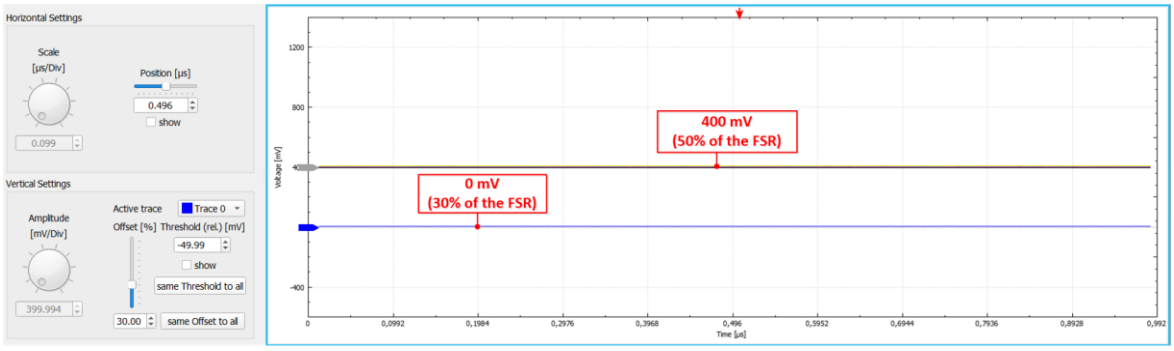


Fig. 13.10: Plot example with the Y-axis unit expressed in mV and Offset parameter for active Trace 0 set on 30%.

The trigger threshold, expressed in mV or LSB, is related to the baseline. By checking in the relevant “show” check box, it can be shown in the plot as a dark yellow horizontal line and marked by an arrow pointing to the left (see **Fig. 13.11**).

Note: In the case of **Digitizer 1.0**, the trigger threshold is absolute, instead. This means that the value is always referred to the 0 ADC count level.

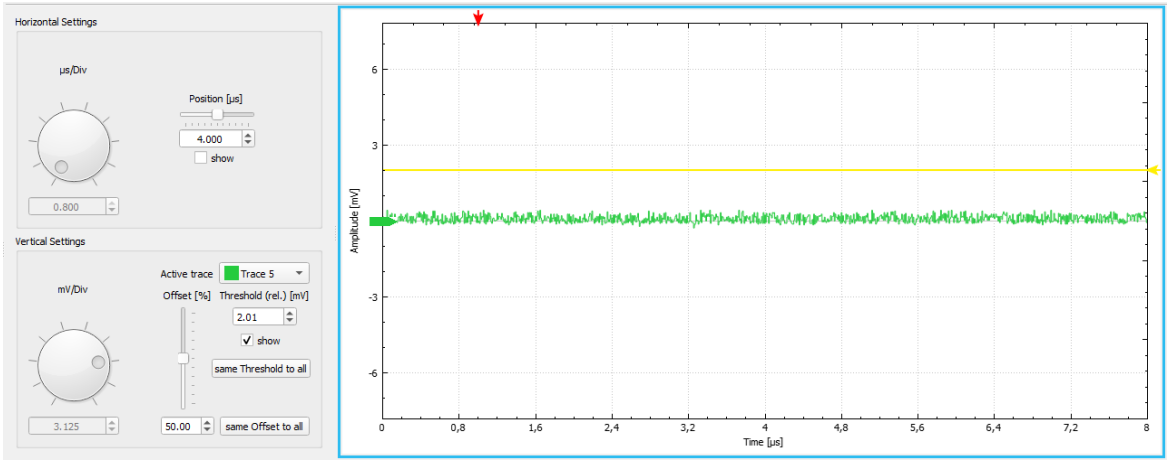


Fig. 13.11: Plot example with a vertical zoom active. The zoom center position is given by the baseline level of the active trace. A single y-axis division corresponds to 3.125 mV and the active trace threshold is visible and is set to 2.01 mV

When a vertical zoom is applied, it will always be related to the active trace: the zoom center in the vertical direction is given by the baseline level of the active trace, which is indicated by a marker of the same color as the trace itself. While zooming, some traces could so go out of sight becoming no more visible on the plot. In this case, the active trace can be changed: the plot y-axis range is updated and becomes centered on the new active trace baseline.

If the oscilloscope tools panel is closed, different user interactions become available and allow the zoom in and out on the graph plot by the User:

- By holding the Ctrl button on the keyboard and selecting a rectangular region using the mouse
- By positioning the mouse pointer on the x or y-axis and using the mouse wheel (only that axis is zoomed)
- By positioning the mouse pointer inside the plot and using the mouse wheel (both axes are zoomed, and the enlarged region is centered on the mouse pointer position)

13.4 Plot Types

The plot type can be selected using the “Plot type” buttons (see **Tab. 13.1**) and can be changed also runtime when data acquisition is active.

WaveDump2 supports three different kinds of plots:

- *Waveforms* is the standard plot type showing the waveforms as recorded by the digitizer input channels. It is possible to plot the average of a given number of waveforms (“N waves to average” control). In this case, the replot rate can be lower as a new replot occurs only when the selected number of waveforms has been collected.
- *FFT* shows the Fast Fourier Transform of the signal to analyze it in the frequency domain. In this case, it is also possible to plot the average of a given number of FFTs.
- *Samples Histogram* is filled with the waveform sample values. The histogram is continuously updated while data acquisition is running.

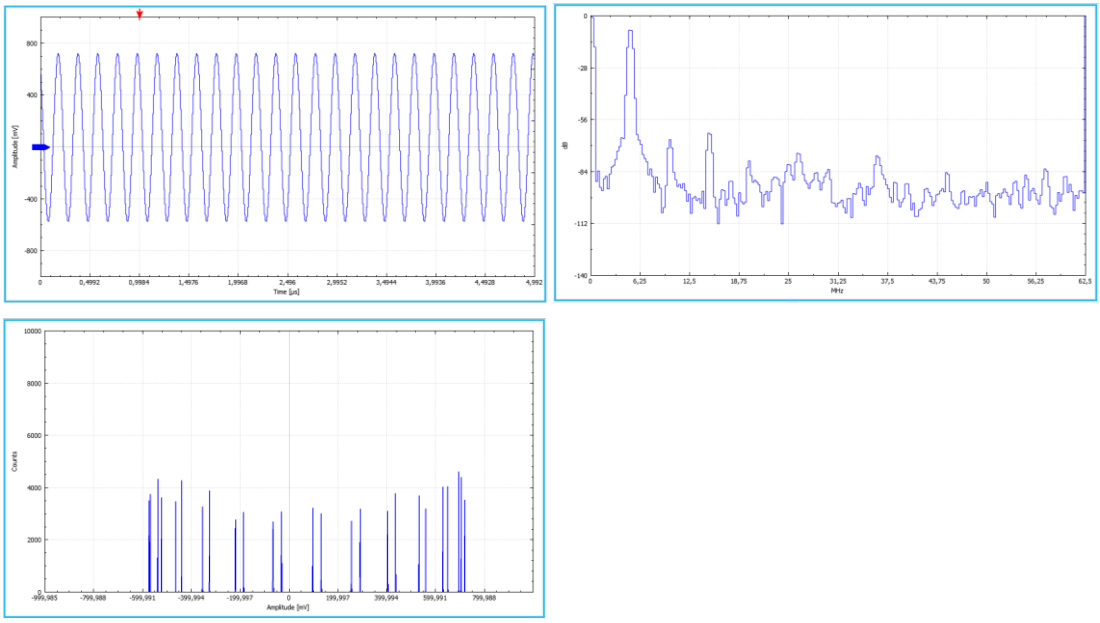
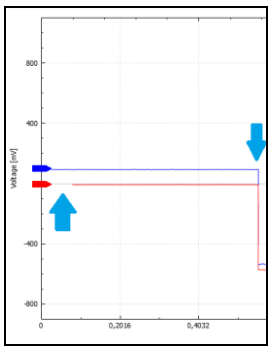


Fig. 13.12: Plot examples for an input sinusoidal signal connected to the active trace. Waveforms plot on the top left, FFT plot on the top right, and Samples Histogram plot on the bottom left

Note that, in the Waveforms type and only in the case of acquisition from multiple synchronized boards, the software applies an automatic compensation for hardware effects like the jitter between the clock and the common trigger, and the skew due to the run propagation, depending on how these signals are propagated through the system. The jitter compensation is hardcoded and applies only to the plot visualization, while the waves recorded in the output file are always raw (uncompensated). The run delay applies both to the plot and the timestamp of the events saved into the output file/s. If necessary, the User can set the *RunDelay* parameter by the Manual Controller (Chap. **17**) or in the Sync_Preset relevant file (Chap. **3**).

Fig. 13.13: Graphical effect of the software compensation on the plot of two waveforms when the same pulse is split and fed to two channels of the digitizer to demonstrate the synchronization.



14 Device Manager Panel

The Device Manager panel can be opened/closed using the relevant button in the Icon bar (see Chap. **11**) or by the "Window" drop-down menu in the Menu bar (see Sec. **10.5.1**).

This panel allows exploring the full device tree to see the list of the device or channel parameters, and to get all the info about them. When one parameter or feature is selected from the tree, the Property table is filled with all the corresponding info, such as the allowed values or the minimum and maximum values, the unit of measurement (if defined), the access type, and the query string. Besides, a short description of the selected element is provided (see **Fig. 14.1**).

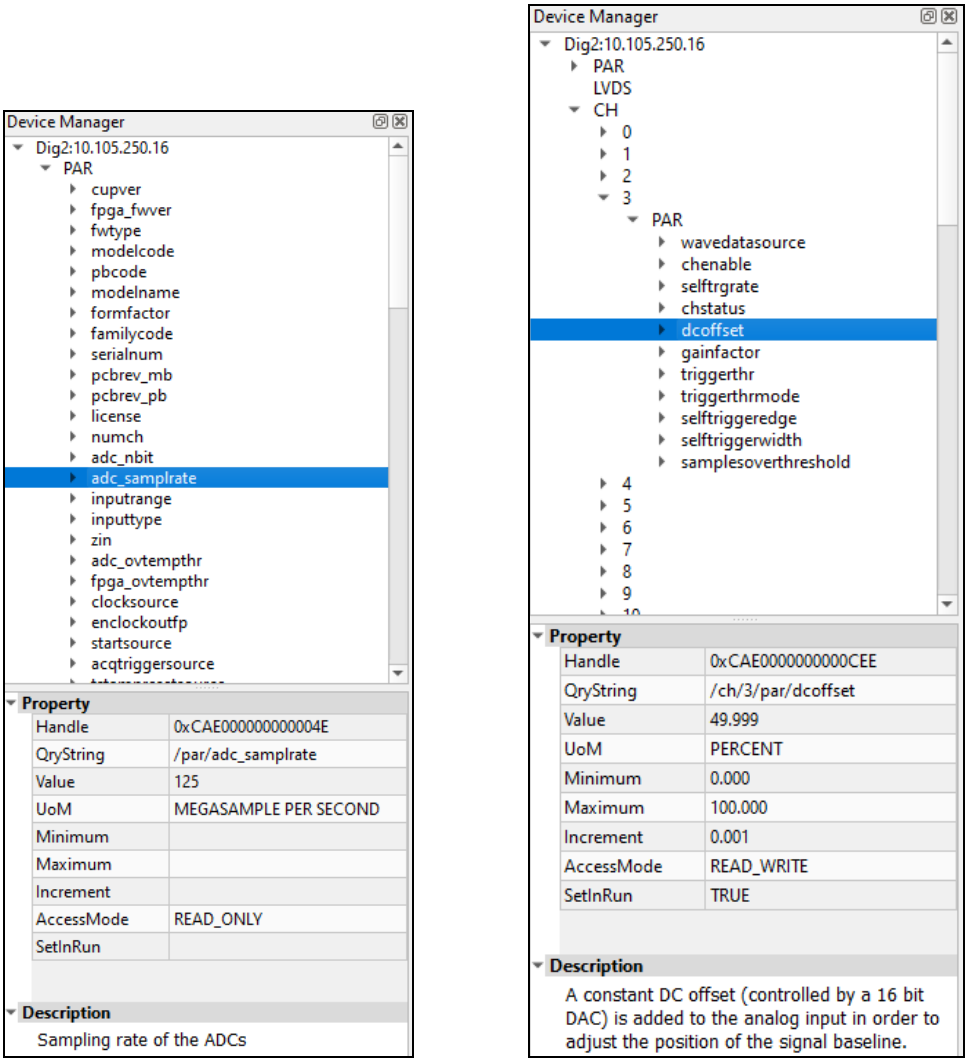


Fig. 14.1: The Device Manager panel showing info about the *adc-samplrate* device parameter (on the left), and about the *dcoffset* parameter of channel 3 (on the right)

From the Device Manager panel, it is also possible to change the current value of the selected parameter. If the parameter is not read-only, the "Value" row of the Property table is enabled, and it is possible to enter a new value by double-clicking on it. If multiple specific values are allowed for the parameter, then the "Value" row is converted into a combo box where it is possible to select the desired option.

Note that, just like for the Device Manager, any manual change of one or more parameters should be executed with caution.

15 Log Panel

The Log panel (**Fig. 15.1**) can be opened/closed using the relevant button in the Icon bar (see Sec. **11**) or by the "Window" drop-down menu in the Menu bar (see Sec. **10.5.2**).

Opening Wavedump2, the Log panel is shown by default, but it can be closed at any moment just like the other panels.

Fig. 15.1: The Log panel

The Log panel sequentially lists all the commands issued by WaveDump2 to the connected devices, including the positive or negative results. In case of errors, it is possible to see the last action successfully executed and the one that caused the error.

The Log panel is synchronized with a log file, *WD2Log.txt*, generated by WaveDump2 in:

- *C:\Users\<USER>\AppData\Roaming\WaveDump2* folder in the case of Windows OS

  (note that AppData could be a hidden folder, so it is required to enable the "show hidden files and folders" option in Windows directory management).

- */home/<USER>/.local/share/WaveDump2* folder in the case of Linux OS.

16 Errors Monitor

The software automatically checks for possible errors reported by the connected devices and for possible connection problems. Error events are flagged in the Bottom bar (see Sec. **9.7**).

If there is no error to report, a green LED is visible at the bottom-right corner of the GUI.

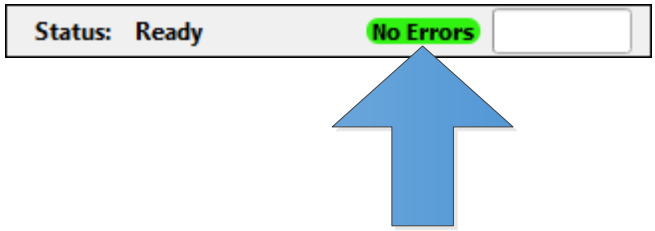


Fig. 16.1: Green Error LED

In the case of connection a connection error, when the connection with a device is lost, an error message is shown, and the device is deleted from the list of connected devices.

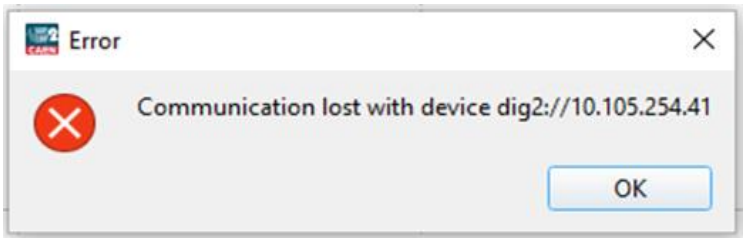


Fig. 16.2: Communication lost error message

Once the connection problem has been solved, it is possible to reconnect the device to the software.

Furthermore, if one of the connected devices reports one or more errors, the software shows a specific message.

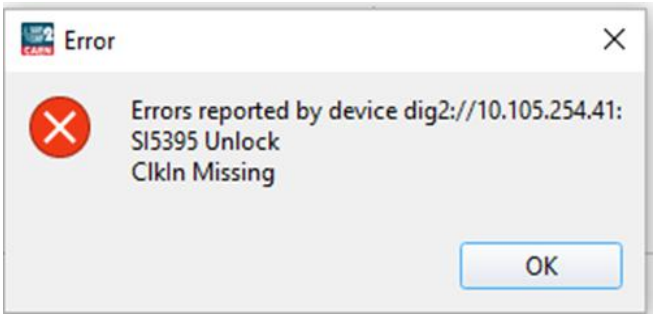


Fig. 16.3: Multiple errors message

In this case, the LED becomes red and alerts the User that something is wrong with one or more devices.

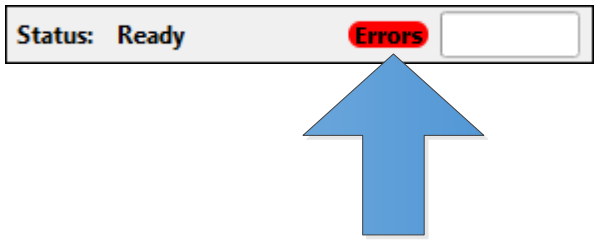


Fig. 16.4: Red Errors LED

The error message can be closed, but the status of the LED does not change until the error disappears.

PLL lock loss and overtemperature events are also detected.

Errors from on the active device(s) are logged in the Error Log window (see Sec. **10.1.7**).

If ALL is selected (see Chap. **12**), the errors from all the connected devices are reported, if any

16.1 Overtemperature Event

To preserve hardware damages, the Digitizer 2.0 and some Digitizer 1.0 (especially, 725 and 730 series) implement automatic protection from over-temperature events.
WaveDump2 manages this mechanism and dynamically monitors the temperatures of the critical components (see Sec. **10.1.6**), the same as it is done by the Web Interface **[RD4]**.

In the case of an excessive overheating, referring to a temperature limit that is fixed in the firmware, the following steps automatically take place on the connected device:

- The FAIL red LED on the device front panel lights up **[RD4][RD3];**
- All the critical hardware components, including the ADCs, are shut down;
- If an acquisition was in progress, the run is stopped (any data stored up to that point can still be retrieved).

In these conditions, WaveDump2 shows an overtemperature alert message (see **Fig. 16.5**), sets the Error flag (see Chap. **16**), and disconnects the device. The communication with the Digitizer is still possible by the Web Interface only for diagnostics.

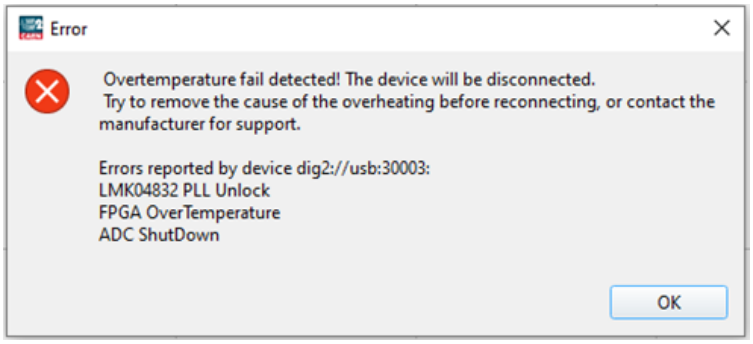


Fig. 16.5: Overtemperature message

IN THE EVENT OF OVERTEMPERATURE, TRY TO REMOVE ANY POSSIBLE EXTERNAL CAUSE OF OVERHEATING.
CONTACT CAEN SUPPORT IF THE CONDITION PERSISTS.

BEFORE STARTING A NEW RUN FOLLOWING AN OVERTEMPERATURE EVENT, A DIGITIZER RESET OR POWER CYCLE IS STRICTLY REQUIRED!

Trying to connect the device to the software, if it did not exit the overheating condition, or it was not reset/power-cycled yet, another alert message shows up (see **Fig. 16.6**).

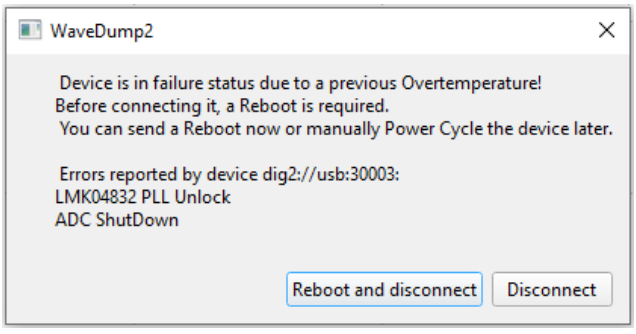


Fig. 16.6: Reset device message following overtemperature event.

17 Manual Controller Panel

The Manual controller panel (**Fig. 17.1**) can be opened/closed using the relevant button in the Icon bar (see Sec. **11**) or by the "Window" drop-down menu in the Menu bar (see Sec. **10.5.3**).

Fig. 17.1: The Manual Controller Panel

This panel can be used for test or as an advanced tool for expert users. In fact, it allows to manually read or modify the current values of the device parameters (from the Dig2 or the Dig1 library) or send supported command to the target digitizer. It is so required knowledge of the specific device settings and the corresponding query strings.

Note: The Dig2 parameter and command documentation is integrated into the CUP file and readable in the Web Interface from v1.2.0 on, where it can also be downloaded to disk as PDF file. The Dig1 documentation can be consulted in html format inside the library installation folder.

Note: The Dig2 parameter and command documentation is integrated into the CUP file and readable in the Web Interface from v1.2.0 on, where it can also be downloaded to disk as PDF file. The Dig1 documentation can be consulted in html format inside the library installation folder. From revision 1.3.0, the manual controller has been integrated also in the Web Interface for Dig2 parameters only.

Usage:

- Select between the connected devices in the "Device" combo box.
- To read out a parameter, type in the "QueryString" lineedit using the syntax: */par/<parameter>* for common parameters; */ch/<ch_number>/par/<parameter>* for channel parameters. Then, press "Get" and the current value is echoed in the "Value" text box.
- To modify a parameter, type in the "QueryString" lineedit using the syntax: */par/<parameter>* or */ch/<ch_number>/par/<parameter>*. Select the new value in the "Value" slide menu or type it in the text box, then press "Execute" to modify.
- To send a command, type in the "QueryString" lineedit with the syntax: */cmd/<command>*. Then, press "Send Command" to execute.

Note that this tool should be used with caution because some settings might cause undefined behaviour in both the software and the device.

18 Data Acquisition

For Digitizer 2.0, a first and simple approach to acquiring input signals through WaveDump2 can be found in the Digitizer User Manual **[RD2] [RD4]**.

Once a device or more devices have been configured, data acquisition can be controlled from the Control panel (see Chap. **12**).

The acquisition can be started and stopped for one device only or all the connected devices at once (**Fig. 18.1**). In the latter case, it is necessary to choose the "ALL" option from the Control panel combo box.

Fig. 18.1: The Start/Stop acquisition settings for a single device (on the left) and all devices at once (on the right)

18.1 Trigger Source

Before starting the data acquisition, the Trigger Source in the Control panel should be set for the device(s) that will start acquiring data. The options are:

- *Software*. The software trigger, generated by the software at a fixed frequency, forces the board to get events simultaneously from all the enabled channels (global trigger). This trigger source is mainly intended for debugging purposes or to help settings the configuration parameters for the target application.
- *Self*. The self-trigger is based on the device's capability of generating a trigger when a programmable threshold is crossed by the input pulse. This is a global trigger source: if at least one channel crosses the threshold, then all the enabled channels get events.
- *Ext-TrgIn*. This option programs the device to sense the external signal (TTL or NIM) on the TRG-IN front panel input as the global trigger.
- *Ext-GPIO* (Digitizer 2.0 only). This option works as the Ext-TrgIn one but senses the external signal on the GPIO front panel connector (TTL or NIM) programmed as input.
- *Internal* (Digitzer 2.0 only). The internal trigger source is a programmable square wave that can be used as an internal periodic trigger, mainly for test purposes. The wave configuration must be done by the Manual Controller (Chap. **17**).

More information about the trigger sources can be found in the FELib Scope Parameters **[RD7]**.

If the *Self* option is selected, it is possible to set the channels to be ORed to generate the global trigger in the self-trigger channel mask (**Fig. 18.2**).

By using the "Set Self Trigger Mask" button in the Control panel, it is possible to set the mask of the channels participating in the global trigger generation: in the opening dialog (see **Fig. 18.2**), click on the number to enable/disable the relevant channel or click on "Select All" for all the channels at once. Press the "Ok" button to confirm. The global trigger will be the OR of the self-triggers from the selected channels.

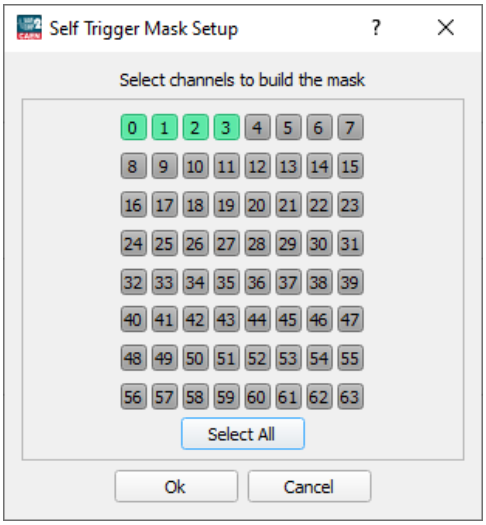


Fig. 18.2: The Self-trigger channel mask where channels 0 to 3 are enabled for the self-trigger.

18.2 Trigger Mode

In a very similar way to the oscilloscope, the Trigger Mode setting in the Control panel determines upon which signal condition a new waveform is drawn (see **Fig. 18.3**).

The allowed trigger modes are:

- *Auto*. This mode causes the oscilloscope to sweep, even without a trigger. The software tries waiting for a new event from the device and, if no event is detected after a timeout of 500 ms, a software trigger is sent.
- *Normal*. In this mode, the oscilloscope sweeps only if a new trigger is generated by the device and a new event is available. It is still possible to manually send a single software trigger by using the "Force Trigger" button.

Fig. 18.3: Two different options for the trigger settings: on the left, the device trigger source is set to *Software* and the trigger mode is set to *Auto*; on the right, the *Self* trigger source is active, and the trigger mode is set to *Normal*

Note: Trigger Mode is a pure software setting, so it cannot be saved in a configuration file (see Chap. **21**), while it is saved (and loaded) in a settings file (see Chap. **22**). Remind to possibly set the Trigger Mode before or after loading a previously saved configuration file

19 Statistics Panel

The Statistics panel can be opened/closed using the relevant button in the Icon bar (see Sec. **11**) or by the "Window" drop-down menu in the Menu bar (see Sec. **10.5.4**).

This panel collects runtime all the information about the current data acquisition for every connected device.

Statistic	Description
Device	String identifying the connected device.
Acq Time	Acquisition time. Resets with the start acquisition.
Read Evts	Event counter. Incremented with every event read out from the connected device.
Proc Evts	The counter of the events processed by the software. Incremented when the event meets the coincidence condition set in Build Matching Window.
Lost Evts	Counter of the not accepted events (triggers) due to a memory full.
Build Miss Events	Meaningful only if a sync start mode is set with Full Multiplicity enabled (see **Tab. 20.5**). It is the counter of the events not meeting the coincidence condition set in "Build Matching Window".
ICR [kcps]	Incoming Count Rate.
Throughput [MB/s]	Device throughput. Estimated as: ICR * Record Length * Nr of Bytes per sample * Nr of enabled channels
Status	Acquisition flags: Ready (ready for acquisition); Running (acquisition in progress); Busy (channel memories are full; **To Be Implemented**).
Run ID	Identifier of the current run. Incremented on each start acquisition.
Global Evts	Meaningful only if a sync start mode is set with Full Multiplicity enabled (see **Tab. 20.5**). It is the counter of the synchronized events built by the software each time the timestamps from the connected devices related to the same event ID meet the coincidence condition set by Build Matching Windows.
Tot MBytes Read	The overall amount of data read out by the software. Estimated as: Read Evts * Record Length * Nr of Bytes per sample * Nr of enabled channels * Nr of connected devices
Out of Sync Evts	Counter of the non-synchronized events. It counts the build missing events from all the connected devices.

Tab. 19.1: Table of Statistics information

The Statistics panel during an acquisition run of a single device is shown in **Fig. 19.1**: after 48 seconds (*Acq Time*), a total of 34353 events have been detected (*Read Evts*) and processed (*Proc Evts*), but a huge number of events got lost (*Lost Evts*) due to the high trigger rate (i.e. the device is busy).

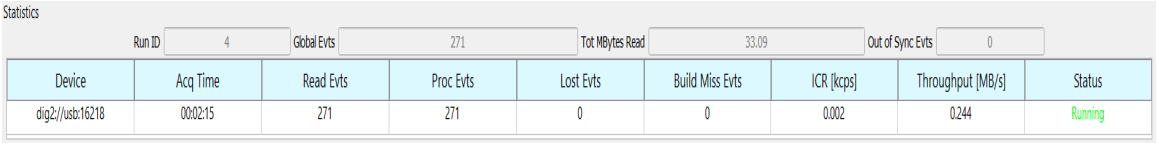


Fig. 19.1: The Statistics panel in case of a single device acquisition

In **Fig. 19.2**, the data acquisition has been started simultaneously for the two connected devices (not synhcronized). The first device acquires upon the external trigger source, while the second one is upon software-trigger. This results in two very different readout rates, and it is also the reason why there are a lot of *Build Miss Evts* for the first device: the software builds global events collecting one event (if available) from every running device and, in this case, most of the times no data was available from the first device.

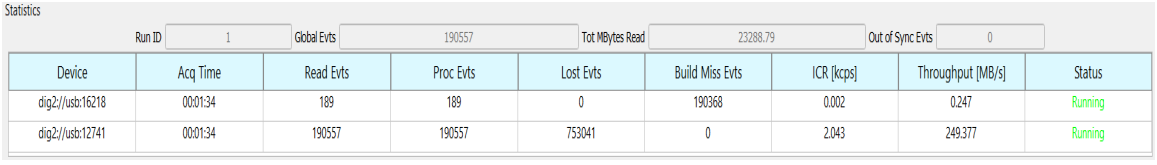


Fig. 19.2: The Statistics panel in case of two-device acquisition

Note: In the case of USB-3.0 connection in Linux OS, experiencing a readout rate much lower than 280 MB/s (declared in the hardware specifications **[RD1] [RD3]**) could be related to the value of the MTU parameter set in the operating system. Linux usually sets an MTU of 1500 by default, while the declared maximum rate has been tested with an MTU of 15000.

20 Device Configuration

According to what is described in Chap. **12** and Sec. **13.3**, some key device settings can be managed from the Control panel and the Oscilloscope Tools panel, but WaveDump2 provides the complete configuration of the connected devices in a dedicated GUI accessible from the Main menu (see Sec. **10.2**):

- By selecting a device from the list of connected devices, the configuration GUI for that device is opened (see Sec. **10.2.2**).
- By selecting the Setup Configuration option (see Sec. **10.2.1**), the system settings GUI is opened, which contains as many tabs of settings as the connected devices. It is then possible to individually configure each device or to apply the same settings to all the devices.

The configuration GUI content is slightly different for Digitizer 2.0 and Digitizer 1.0, and specific for every digitizer model.

20.1 Configuration GUI for the Digitizer

The configuration GUI is divided into two sections: the Board settings and the Channels settings.

The software parameters here described find reference in the Scope firmware parameters of the FElib library **[RD7]**.

20.1.1 Board Settings Section

The Board settings section is organized into two tabs: the Main settings tab and the Advanced tab.

The Main settings tab contains all the most important settings that the User must configure before starting the data acquisition (see **Tab. 20.1**. and **Tab. 20.3**).

The Advanced tab includes additional settings for expert users and extra options for the trigger and other supported functions (see **Tab. 20.2** and **Tab. 20.4**).

DIGITIZER 2.0

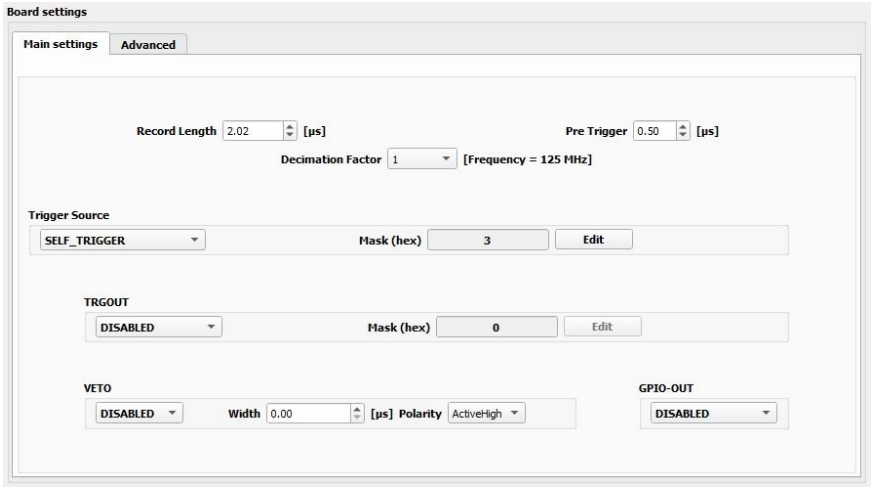


Fig. 20.1: Digitizer 2.0 - Main settings tab of the Board settings section

Setting	Description
Record Length	This parameter sets the width of the acquisition window in samples or time units (see Sec. **13.1**).
Pre Trigger	This parameter sets the pre-trigger value in samples or time units (see Sec. **13.1**).
Decimation Factor (2740/2745 only)	This parameter configures the "n" factor of the decimation function implemented in the firmware. Options are: 1 (no decimation), 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024. The 2740-45 digitizer still samples the inputs at 125 MHz, but the digitized samples will be stored into the memory at 125/n MHz. Pre-Trigger and Record Length values are automatically updated as well as the plot axes scale.
Trigger Source	This parameter selects the trigger source in the same way as in the Control panel (see Sec. **18.1**). In the case that the SELF-TRIGGER option is set, it is possible to configure the trigger Mask by clicking the "Edit" button.
TRGOUT	This section allows enabling the device TRG-OUT front-panel connector and selects the output signal: TRGIN, SELF-TRIGGER (with its channel mask), SIN, GPIO, and RUN.
VETO	The VETO section allows selecting a possible veto source for the acquisition, which can be either SIN, GPIO, or the LVDS option. The veto width can then be set in samples or time units, as well as the polarity of the veto signal (active high/low).

GPIO-OUT	In this section, it is possible to enable the GPIO front panel connector as output and set the output signal optionally as TRGIN, SELF-TRIGGER, SIN, GPIO, and RUN.

Tab. 20.1: Digitizer 2.0 - Main settings description

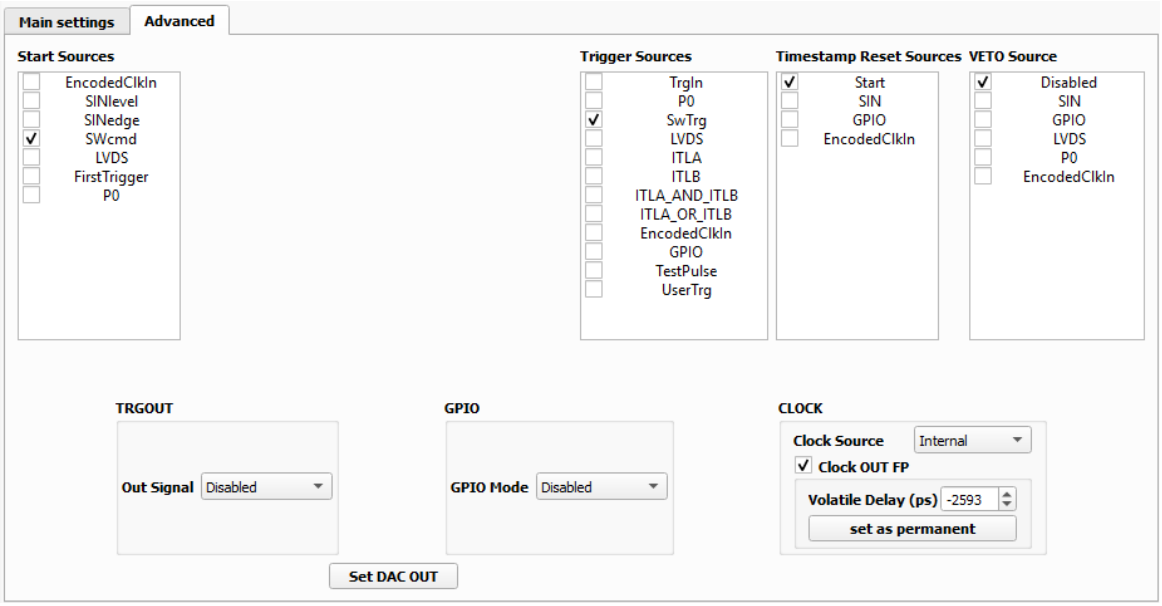


Fig. 20.2: Digitizer 2.0 - Advanced table of the Board settings section

Setting	Description
Start Sources	This setting configures the start-acquisition source. Options are: – *EncodedClkIn*. In the Master/Slave connection of multiple digitizers, the start acquisition is driven by the synchronization (SYNC) signal propagated on the CLKOUT/CLKIN connectors together with the clock. The start acquisition is given only to the Master that sets and keeps SYNC high. So, each slave starts the acquisition when SYNC is high and stops it when it is low (after the stop acquisition on a software command is issued to the Master). – *SINlevel*. The acquisition starts when the signal on the SIN connector is high and stops when it is low. – *SINedge*. The acquisition starts on the rising edge of the SIN signal (must be stopped on a software command). – *SWcmd*. The acquisition starts and stops on software command. – *LVDS*. The acquisition starts on a signal coming through the LVDS connector (must be stopped on a software command). – *FirstTrigger*. The acquisition starts on the rising edge of the first trigger pulse arriving at the TRGIN connector; the pulse is not used as a trigger, while actual triggers start from the second pulse on TRGIN (stop must be on a software command). – *P0*. The acquisition starts on a spare signal from the VME bus on the P0 digitizer connector (stop must be on a software command).
Trigger Sources	This setting configures the source of the common acquisition trigger. Options are: – *TrgIn*. The signal provided on the TRGIN digitizer connector. – *P0*. A spare signal from the VME bus on the P0 digitizer connector. – *SWTrg*. Forced trigger issued by software. – *LVDS*. The trigger signal comes through the LVDS connector. – *ITLA*. The trigger is the output of the ITLA self-trigger logic block. – *ITLB*. The trigger is the output of the ITLB self-trigger logic block. – *ITLA_AND_ITLB*. The trigger is the AND of the outputs from the ITLA and ITLB logic block. – *ITLA_OR_ITLB*. The trigger is the OR of the outputs from the ITLA and ITLB logic block. – *EncodedClkIn*. Not yet implemented – *GPIO*. The trigger is the signal on the GPIO connector programmed as input. – *TestPulse*. The trigger is an internal test pulse. – *UserTrg*. The trigger comes from the User Logic (related to the open FPGA).
Timestamp Reset Sources	This setting selects the way to reset the timestamp counter. Options are: – *Start.* Reset at each start of the run. – *SIN.* Reset on the leading edge of the SIN signal. – *GPIO.* Reset on the leading edge of the GPIO input signal. – *EncodedClkIn*. **Not yet implemented**
VETO Source	This setting selects the source of the veto for the acquisition.

	Options are: – *SIN.* The signal provided in the S-IN connector. – *LVDS.* The signal on the LVDS connector when programmed in Sync mode. – *GPIO.* The signal on the GPIO connector when programmed as input. – *P0.* The signal from the VME backplane. – *EncodedClkIn.* Not yet implemented. – *Disabled.* The veto is disabled.
TRGOUT	This setting selects the signal that is routed to the TRGOUT connector digital output. Options are: – *TRGIN.* TRGOUT is a delayed copy of the TRG-IN signal. – *P0.* TRGOUT propagates the P0 trigger. – *SwTrg.* TRGOUT propagates the software trigger. – *LVDS.* TRGOUT propagates the LVDS trigger. – *ITLA.* TRGOUT propagates the output of the ITLA internal logic block. – *ITLB.* TRGOUT propagates the output of the ITLB internal logic block. – *ITLA_AND_ITLB.* TRGOUT propagates the AND of ITLA and ITLB outputs. – *ITLA_OR_ITLB.* TRGOUT propagates the OR of ITLA and ITLB outputs. – *EncodeClkIn.* **Not yet implemented**. – *Run.* TRGOUT propagates the Run signal. – *RefClk.* TRGOUT is the 62.5MHz clock signal used for the phase alignment in multi-board synchronization. – *TestPulse.* TRGOUT is the internal Test Pulse. – *Busy.* TRGOUT propagates the Busy signal of the board. – *UserTrgout.* TRGOUT propagates the trigger coming from the User Logic (related to the open FPGA). – *Fixed0.* TRGOUT = 0 (low level). – *Fixed1.* TRGOUT = 1 (high level). – *SyncIn.* TRGOUT is the SyncIn signal. – *SIN.* TRGOUT propagates the S-IN signal. – *GPIO.* TRGOUT propagates the GPIO input signal. – *LBinClk. TRGOUT* is the Internal Logic B clock signal. – *AcceptTrg.* TRGOUT is the Accepted Trigger signal. – *TrgClk.* TRG-OUT is the Trigger Clock signal. – *Disabled*. TRGOUT is disabled.
Set DAC OUT	This setting programs the function of the DAC OUT connector analog output. Options are: – *Fixed Level.* Output is a DC voltage level that is set in the submenu (see Fig. 20.3). – *Sine Wave 5MHz.* Output is a 5-MHz sine wave with fixed amplitude and offset 0 V. – *Ramp 7.32 kHz.* Output is a fixed ramp signal covering the whole ADC dynamic. – *Square 62.5 MHz.* Output is 62.5-MHz square wave with fixed amplitude and duration, centred around 0 V. – *Square 5 MHz.* Output is 5-MHz square wave with fixed amplitude, centred around 0 V. – *Positive Pulse 1 kHz, 16 ns.* Output is a 1-kHz and 16ns-width pulse with positive polarity and baseline fixed at 0 V. – *Negative Pulse 1 kHz, 16 ns.* Output is a 1-kHz and 16ns-width pulse with negative polarity and baseline fixed at 0 V. – *User Defined Pulse.* Output is a pulse with period, width, and amplitude levels configurable in the submenu (see **Fig. 20.3**). – *Input channel echo.* Output is a copy of the analog signal received on the input channel, where the channel is selected in the submenu (see **Fig. 20.3**).
GPIO	This setting selects the signal that is routed to the GPIO connector when this is used as output. Options are: – *TrgIn.* GPIO out is a delayed copy of the TRG-IN signal. – *P0.* GPIO propagates the P0 trigger. – *SIN.* GPIO propagates the S-IN signal. – *LVDS.* GPIO propagates the LVDS trigger – *ITLA.* GPIO propagates the output of the ITLA internal logic block. – *ITLB.* GPIO propagates the output of the ITLB internal logic block. – *ITLA_AND_ITLB.* GPIO propagates the AND of ITLA and ITLB outputs. – *ITLA_OR_ITLB.* GPIO propagates the OR of ITLA and ITLB outputs. – *EncodedClkIn.* **Not yet implemented**. – *SwTrg.* GPIO propagates the software trigger. – *Run.* GPIO propagates the Run signal. – *RefClk.* GPIO is the 62.5MHz clock signal used for the phase alignment in multi-board synchronization. – *TestPulse.* GPIO is the internal Test Pulse. – *Busy.* GPIO propagates the Busy signal of the board. – *UserGPIO.* GPIO propagates the GPIO signal coming from the User Logic (related to the open FPGA). – *Fixed0.* GPIO = 0 (low level). – *Fixed1.* GPIO = 1 (high level).
CLOCK	In this section, it is possible to select the Clock Source between internal (the local oscillator) and external (the clock signal on CLKIN front panel connector), as well as enable the clock propagation on CLKOUT front panel connector (the relevant green LED should be on). It is also possible to set the delay to apply to the CLKOUT signal especially used in the clock synchronization of multiple boards. The delay can be set either

	as “volatile” and it will be reset when the board is powered off, or “permanent” and the value will be held by default at the next power on. Note that the permitted values for the volatile or permanent delay are multiples of 74.074 ps (according to the underlying library **[RD7]**). The typed value is automatically updated by the software to the closest multiple

Tab. 20.2: Digitizer 2.0 Advanced settings description

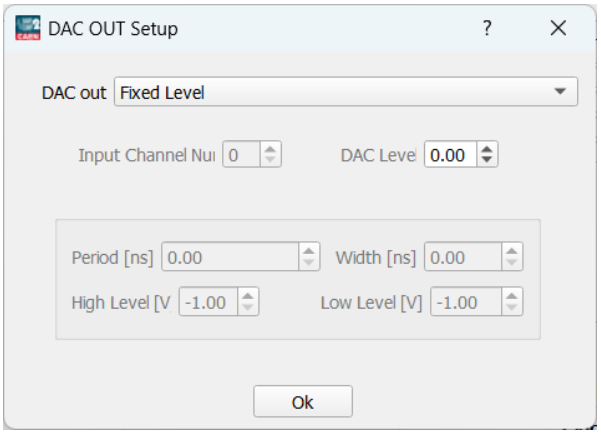


Fig. 20.3: Digitizer 2.0 – DAC OUT submenu

DIGITIZER 1.0

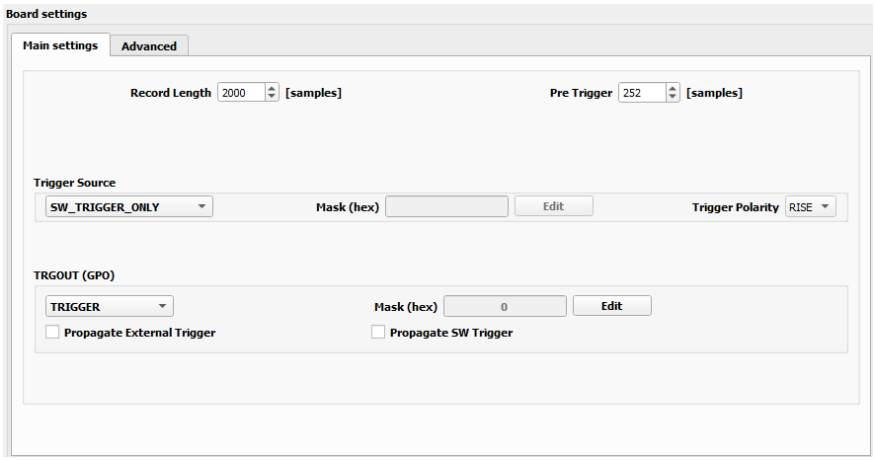


Fig. 20.4: Digitizer 1.0 - Main settings tab of the Board settings section

Setting	Description
Record Length	This parameter sets the width of the acquisition window in samples or time units (see Sec. **13.1**).
Pre Trigger	This parameter sets the pre-trigger value in samples or time units (see Sec. **13.1**).
Trigger Source	This parameter selects the trigger source in the same way as in the Control panel (see Sec. **18.1**). In the case that the SELF-TRIGGER option is set, it is possible to configure the trigger Mask by clicking the “Edit” button and the trigger polarity (RISE/FALL)
TRGOUT (GPO)	This section allows enabling the TRGOUT front-panel connector of VME digitizers, or the GPO connector on NIM and Desktop digitizers, and selects the output signal: TRIGGER, SIN, RUN, and REFCLK.

Tab. 20.3: Digitizer 1.0 - Main settings description

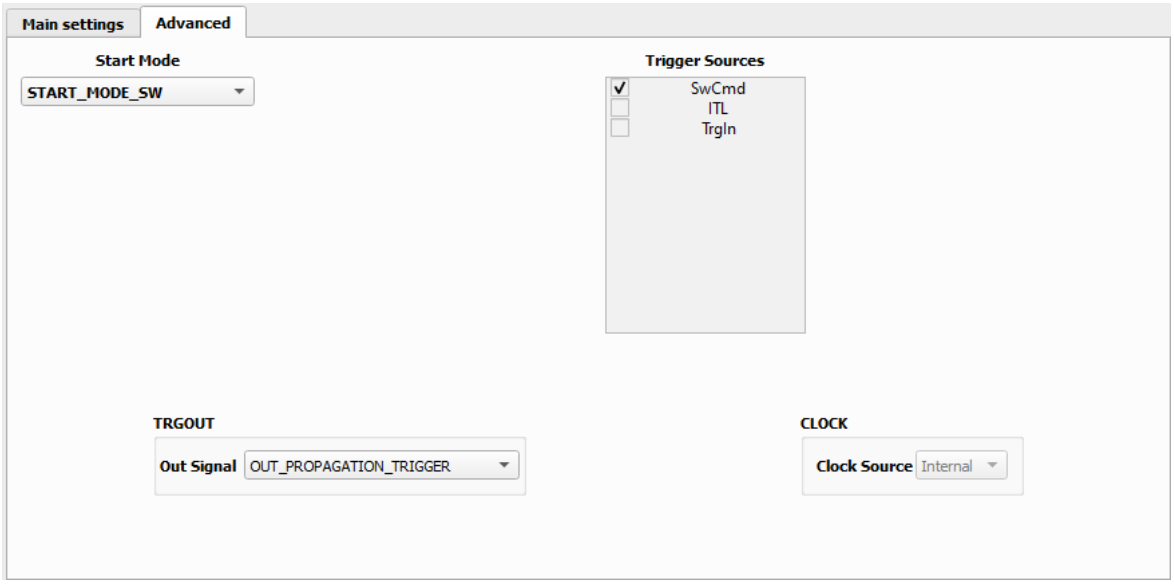


Fig. 20.5: Digitizer 1.0 - Advanced tab of the Board settings section

Setting	Description
Start Mode	This setting configures how the start-acquisition is managed on the active device. Options are: – *START_MODE_SW*. The acquisition starts on software command (stop must be on software command). – *START_MODE_S_IN*. The acquisition is driven by SIN signal, depending on the edge or the level. If the level, then the acquisition is on as long as S-IN is high, while stops when it is low. If the edge, the acquisition starts on the rising edge of S-IN (stop must be on software command). – *START_MODE_FIRST_TRG*. In this case, the acquisition starts on the rising edge of the first trigger pulse arriving at the TRGIN connector; this pulse is not used as a trigger, but actual triggers start from the second pulse on TRGIN (stop must be on software command). – *START_MODE_LVDS*. The acquisition starts on a signal coming through the LVDS connector (must be stopped on software command).
Trigger Sources	This setting configures the source of the common acquisition trigger. Options are: – *TrgIn*. The acquisition trigger comes from the TRGIN connector. – *SWCmd*. The acquisition trigger is issued by software. – *ITL*. The acquisition trigger is the output of the self-trigger logic.
TRGOUT	This setting configures the TRGOUT connector signal. Options are: – *OUT_PROPAGATION_LEVEL0*. TRGOUT is a constant low-level signal (NIM/TTL). – *OUT_PROPAGATION_LEVEL1*. TRGOUT is a constant high-level (NIM/TTL). – *OUT_PROPAGATION_TRIGGER*. TRGOUT is the Trigger signal. – *OUT_PROPAGATION_RUN*. TRGOUT is the Run signal. – *OUT_PROPAGATION_DELAYED_RUN*. TRGOUT is the Run signal delayed by the Run Delay factor. – *OUT_PROPAGATION_SAMPLE_CLOCK*. TRGOUT is the sampling clock signal. – *OUT_PROPAGATION_PLL_CLOCK*. TRGOUT is the PLL clock signal. – *OUT_PROPAGATION_BUSY*. TRGOUT is the Busy signal. – *OUT_PROPAGATION_PLL_UNLOCK*. TRGOUT is the signal monitoring the PLL lock loss events. – *OUT_PROPAGATION_VPROBE*. TRGOUT is the virtual probe signal according to the options supported by the digitizer firmware. – *OUT_PROPAGATION_SYNCIN*. TRGOUT the SIN signal
CLOCK	This read-only setting shows the Clock source status.

Tab. 20.4: Digitizer 1.0 - Advanced settings description

20.1.2Channel Settings Section

This section is dedicated to single-channel parameters. By clicking one of the channel buttons, it is possible to see and modify its parameters: channel enable status, baseline level, trigger threshold (expressed in the same units as in Chap. **12**), and trigger polarity. For those digitizers supporting the configurable input scale ranges, the gain parameter can here be set.

Only on Digitizers 2.0 (xx27XX), there is a filter option, called “high frequency reject”. Enabling this function when in self-trigger mode (see Sec. **18.1**), avoid spurious triggers occurring with very noisy signals at low thresholds or signals with a very slow and noisy falling time. Filter parameters are set hardcode to fit a wide range of detector signals. Fine tuning must be done by the Manual Controller (see Chap. **17**) referring to the library parameters **[RD7]**.

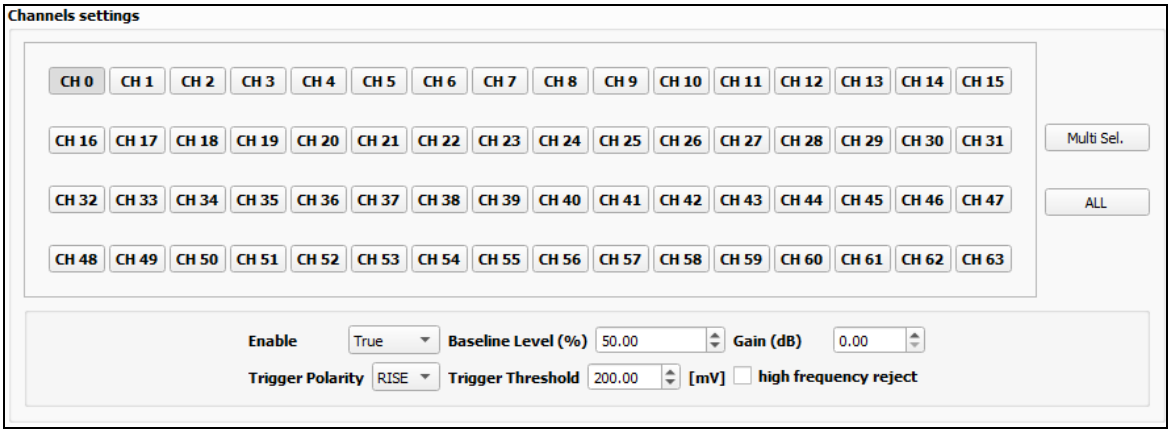


Fig. 20.6: The Channel Settings Section for a 2745 digitizer

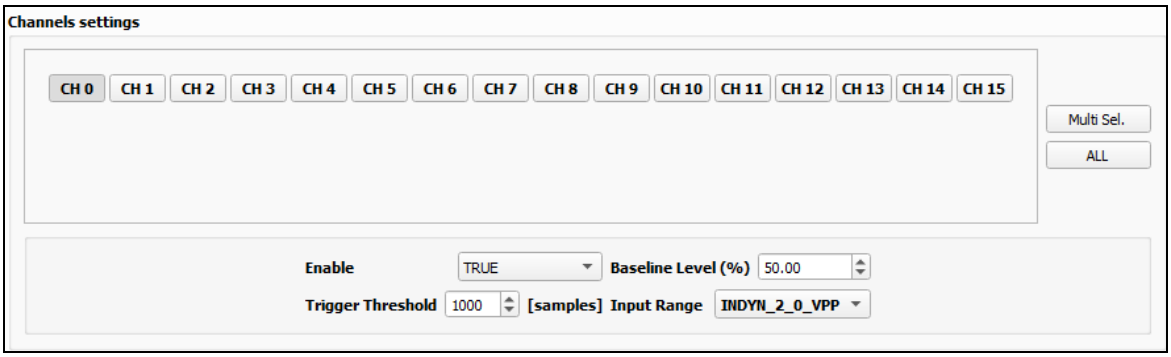


Fig. 20.7: The Channel Settings Section for a V1725 digitizer

It is also possible to select more than one channel or all the channels at once by clicking the “Multi Sel” or the “ALL” button. In this case, if the selected channels have different settings, the GUI elements do not show any value and are colored in red (see **Fig. 20.8**). By entering a new value inside the GUI widget, it will be applied to all the selected channels.

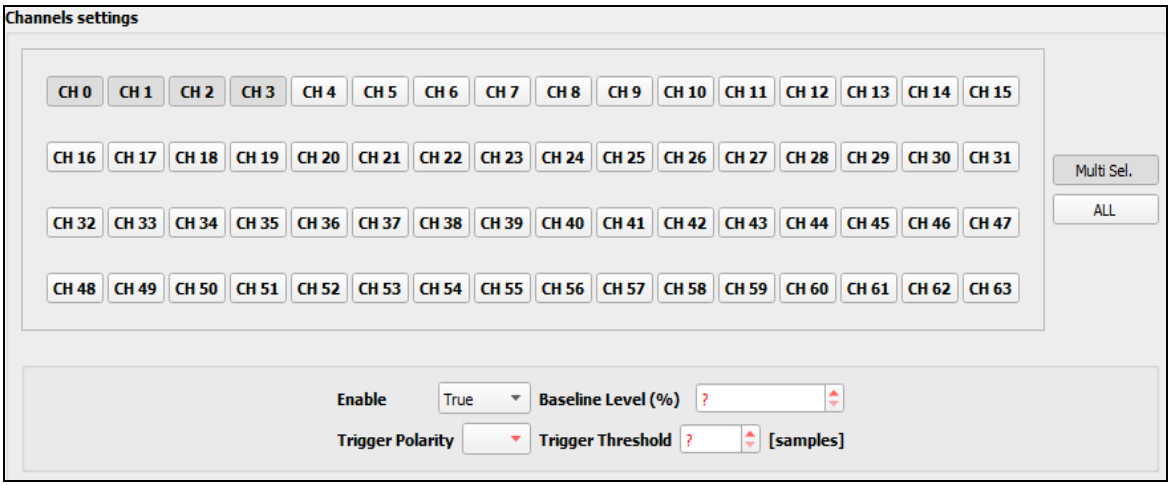


Fig. 20.8: Multi-channel selection: the selected channels have different baseline levels, trigger polarity, and trigger threshold

20.2 The Setup Configuration GUI

The Setup configuration GUI (an example is shown in **Fig. 20.9**) is designed to let the User configure all the connected devices at once.

The GUI contains a Global Settings section, one specific configuration tab for every connected device, and a COMMON tab.

DIGITIZER 2.0

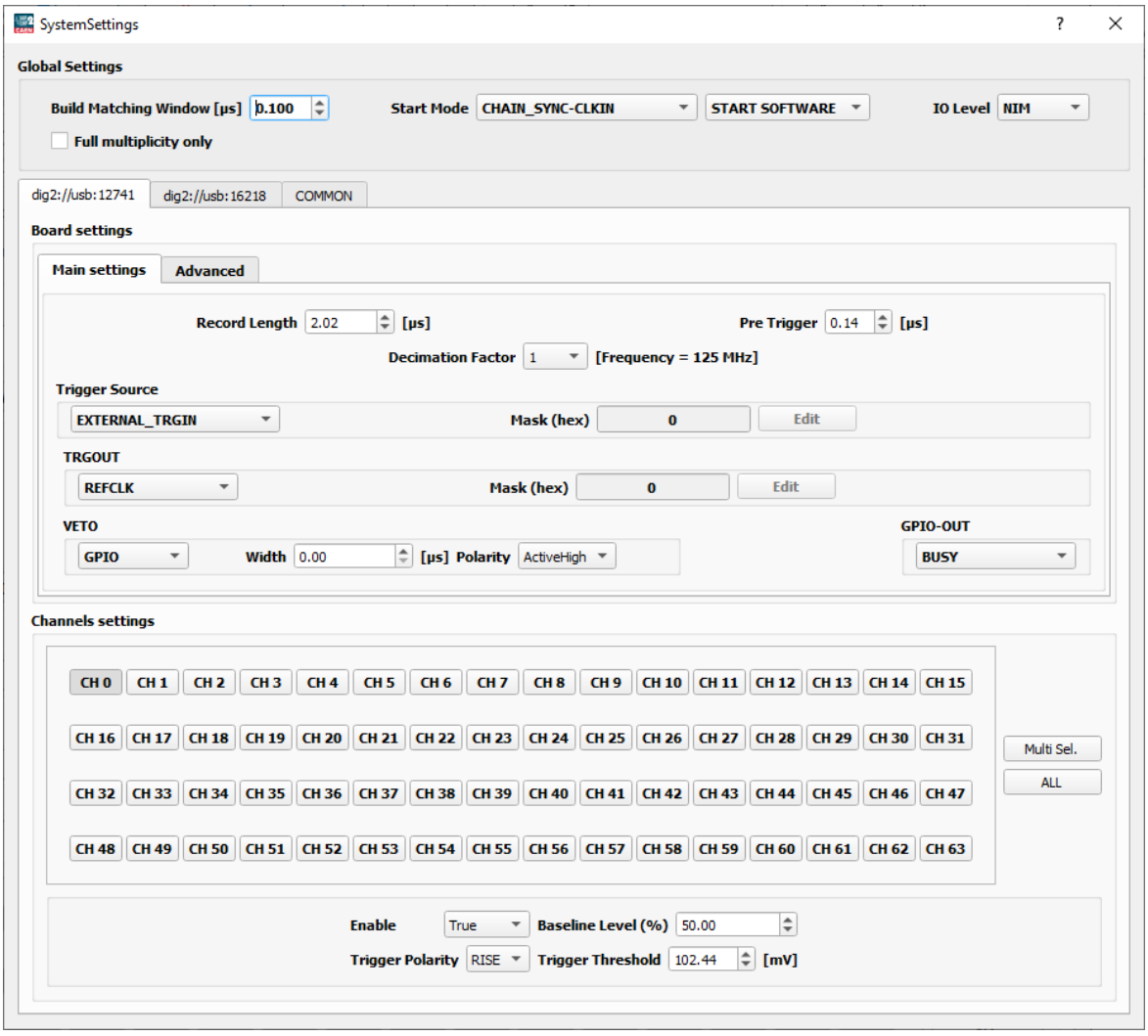


Fig. 20.9: Setup Configuration GUI with two connected 2740 devices

Setting	Description
IO Level	This parameter sets the kind of signal to provide to the digital IO connections on the digitizer front panel. The setting is the same for all the devices. Options are: TTL/NIM (default).
Start Mode	This parameter determines how the boards will acquire data. Options are: – *ASYNC.* Each connected device acquires data independently from the others upon its internal clock (default). Start and stop-acquisition are on software command. – *CHAIN_SYNC-CLKIN.* This mode is for synchronized acquisition. All devices are programmed so that the clock and run signals (sync) are both propagated in Daisy chain through the CLKIN/CLKOUT front panel connectors. The master device is programmed to work on its internal clock and can start the acquisition either on software command (START BY SOFTWARE) or external signal (START BY HARDWARE). Each slave device is programmed to work on the external clock and run coming from previous device. – *CHAIN_SIN-GPIO*. This mode is for synchronized acquisition. All devices are programmed so that the clock signal is propagated through the CLKIN/CLKOUT connectors, while the run signal is propagated through SIN/GPIO (programmed as output) ones. The master device is programmed to work on its internal clock and can start the acquisition either on software command (START BY SOFTWARE) or external signal (START BY HARDWARE). Each slave device is programmed to

	work on the external clock and run coming from previous device. – *CHAIN_SIN-TRGOUT*. This mode is for synchronized acquisition. All devices are programmed so that the clock signal is propagated through the CLKIN / CLKOUT connectors, while the run signal is propagated through SIN / TRGOUT ones. The master device is programmed to work on its internal clock and can start the acquisition either on software command (START BY SOFTWARE) or external signal (START BY HARDWARE). Each slave device is programmed to work on the external clock and run coming from previous device. – *CHAIN_1ST-TRIGGER*. This mode is for synchronized acquisition. All devices are programmed so that the clock signal is propagated through the CLKIN / CLKOUT connectors, while the run signal is propagated through TRGIN/TRGOUT ones. The master device is programmed to work on its internal clock and starts the acquisition as the first trigger arrives either on software command (START BY SOFTWARE) or external signal (START BY HARDWARE). So, the first trigger arriving at the master board is not used to take events but as the run source, which is then propagated through the system. Each slave device is programmed to work on its internal clock and run coming from the previous device.
Build Matching Window	This parameter is available only in case of acquisition from a synchronized multi-board system (i.e. Start Mode ≠ ASYNC). For the same event ID from different devices, if the timestamp difference falls within the programmed time window, expressed in µs unit, the relevant events are considered synchronized and accepted; they are rejected otherwise.
Full Multiplicity only	This flag is available only with the acquisition from a synchronized multi-board system (i.e. Start Mode ≠ ASYNC). If enabled, only the synchronized events (i.e. satisfying the Build Matching Window condition) are counted in the Global Evts statistics, saved in the single output file, and plotted, while non-synchronized events are counted in the Build Miss Evts statistics. If disabled, all the events (synchronized and non-synchronized) are saved to the output file and plotted, while Global Evts and Build Miss Evts statistics are not active in this case.

Tab. 20.5: Digitizer 2.0 - Global Settings table

DIGITIZER 1.0

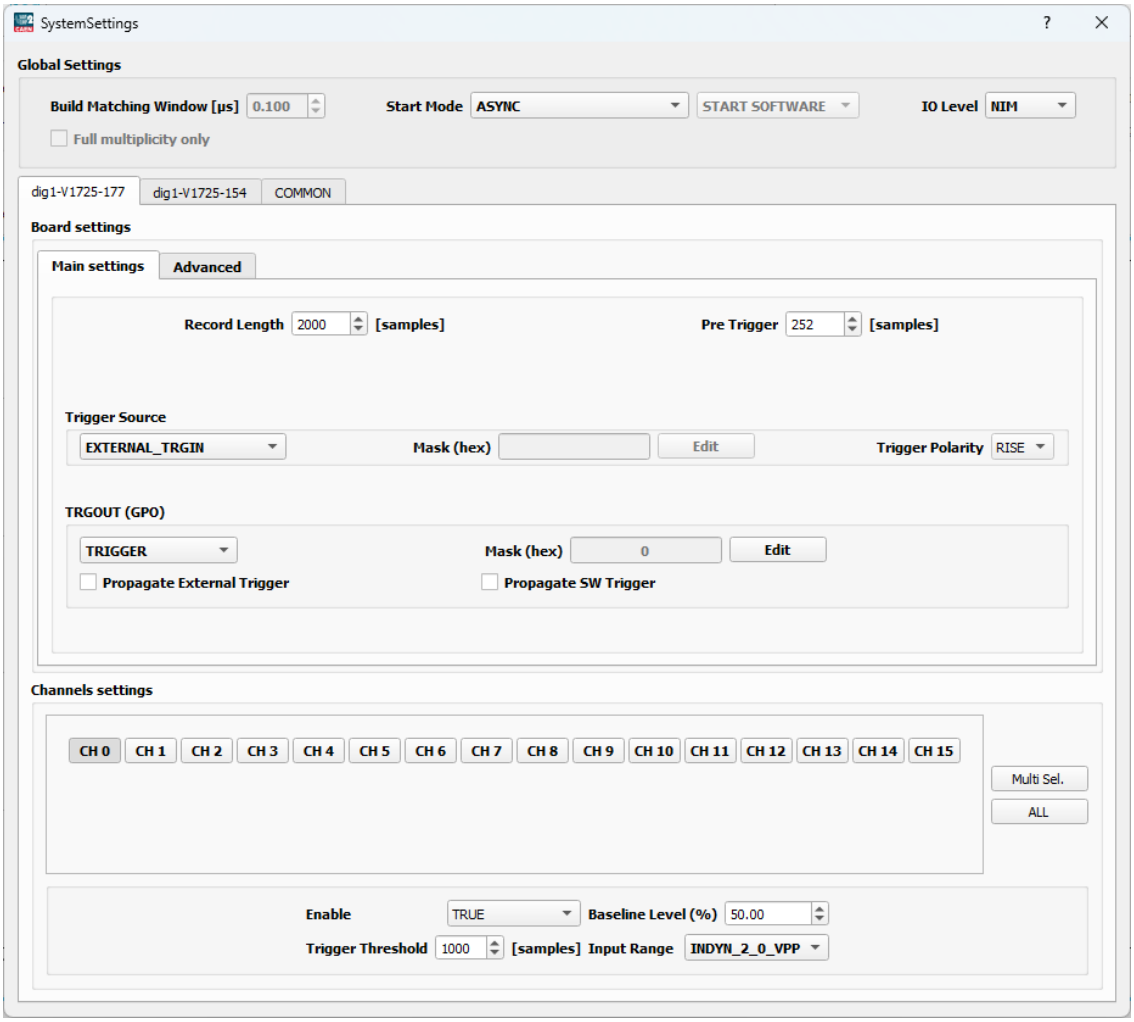


Fig. 20.10: Setup Configuration GUI with two connected V1725 devices

Setting	Description
IO Level	This parameter sets the kind of signal to provide to the digital IO connections on the digitizer front panel. The setting is the same for all the devices. Options are: TTL / NIM (default).
Start Mode	This parameter determines how the boards will acquire data. Before using these settings, the clocks must have been already synchronized by reprogramming the PLL of the digitizers to propagate the reference frequency through the CLKIN/CLKOUT front panel connectors. Options are: – *ASYNC.* Each connected device acquires data independently from the others upon its internal clock (default). Start and stop-acquisition are on software command. – *CHAIN_TRGIN-TRGOUT.* This mode is for synchronized acquisition. All devices are programmed so that the run signal is propagated through the TRGIN/TRGOUT connectors. The master device can be programmed to start the acquisition either on software command (START BY SOFTWARE) or external signal (START BY HARDWARE). Each slave device is programmed to start the acquisition on the run coming from the previous device. After the run signal, master and slave devices are all re-programmed to propagate triggers through TRGOUT/TRIGIN. – *CHAIN_ONE2ALL_EXTOR.* This mode is for synchronized acquisition. All devices are programmed to start the run on TRGIN. Master device is programmed to start acquisition on software command (START BY SOFTWARE) or external signal (START BY HARDWARE). All devices are programmed to propagate the channel self-trigger to TRGOUT without triggering the event acquisition. After the run, all devices are re-programmed to accepts triggers on TRGIN. – *CHAIN_SIN_TRGOUT.* The devices are synchronized. Master device can be programmed to start acquisition on software command (START BY SOFTWARE) or external signal (START BY HARDWARE). All devices are programmed to propagate the start run through S-IN / TRG-OUT. All devices trigger independently on the logic OR of their own self-triggers. – *CHAIN_1ST-TRIGGER*. The devices are synchronized. All devices are programmed to propagate the trigger and run signals through the TRGIN/TRGOUT connectors. Only the first trigger received by the master board does not play as the trigger (no event is taken) but as the run source, which is then propagated through the system. The acquisition on the master board can start either on software command (START BY SOFTWARE) or external signal (START BY HARDWARE).
Build Matching Window	This parameter is available only in case of acquisition from a synchronized multi-board system (i.e. Start Mode ≠ ASYNC). For the same event ID from different devices, if the timestamp difference falls within the programmed time window, expressed in µs unit, the relevant events are considered synchronized and accepted; they are rejected otherwise.
Full Multiplicity only	This flag is available only with the acquisition from a synchronized multi-board system (i.e. Start Mode ≠ ASYNC). If enabled, only the synchronized events (i.e. satisfying the Build Matching Window condition) are counted in the Global Evts statistics, saved in the single output file, and plotted, while non-synchronized events are counted in the Build Miss Evts statistics. If disabled, all the events (synchronized and non-synchronized) are saved to the output file and plotted, while Global Evts and Build Miss Evts statistics are not active in this case.

Tab. 20.6: Digitizer 1.0 - Global Settings table

Selecting a Start Mode option that requires the synchronization of the boards, a popup window opens (**Fig. 20.11**).

Inside the dialog box, it is possible to manage the order of the boards in the chain. Once the master board is defined (i.e. clock master, that is the first board in the chain), all the other boards will be slaves, but the order can be changed. The User must simply select a device in a row and use the “Move Up” and “Move Down” buttons.

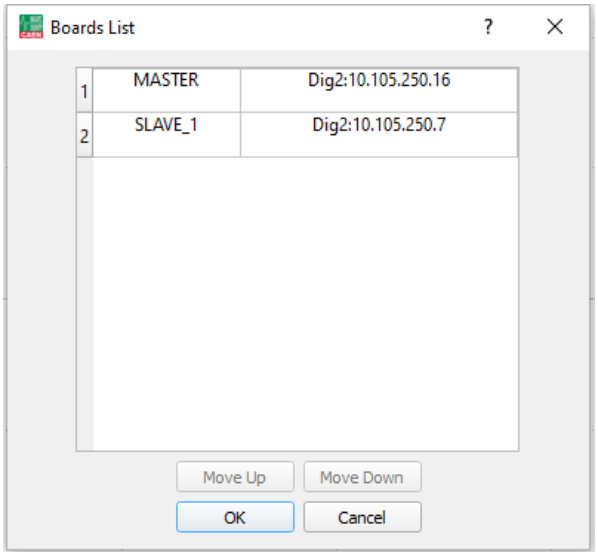


Fig. 20.11: Boards chain configuration dialog

Each configuration tab is specific for a connected device as described in Sec. **20.1.1**. These tabs allow configuring any device independently from the others.

The COMMON tab allows instead applying one or more settings to all the connected devices at the same time. In the case that the devices have different values for some parameters, the COMMON tab widgets become colored in red and do not show any value.

21 Configuration Files

When a device is connected in WaveDump2, the software applies an initial configuration defined as the COMMON configuration. Starting from the default configuration, the software keeps a trace of all the settings applied both to a device individually and made in the COMMON settings (the COMMON settings correspond to the COMMON tab of the Setup configuration GUI described in Sec. **20.2**).

At any time, it is possible to save the current system configuration to a *wconf* file by the "Save" and "Save as" functions optionally from:

- The Menu Bar of the WaveDump2 GUI (see Sec. **10.1.5**)
- The Icon Bar of the WaveDump2 GUI (see Chap. **11**)

The *wconf* configuration file is an ASCII file containing the list of the parameters (identified by the query string) and their values.

Note that only the hardware parameters (i.e. those corresponding to firmware parameters of the board) are saved in a .wconf file.

Using the "Save" function, the current configuration is always saved by the software to a predefined *WaveDump2_Config.wconf* file on the host disk space at the following path:

- *C:\Users\<USER>\WaveDump2* for Windows OS
- *home/<USER>/WaveDump2* for Linux OS

Alternatively, the User can change the file name and the path by using the "Save As" function.

The configuration file contains different sections:

`[COMMON_GLOBAL_SETTINGS]` including common settings from the COMMON tab of the Setup configuration GUI;

`[COMMON_CHx]` including common settings from the Channel Settings section of the Setup configuration GUI;

`[COMMON_VGAx]` that is the input variable gain value (if supported by the digitizer)

`[DEVICES]`. including the connected devices name and connection settings

`[dig2NAME_GLOBAL_SETTINGS]` including board settings of each device;

`[dig2NAME_CHx]` including the channel setting of each device. These last two sections correspond to the settings that are specific for the device named DEVICE_ID and its channels;

`[LOAD_SETTINGS_FILE]`
`filename=PATH/filename` can be optionally added by the User and allows loading a settings file (*wsets*);

`[OUTPUT]` including the output file settings;

When the software is started, it is possible to import a previously saved *wconf* file that will be reloaded in Wavedump2 optionally from:

- The Menu Bar of the WaveDump2 GUI (see Sec. **10.1.3**)
- The Icon Bar of the WaveDump2 GUI (see Chap. **11**)

This operation can be performed only with no device connected. WaveDump2 re-establishes the connection with the devices found in the configuration file, applies the COMMON settings first, and then the individual device settings.

If the .wconf file extension has been associated with the software during the installation (see Chap. **2**), it is possible to open WaveDump2 and load the configuration from the file at once by:

- Double-click on the .wconf file in Windows OS
- Type the command "WaveDump2 /home/<USER>/…/<filename>.wconf" in Linux OS

Not that a user-configuration file can even be set as default in the WaveDump2 home screen (**Fig. 21.1**). This way, the selected settings will be applied at the next launch instead of the software default ones.

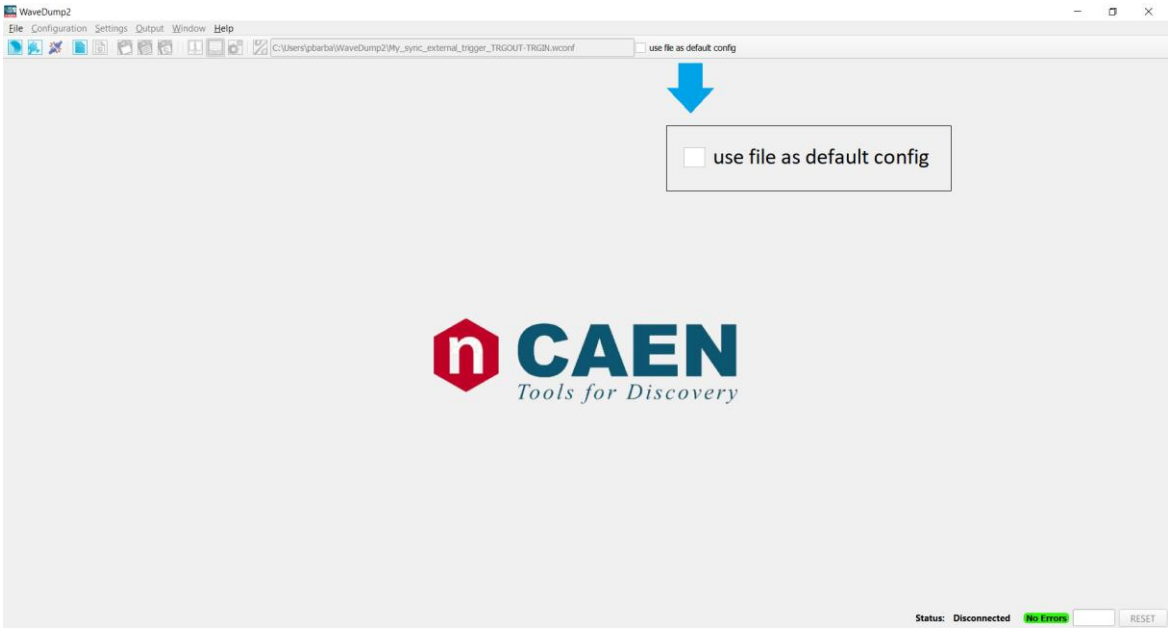


Fig. 21.1: Use file as a default config option

22 Settings (Scripts) Files

The software gives the possibility to record and reload a precise sequence of operations that have been carried out by the User. This is possible using the settings (i.e. scripts) files, which are *wsets* files.

To save a sequence of operations, the procedure is:

- Enable the function by clicking on the "Start/Stop saving as settings file" button in the Icon Bar (see Chap. **11**); the software then requires you to write the name of the .wsets file that will be created and select the destination path, that by default is:
  - C:\Program Files\<USER>\WaveDump2\bin in Windows OS
  - /home/<USER>/Downloads/WaveDump2* in Linux Os
- Perform the desired sequence of operations
- Disable the function with another click on the same button; the sequence of operations is finally saved to file

To reload a previously saved *wsets* file, you can optionally:

- Select the "Load" function in the Settings menu of the Menu Bar (see Sec. **10.3.1**)
- Click on the "Load Settings file" button in the Icon Bar (see Chap. **11**).

Note that any device mentioned in the file must be already connected before reloading. If a device is not found among the connected devices, the settings related to it are skipped.

Also note that, if the *wsets* file contains a data acquisition (identified by START_ACQ and STOP_ACQ instructions below), it will be automatically carried out and the software will be frozen for all this time. A progress bar will notify the time remaining to complete the planned acquisition.

The *wsets* script files are ASCII files containing a list of instructions that can be managed by the software and executed one after the other.

A single line of the file can contain:

- A software instruction identified as "SW_OPTION": This is purely a software setting involving the software GUI or the software behavior in general.

  The syntax of this kind of instruction is:

  SW_OPTION <SW_ACTION> <VALUE> (the tags are divided by a space)

- A hardware instruction identified as "HW_OPTION": This is a device setting or command.

  The syntax of this kind of instruction is:

  HW_OPTION <DEVICE_NAME> SET <QUERY> <VALUE> (the tags are divided by a space)

The supported software actions are listed below:

`YUNIT_CHANGE <0/1>`	→ Change the Y axis unit (0=mV, 1=ADC channels)
`XUNIT_CHANGE <0/1>`	→ Change the X axis unit (0=µs, 1=samples)
`TOOLS_SHOW <TRUE/FALSE>`	→ Show/hide the Oscilloscope Tools panel
`PLOT_FREEZE <TRUE/FALSE>`	→ Freeze/restart the plot
`PALETTE_SHOW <TRUE/FALSE>`	→ show/hide the Palette panel
`LOG_SHOW <TRUE/FALSE>`	→ Show/hide the Log panel
`STATS_SHOW <TRUE/FALSE>`	→ Show/hide the Statistics panel
`MANUAL_SHOW <TRUE/FALSE>`	→ Show/hide the Manual Controller panel
`DEVMANAGER_SHOW <TRUE/FALSE>`	→ Show/hide the Device Manager panel
`PLOTTYPE_CHANGE <0/1/2>`	→ Change the plot type (0=waveforms, 1=FFT, 2=samples histogram)
`NWAVES_SET <N>`	→ Set the number of waves to average by N
`ACTIVE_DEV_CHANGE <DEVICE_NAME>`	→ Set <DEVICE_NAME> as the Active Device (ALL is allowed)
`START_ACQ`	→ Start acquisition and data readout for the active device (or for ALL)
`STOP_ACQ <DEVICE_NAME> <STOP_TIME_ms>`	→ Stop acquisition and data readout for <DEVICE_NAME> (or

	ALL) after a time given by STOP_TIME_ms
TRIGGER_MODE_CHANGE <DEVICE_NAME> <0/1>	→ Change the Trigger Mode of DEVICE_NAME (0=Auto, 1=Normal)
SEND_SW_TRIGGER <DEVICE_NAME>	→ Send a Software Trigger to DEVICE_NAME
SAVE_FOLDER_CHANGE <PATH>	→ Set the Output files destination folder path to PATH
FILE_PREFIX_CHANGE <PREFIX>	→ Set the Output files prefix to PREFIX
FILE_TYPE_CHANGE <TYPE>	→ Set the Output files type to TYPE (MULTIPLE or SINGLE)
FILE_FORMAT_CHANGE <FORMAT>	→ Set the Output files format to FORMAT (ASCII or BINARY)
FILE_HEADER_ENABLE <TRUE/FALSE>	→ Enable/disable the Output files header
DATA_SAVE_ENABLE <TRUE/FALSE> →	→ Enable/disable Output files save
FILE_SYNC_UNIQUE <TRUE/FALSE>	→ Enable/disable the data saving to unique file for synchronized acquisition
GLOBAL_START_MODE_CHANGE	→ Set the Global Start mode for synchronized acquisition (SW_CHAIN_SYNC-CLKIN, SW_CHAIN_1ST_TRIGGER, SW_CHAIN_SIN-GPIO, SW_ASYNC)
COINCIDENCE_WINDOW_CHANGE	→ Set the coincidence window (ns unit)
FULLY_MATCHING_EVENTS_ONLY <TRUE/FALSE>	→ enable/disable the Fully Matching Events Only option

Regarding the hardware actions, the <QUERY> and <VALUE> fields following the SET command can be any among those supported by the device (refer to the FELib related documentation **[RD7]**).

An example of a .wset file is shown below in **Fig. 22.1**.

```
SW_OPTION PALETTE_SHOW TRUE
SW_OPTION TOOLS_SHOW TRUE
SW_OPTION TRACE_CHANGE_1 dig2://10.105.254.40 20
SW_OPTION TRACE_CHANGE_2 dig2://10.105.254.41 1
SW_OPTION TRACE_ENABLE_3 FALSE
SW_OPTION TRACE_ENABLE_4 FALSE
SW_OPTION TRACE_ENABLE_5 FALSE
SW_OPTION TRACE_ENABLE_6 FALSE
SW_OPTION TRACE_ENABLE_7 FALSE
HW_OPTION dig2://10.105.254.40 SET /ch/20/par/DCOffset 29.999
SW_OPTION TRIGGER_MODE_CHANGE dig2://usb:16080 1
HW_OPTION dig2://usb:16080 SET /par/AcqTriggerSource SwTrg|ITLA
HW_OPTION dig2://usb:16080 SET /par/ITLAMask 0x1
HW_OPTION dig2://usb:16080 SET /par/ITLAMainLogic OR
HW_OPTION dig2://usb:16080 SET /par/ITLAPairLogic None
HW_OPTION dig2://usb:16080 SET /par/ITLAGateWidth 16
SW_OPTION ACTIVE_DEV_CHANGE dig2://10.105.254.40
HW_OPTION dig2://10.105.254.40 SET /par/PreTriggerS 25
SW_OPTION ACTIVE_DEV_CHANGE ALL
SW_OPTION START_ACQ ALL
SW_OPTION STATS_SHOW TRUE
SW_OPTION STOP_ACQ ALL 34312
```

Fig. 22.1: An example of a wsets file with a sequence of settings on two connected boards, including start and stop the acquisition Example of WSET file structure

23 Output Settings

In the Output section of WaveDump2, the User configures the desired save mode and file type for the waveforms collected during the acquisition run (see Sec. **10.4**).

23.1 Standard Save Modes and Output Files

WaveDump2 allows three standard save modes to two output file types:

- *One file per Board*: A single file for each connected board is created containing the waveforms of all the enabled channels (**Fig. 23.2**).
- *One file per Channel*: A different file is created for every channel of the board, including empty files for the disabled channels. (**Fig. 23.2**).
- *Multi-Board single file* (available only in synchronized multi-board acquisition): A unique file is generated, containing the data of all the boards in the system ordered by event number. The name of this file contains an additional and fixed prefix (**Fig. 23.3**).

The wave plot is always active in the three save modes above.

The wave data are always saved according to the "X unit" and "Y unit" plot control settings selected in the Control Panel. The "fixed size files" option makes possible splitting the data from the same run to multiple files by a programmed number of events.

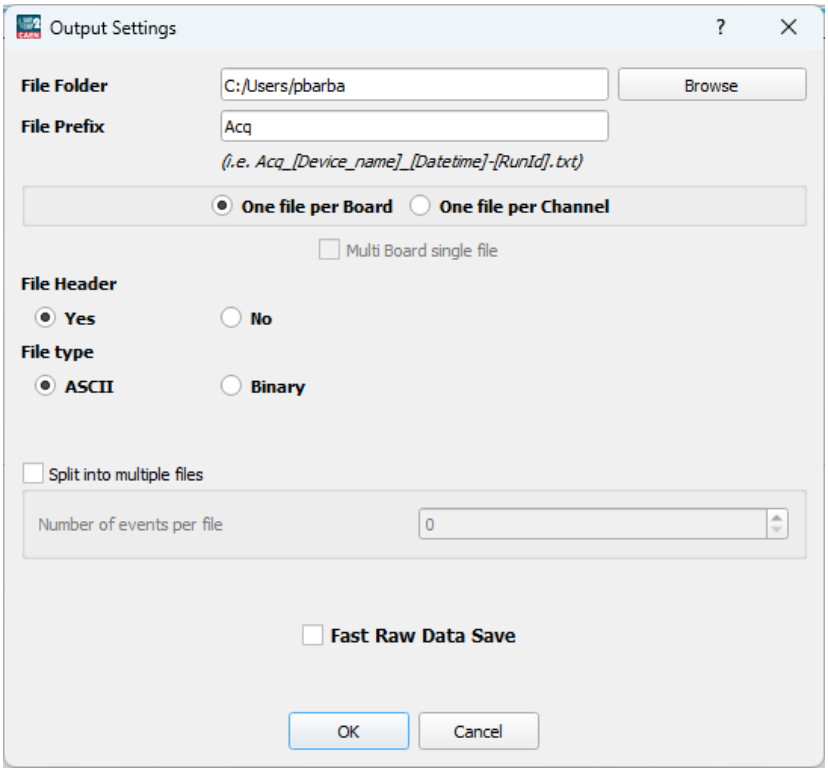


Fig. 23.1: The Output Settings dialog box

In addition to the save mode, the User can configure:

- The destination folder for the output file(s). The default path is:
  - *C:/Users/<USER>* (Windows OS)
  - */home/<USER>/WaveDump2* (Linux OS)
- The file prefix (default value is *Acq*).
- The file header (optional) to be included in the starting part of the event data within the file.
- The file type: ASCII or Binary. If the *ASCII* option is selected, a text file will be generated (TXT), while a binary file (BIN) is generated in the case of *Binary* type selection.

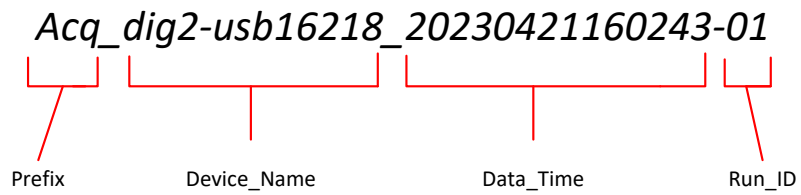


Fig. 23.2: Example of the output file name in case of *One file per Board* setting

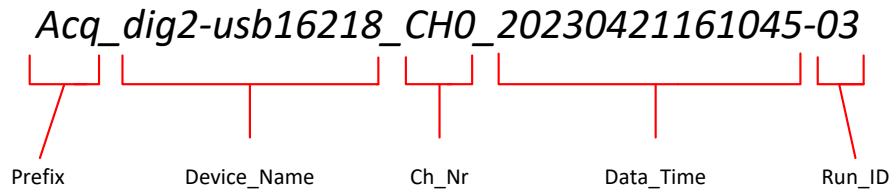


Fig. 23.3: Example of the output file name in case of *One file per Channel* setting

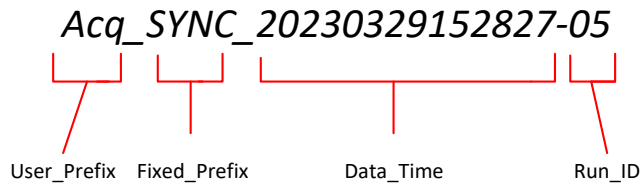


Fig. 23.4: Example of the output file name in case of *Multi-Board single file* setting

23.1.1 ASCII File Format

The ASCII output is a text file storing the sequence of acquired events in a structure where each event is composed of optional Header information by rows followed by the Data by columns.

The Header is structured as follows:

1st raw	=	Event number
2nd raw	=	Timestamp (in units of the digitizer Trigger Clock (that is 8 ns for 2740, 2745, and 2730 digitizers)
3rd raw	=	Samples (the number of samples of the digitized waveform according to the Record Length parameter)
4th raw	=	Sampling Period (the value of 1 sample in µs, that is 0.008 µs for 2740 and 2745, while 0.002 µs for 2730 digitizers)
5th raw	=	Channels (the list of channels participating in the event and enabled in the software)

The Data are the samples of the digitized waveforms by as many columns as the channels, starting from the lower channel index.

Note: In the case of the "One file per Channel" save mode selected, the Channels raw is not present in the header of each file.

Note: In the case of the "Multi-Board single file" save mode is selected and the "Full Multiplicity only" flag is enabled, the Timestamp saved in the global event is the smallest between the events in coincidence (within the Build Matching Window). In the case of the "Full Multiplicity only" flag being disabled, the TS of the single event is saved for those events that are not in coincidence. The Event ID of the global event is incremental and does not take care of the event IDs of the boards.

The ASCII file is formatted to be easily imported into databases or spreadsheets.

23.1.2 Binary File Format

In the Binary output file, each datum is saved on a different number of bytes in compliance with the endianness of the machine.

For the Header:

Event number	=	4-byte unsigned value
Timestamp	=	8-byte unsigned value
Samples	=	4-byte unsigned value
Sampling Period	=	8-byte unsigned value (the value of 1 sample in ns)
Channels	=	4-byte signed value

Each sample of the waveform is saved on a 4-byte float value.

Note: In the case of the "One file per Channel" option selected (see **Fig. 23.1**), the "Channels" info is not present in the header of each file.

If the "Multi Board single file" save mode is selected, the format for the header is:

Global Event ID	=	4-byte unsigned value
Global Event Timestamp	=	8-byte unsigned value
Device[n] Nr of Samples	=	4-byte unsigned value
Sampling Period	=	8-byte unsigned value (the value of 1 sample in ns)
Device[n] Nr of Channels with data	=	4-byte signed value

Then, sequentially follow the samples of the wave as 2-byte unsigned values if the selected unit is ADC counts, while 4-byte float ones if mV.

23.2 Fast Save Mode and WBIN Output File

The Fast Save mode allows recording data with improved readout performances. It can be set for single board acquisition as well as multi-board acquisition in both SYNC and ASYNC modes.

Note: The efficiency of the readout and record in Fast Save mode with respect to the standard binary mode depends on the performances of the host PC.

In Fast Save mode, the plot is disabled, and the data are saved to *wbin* binary files (Sec. **23.2.1**) for further offline analysis. One file per connected board is generated if the recorded data do not exceed 4 GB. Otherwise, the software automatically splits the data it into multiple files, each one with a fixed maximum size of 4 GB.

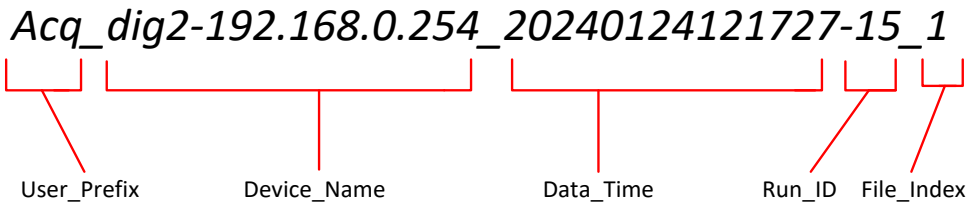


Fig. 23.5: Example of the output file name in case of *Fast Save* mode

WaveDump2 can manage the *wbin* files through the Load Raw Data function (see Sec. **10.1.4**), importing them as they were virtual devices. It is then possible to start a continuous offline acquisition or manually scroll the files event by event (see Sec. **24**). During an offline run, the waveforms are plotted, and the plot settings can be changed.

Once imported into the GUI, the *wbin* files can saved into ASCII format, if necessary.

For custom offline processing, the USER can develop personalized code basing on the *wbin* file format that is descripted in the following section.

23.2.1 WBIN File Format

The *wbin* binary file starts with a Header, containing the key device info and the main acquisition settings, that allows rebuilding the waveforms data when the file is re-processed offline.

The Header format is common to Digitzers 2.0 and Digitizers 1.0:

Device Model	=	4-byte unsigned value
Device PID	=	4-byte unsigned value
Device number of ADC bits	=	4-byte unsigned value
Sample-to-seconds conversion factor * 1e12	=	4-byte unsigned value
Device Trigger Source	=	4-byte unsigned value. This field can be decoded checking the values of the word bits: if bit value = 1 the corresponding source participates in the global trigger generation: TrgIn bit 0 P0 bit 1 (Dig, 20 only) SwTrg bit 2 LVDS bit 3 ITLA bit 4 (self-trigger for Dig. 1.0 ITLB bit 5 (Dig. 2.0 only) ITLA_AND_ITLB bit 6 (Dig. 2.0 only) ITLA_OR_ITLB bit 7 (Dig. 2.0 only) EncodedClkIn bit 8 (Dig. 2.0 only) GPIO bit 9 (Dig. 2.0 only) TestPulse bit 10 (Dig. 2.0 only)
Device PreTrigger (samples)	=	2-byte unsigned value (recordlength-posttrigger for Dig. 1.0)
Device Number of Channels	=	4-byte unsigned value
For every channel:		
Channel baseline (in LSB)	=	4-byte unsigned value
Channel sample-to-mV conversion factor * 1e6	=	4-byte unsigned value
Channel gain factor *1e6	=	4-byte unsigned value
Channel threshold relative to the baseline (LSB)	=	4-byte signed value

The header is then followed by the raw data buffers read directly from the device (from the raw readout endpoint). To decode the waveform data, please refer to the raw data buffer format described in the CAEN_FeLib documentation **[RD7]** for Digitizer 2.0, while the Digitizer User Manual in case of Digitizer 1.0.

24 Offline Acquisition

WaveDump2 allows importing binary files previously saved in the Fast Save mode (see Sec. **23.2**) from the acquisition of single or multiple boards, the latter either in ASYNC or SYNC mode. One or more *wbin* files can be loaded as in Sec. **10.1.4**, providing that no physical device is connected, and they will be managed as virtual devices.

Continuous or manual run can be started on the imported files, simultaneously or individually. Before starting the offline run, it is possible to set the available start mode options in the Configuration menu like ASYNC, SYNC, Build Matching Window, Full Multiplicity only (Sec. **20.2**).

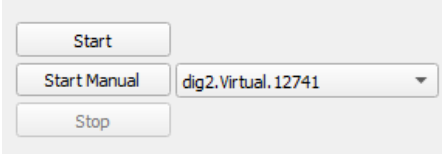


Fig. 24.1: Offline start acquisition menu

24.1 Continuous Run

Selecting the active file and pressing Start, all the events are continuously scrolled (**Fig. 24.2**). The relevant waves are plotted, and a subset of acquisition statistics is updated during the acquisition. Plot settings can be changed but hardware parameters are deactivated. The acquisition automatically stops when all the events are read.

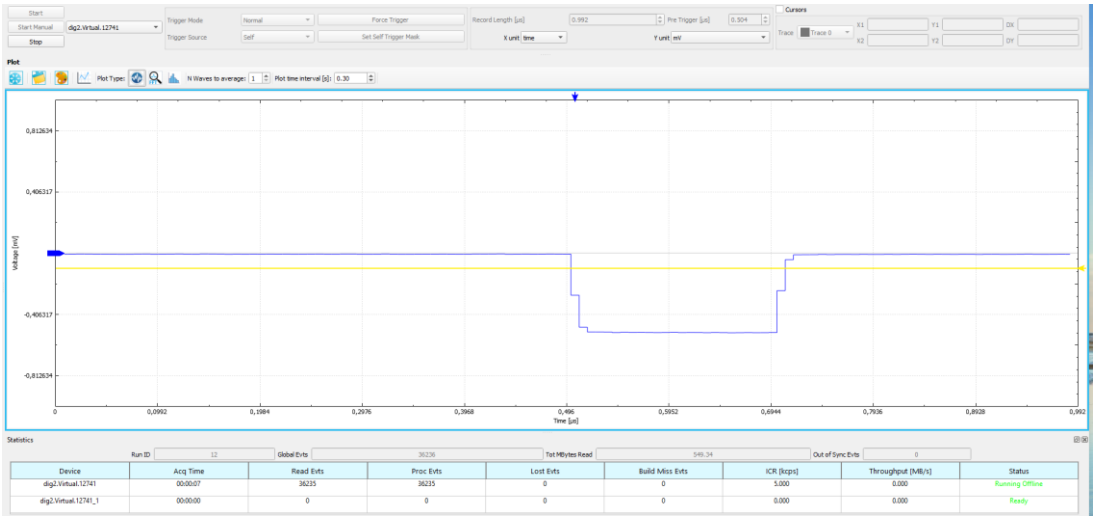


Fig. 24.2: Continuous offline run from single *wbin* file

With multiple files imported and start mode set to ASYNC, the run can be started either individually or simultaneously (ALL option in the active device menu). Setting the start mode to one of the SYNC options, instead, only the simultaneous run can be started.

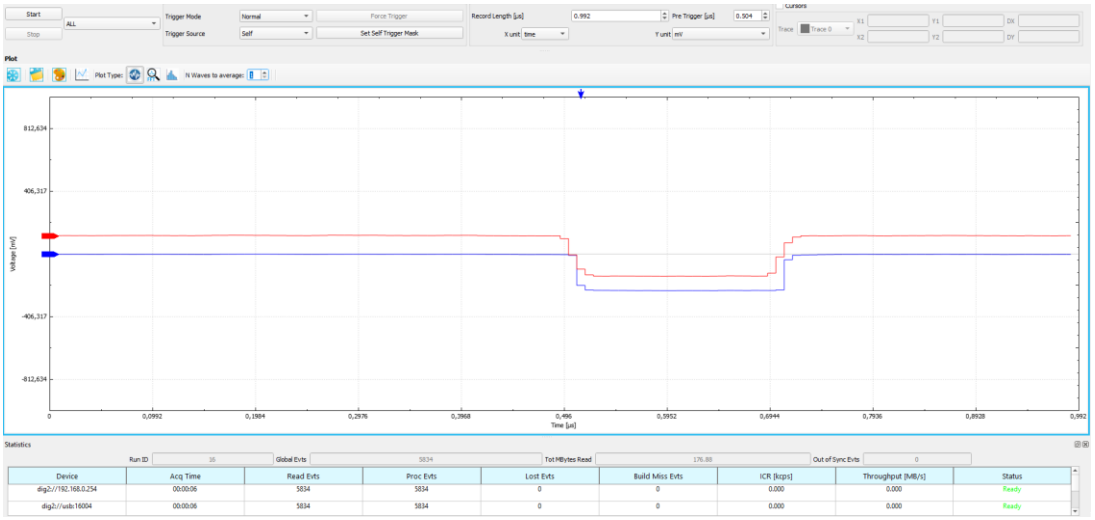


Fig. 24.3: Continuous offline run simultaneously on multiple *wbin* files

24.2 Start Manual

Select the active file and press Start Manual to run the file event by event (**Fig. 24.1**). In the Event tab available aside the plot, it is possible to type the desired event number or scroll the file; the event timestamp information (in nanoseconds) is reported, and the relevant wave is plotted (**Fig. 24.4**). The plot settings can be changed, while the hardware parameters and statistics are deactivated. Press Stop to exit the manual mode.

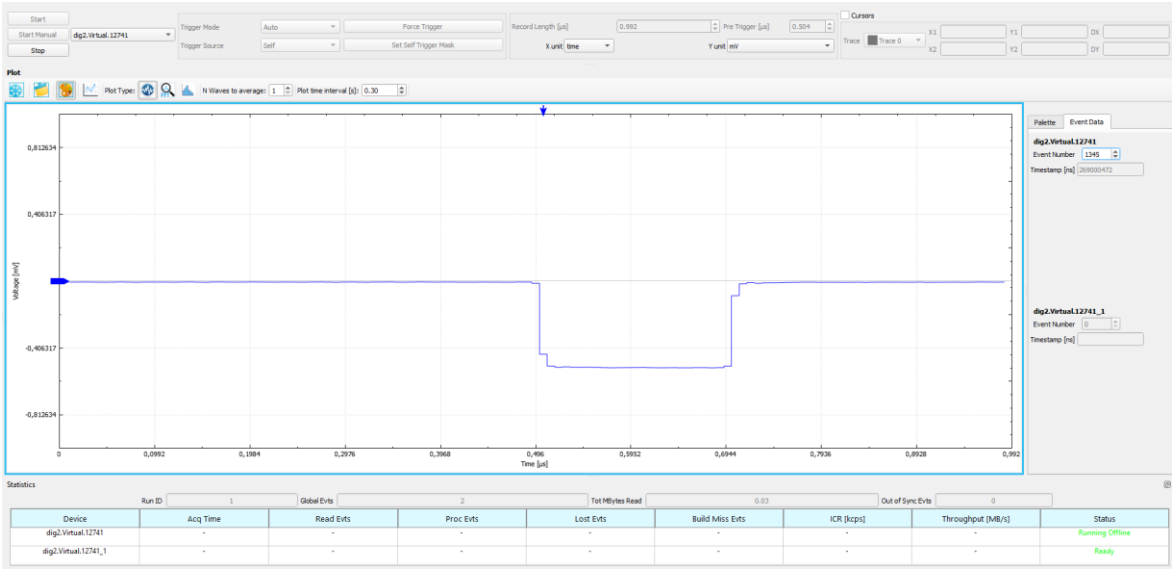


Fig. 24.4: Manual offline run from single *wbin* files

When importing multiple files, if the ASYNC start mode is set, it is possible to manually scroll the files individually or simultaneously, according to the selected active device menu option. If one of the SYNC start modes is set, then only the simultaneous manual scroll is enabled.

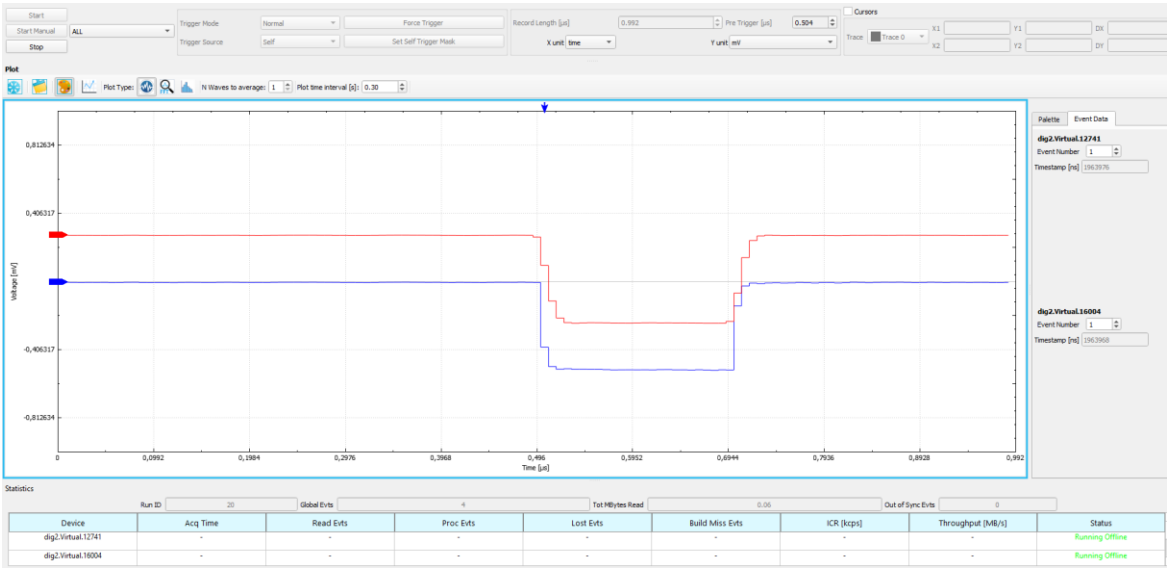


Fig. 24.5: Manual offline run from multiple *wbin* files

Note: When using the Start Manual function with the Digitizer 1.0, consider that the timestamps are related to the last roll-over. This is not a concern in the case of the Continuous Run.

25 Technical Support

To contact CAEN specialists for requests on the software, hardware, and board return and repair, it is necessary a MyCAEN+ account on www.caen.it:

https://www.caen.it/support-services/getting-started-with-mycaen-portal/

All the instructions for using the Support platform are in the document:

A paper copy of the document is delivered with CAEN boards.

The document is downloadable for free in PDF digital format at:

https://www.caen.it/wp-content/uploads/2022/11/Safety_information_Product_support_W.pdf

26 Appendix A – Sync Preset Files

WaveDump2 software is provided with a set of WCONF and WSETS files configuring for three typical setup examples of CAEN digitizer synchronization.

These files are included in the software installation packet and stored in the “Sync_Preset” subfolder of the main destination directory.

Sync Preset Files - Digitizer 1.0	Sync Preset Files - Digitizer 2.0
Sync_independent_channel_triggers_Dig1.wconf/wset	*Sync_independent_channel_triggers.wconf/wset*
Sync_external_trigger_TRGOUT-TRGIN_Dig1.wconf/wset	*Sync_external_trigger_TRGOUT-TRGIN.wconf/wset*
Sync_OR_channel_triggers_Dig1.wconf/wset	*Sync_OR_channel_triggers.wconf/wset*

Tab. 26.1: Sync preset file table

26.1 How to use Sync Preset Files

Before using the wanted file, all the connections must be performed for the specific example. Also, preliminary digitizer programming could be required, that is not made by the sync preset file (e.g. clock synchronization of Digitizers 1.0 **[RD9]**).

The file can then be loaded into the WaveDump2 GUI (see Chap. **21**).

Starting the run, looking at the plotted waves, and checking in the output files saved, the User will have a demonstration that the digitizers are synchronized according to CAEN guidelines before putting the system on the field.

As is, each preset file has been generated and tested for:

- A system made by two homogeneous digitizers running firmware for the waveform acquisition: two V1725 for Digitizers 1.0; two VX2740 for Digitizer 2.0.
- Synchronized clocks, latched to a common reference frequency which is is propagated in daisy chain from the first board (called clock master) to the second (called clock slave). Typically, it is a 62.5-MHz reference clock.
- Readout by the A4818 CAEN adapter and optical daisy chain for V1725 setups, by USB3 direct link for VX2740 ones.
- Two identical input signals, NIM type, split on CH0 of each device.
- High and low trigger rates. In the case of high input rates, vetoing the acquisition of all the boards for the time that at least one is in busy state keeps the data aligned.

Possibly, the User can change a few settings, like the destination path for the output files and connection parameters or tune the record length and pre-trigger according to the input pulses.

The preset files can of course be modified to support different digitizer models, from Digitizer 1.0 and Digitizer 2.0 series.

26.2 Example 1: External Trigger Propagation

Trigger: TRG-IN (NIM) is programmed as the acquisition common trigger source for the master and slave. The TRG-IN signal, generated by external electronics, is fed to the master and propagated to the slave board through TRG-OUT / TRG-IN connection. The slave will sense each trigger with a fixed delay.

Acquisition: The master starts the run by software command. The run signal is then propagated by daisy chain from the master to the slave. The slave will start the run with a fixed delay.

Timestamps: Considering the same events (i.e. same event ID) coming from the two boards, the timestamps should ideally be identical, but practically they will differ for the sum of the run and trigger propagation delay effects. The run delay can be compensated at the firmware level making the master to propagate the run signal with a programmable delay value that depends on the specific setup.

26.2.1Digitizer 2.0

Sync Preset Files:

Sync_external_trigger_TRGOUT-TRGIN.wconf

which calls

Sync_external_trigger_TRGOUT-TRGIN.wset

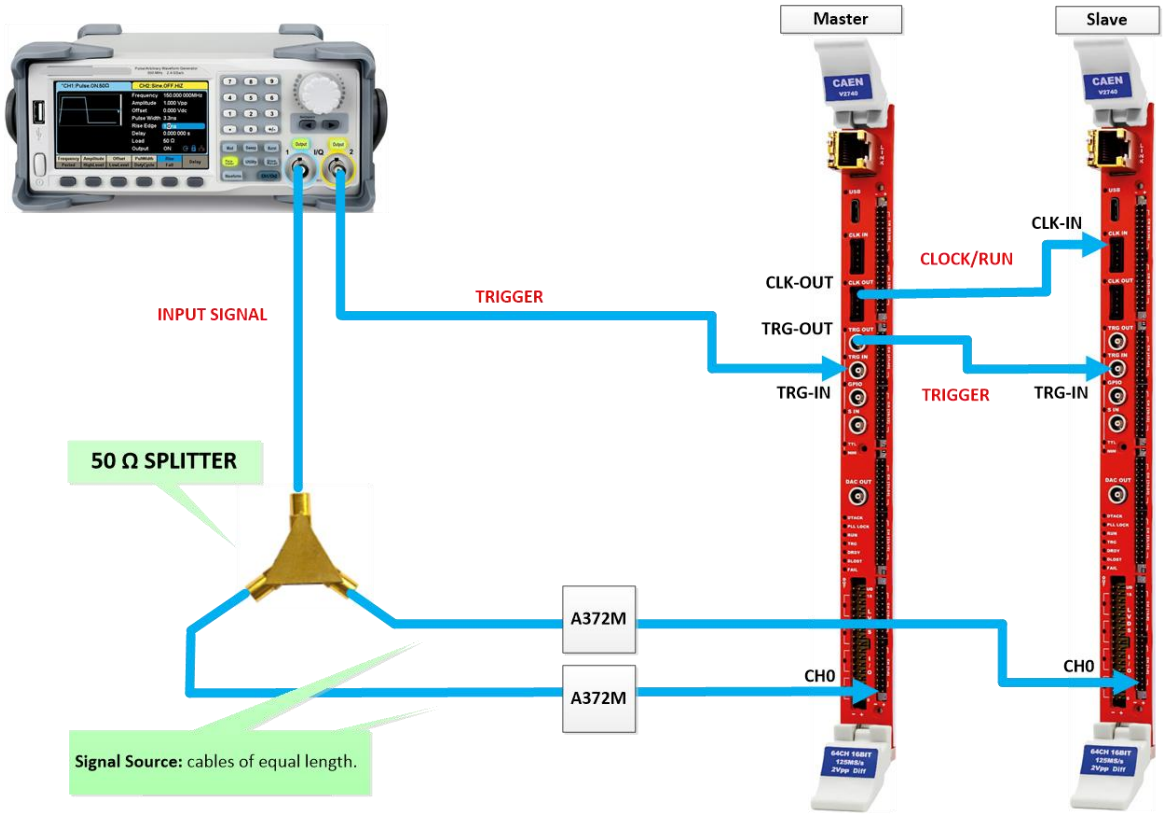


Fig. 26.1: External trigger propagation setup with VX2740 digitizers

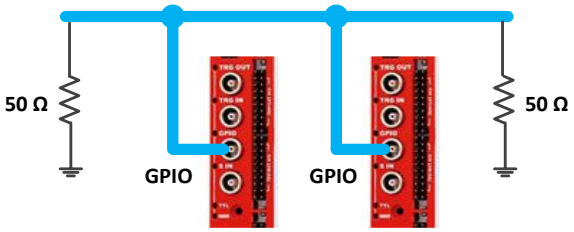
Clock: Daisy chain of CLK-OUT / CLK-IN by the A319A CAEN cable.

Run: Daisy chain of CLK-OUT / CLK-IN by the A319A CAEN cable.

Trigger: External trigger to TRG-IN of the master digitizer, then daisy chain by TRG-OUT / TRG-IN between master and slave. LEMO-to-LEMO cables needed.

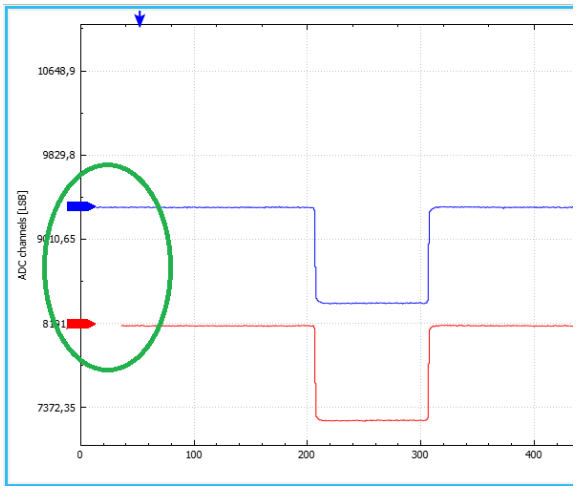
Analog Input: External pulse split and fed in Fan-in to CH0 of master and slave with cables of equal length. The A372M or A372F can possibly be used.

Busy/Veto (high rates): GPIO connection with 50-Ohm termination on both sides. This wired OR configuration is valid only for NIM signals.

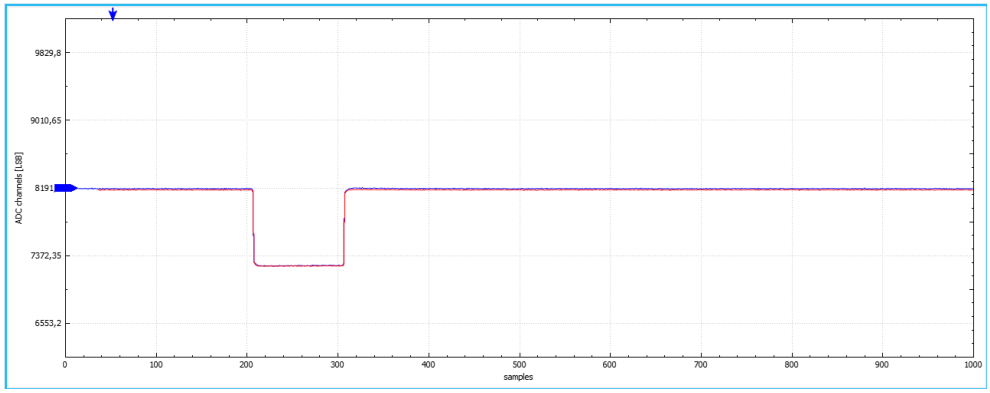


Run delay: To reduce the run propagation delay and make all boards start the run synchronously, WaveDump2 compensates for the master in the WCONF file by the *RunDelay* parameter.

Trigger timestamps: Trigger delay cannot be compensated by firmware. WaveDump2 applies a software algorithm in the plot to align the pulse edges, while data saved to the output file are not compensated (check the *SyncTestFile.txt* in *C:\Users\<USER>\WaveDump2*).



Synchronized waves:



26.2.2Digitizer 1.0

Sync Preset Files:

Sync_external_trigger_TRGOUT-TRGIN_Dig1.wconf

which calls

Sync_external_trigger_TRGOUT-TRGIN_Dig1.wset.

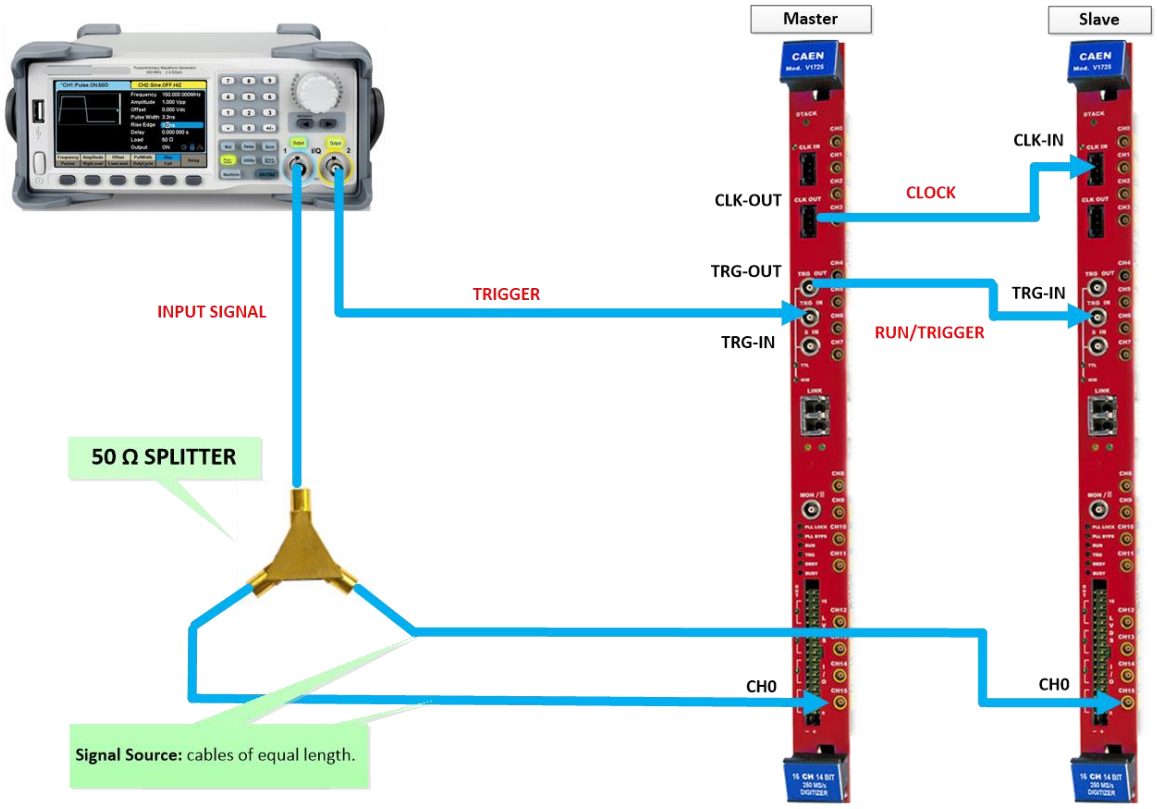
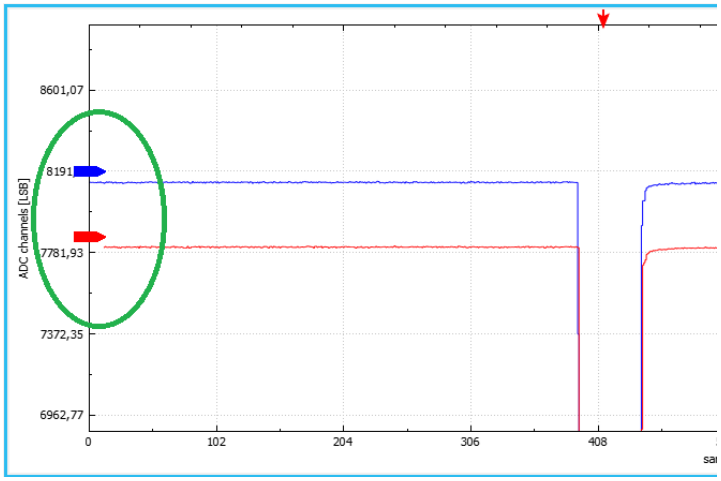


Fig. 26.2: External trigger propagation setup with V1725 digitizers

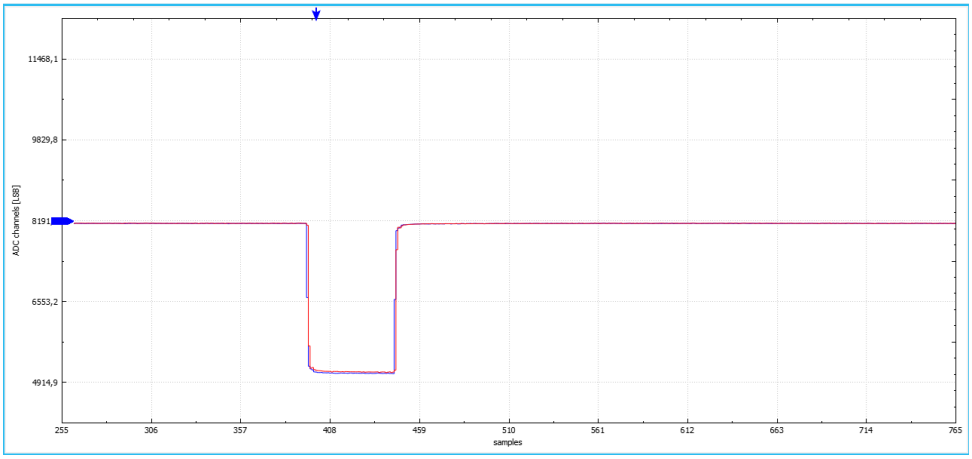
Clock:	Daisy chain of CLK-OUT / CLK-IN by the A317 CAEN cable. The clocks must have been previously synchronized upon the procedure detailed in the Application Note **[RD9].**
Run:	Daisy chain of TRG-OUT/TRG-IN. LEMO-to-LEMO cable needed.
Trigger:	External trigger to TRG-IN for the master digitizer, then daisy chain by TRG-OUT / TRG-IN between master and slave. LEMO-to-LEMO cables needed.
Analog Input:	Fan-in of the externally generated pulse to CH0 of master and slave. LEMO-to-MCX cables of equal length needed.
Busy/Veto (high rates):	LVDS I/Os daisy chain (not managed by the software GUI and not tested yet). Please, contact CAEN for more information (Chap. **25**).
Run delay:	To reduce the run propagation delay and make all boards start the run synchronously, WaveDump2 compensates for the master in the WCONF file by the *Start_Delay* parameter.

Trigger timestamps:

Trigger delay cannot be compensated by firmware. WaveDump2 applies a software algorithm in the plot to align the pulse edges, while data saved to the output file are not compensated (check the *SyncTestFile.txt* in *C:\Users\<USER>\WaveDump2*).



Synchronized waves:



26.3 Example 2: Independent Channel Triggers

Trigger: Each board triggers by the logic OR of the channel auto-triggers.

Acquisition: The master starts the run by software command. The run signal is then propagated by daisy chain from the master to the slave. The slave will start the run with a fixed delay.

Timestamps: Considering the same events (i.e. same event ID) coming from the two boards, the timestamps should ideally be identical, but practically they will differ for the run propagation delay effect plus a possible jitter (±1 trigger clock hit) since the triggers are not synchronous but generated independently by the input channels of the two boards. The run delay can be compensated at the firmware level making the master to propagate the run signal with a programmable delay value that depends on the specific setup.

26.3.1 Digitizer 2.0

Sync Preset Files:

Sync_independent_channel_triggers.wconf

which calls

Sync_independent_channel_triggers.wset

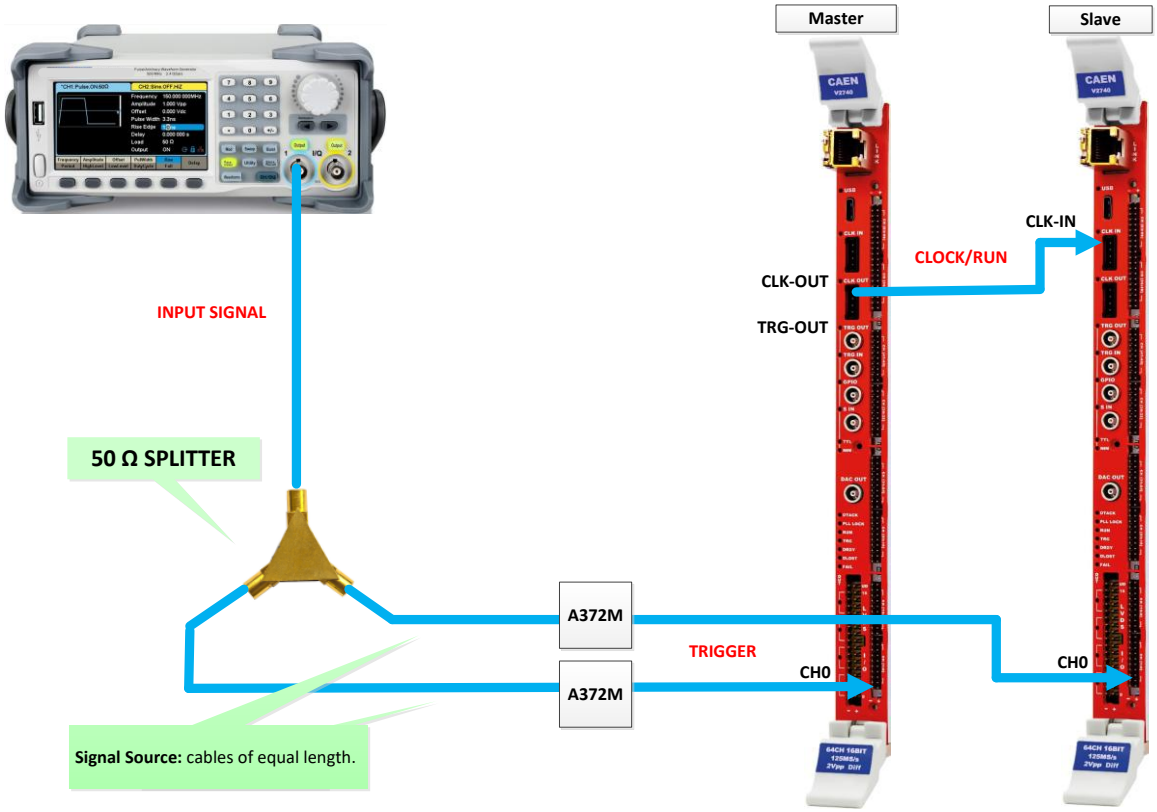


Fig. 26.3: Independent channel triggers setup with VX2740 digitizers

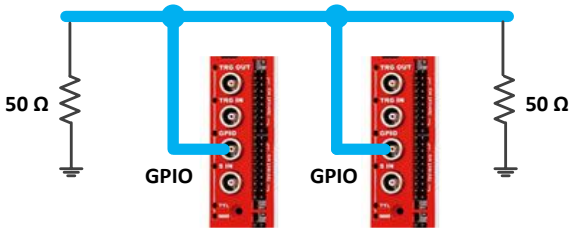
Clock: Daisy chain of CLK-OUT / CLK-IN by the A319A CAEN cable.

Run: Daisy chain of CLK-OUT / CLK-IN by the A319A CAEN cable.

Analog Input: Fan-in of the externally generated pulse to CH0 of master and slave. LEMO-to-MCX cables of equal length needed.

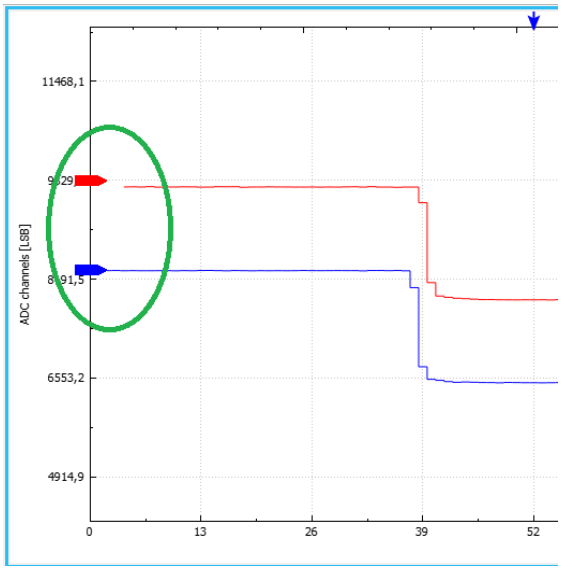
Trigger: Independent triggering of master and slave as the pulse crosses the channel discriminator threshold on CH0.

Busy/Veto (high rates): GPIO connection with 50-Ohm termination on both sides. This wired OR configuration is valid only for NIM signals.

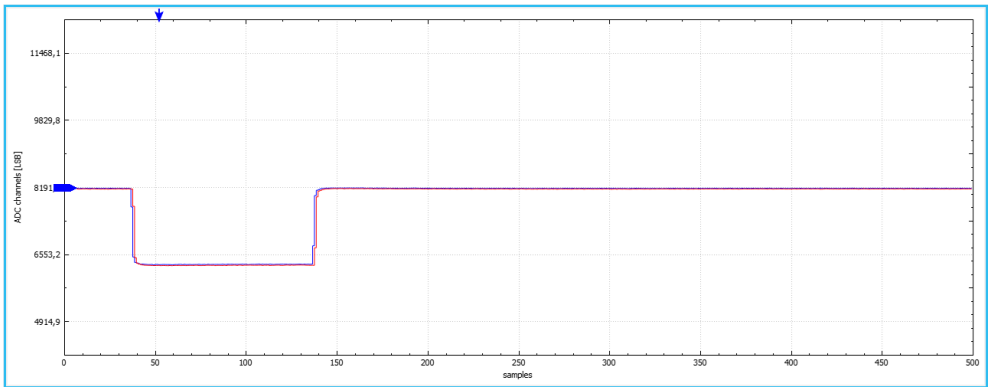


Run delay: To reduce the run propagation delay and make all boards start the run synchronously, WaveDump2 compensates for the master in the WCONF file by the *RunDelay* parameter.

Trigger timestamps: WaveDump2 applies a software algorithm in the plot to align the pulse edges compensating the residual jitter effect, while data saved to the output file are not compensated (check the *SyncTestFile.txt* in *C:\Users\<USER>\WaveDump2*).



Synchronized waves:



26.3.2Digitizer 1.0

Sync Preset Files:

Sync_independent_channel_triggers_Dig1.wconf

which calls

Sync_independent_channel_triggers_Dig1.wset

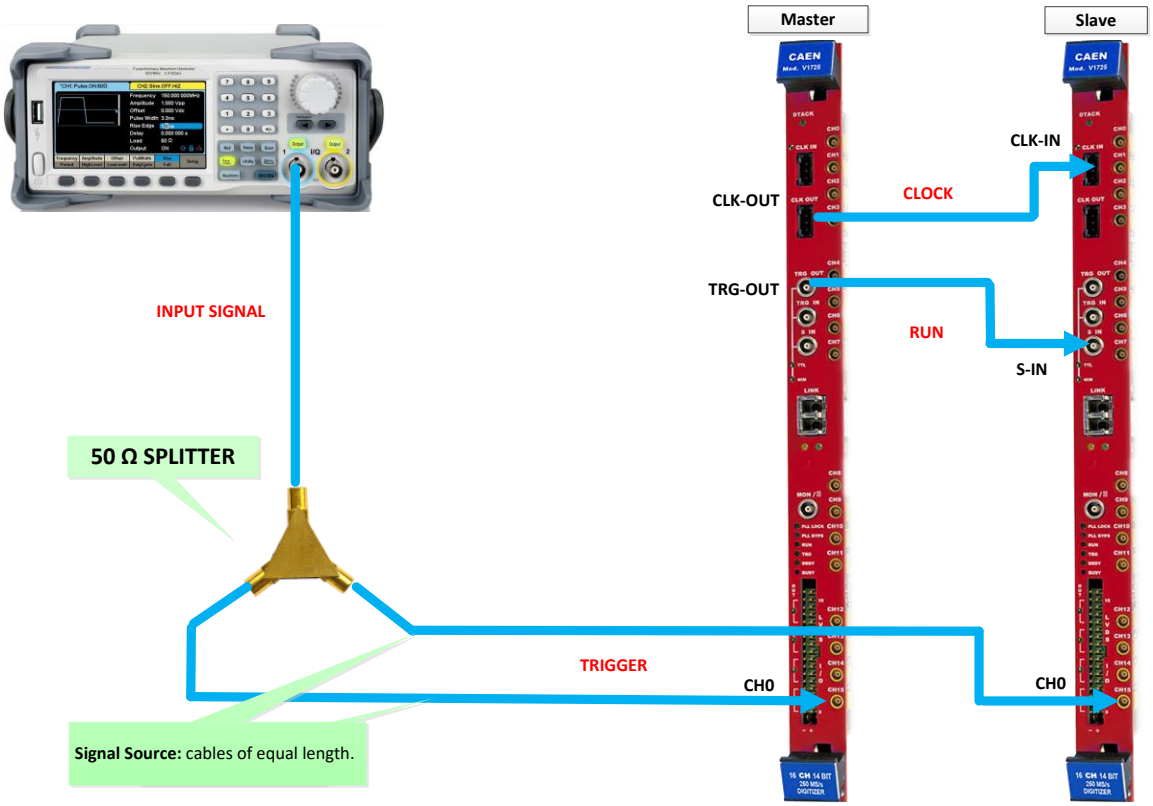
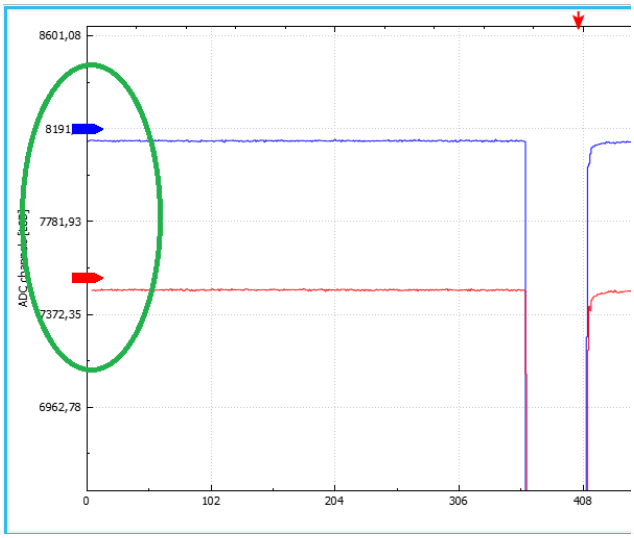


Fig. 26.4: Independent channel triggers setup with V1725 digitizers

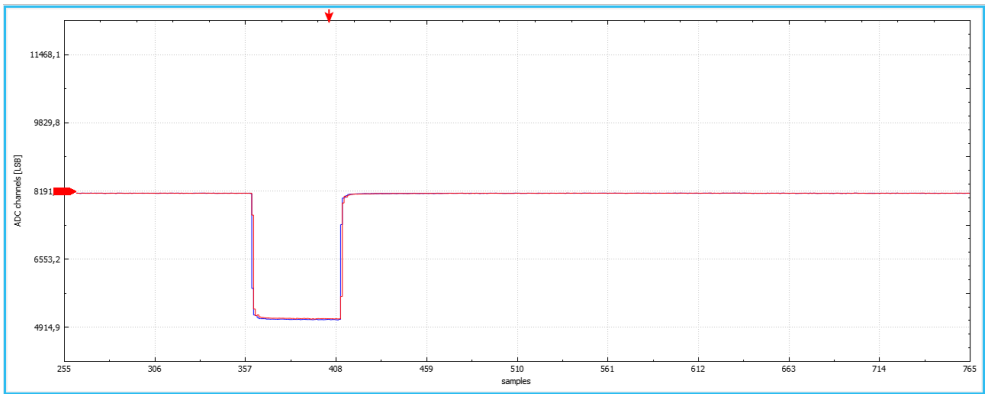
Clock:	Daisy chain of CLK-OUT / CLK-IN by the A317 CAEN cable.
Run:	Daisy chain of TRG-OUT / S-IN connectors. LEMO-to-LEMO cable needed.
Analog Input:	Fan-in of the externally generated pulse to CH0 of master and slave. LEMO-to-MCX cables of equal length needed.
Trigger:	Independent triggering of master and slave as the pulse crosses the channel discriminator threshold on CH0.
Busy/Veto (high rates):	LVDS I/Os daisy chain (not managed by the software GUI and not tested yet). Please, contact CAEN for more information (Chap. **25**).
Run delay:	To reduce the run propagation delay and make all boards start the run synchronously, WaveDump2 compensates for the master in the WCONF file by the *Start_Delay* parameter.

Trigger timestamps:

WaveDump2 applies a software algorithm in the plot to align the pulse edges compensating the residual jitter effect, while data saved to the output file are not compensated (check the *SyncTestFile.txt* in *C:\Users\<USER>\WaveDump2*).



Synchronized waves:



26.4 Example 3: Trigger from External Logic Unit

Trigger: TRG-IN (NIM) is programmed as the acquisition common trigger source for the master and slave. Each board provides its trigger requests to an external logic unit through the TRG-OUT connector. The external unit makes the OR of the trigger requests that is then provided in fan-in to the TRG-IN connectors. In this setup, when the input pulse crosses the threshold, the trigger is not locally used to get events, but the event acquisition takes place on TRG-IN after the external logic processing.

Acquisition: In this case, the acquisition is managed differently for the Digitizer 1.0 and Digitizer 2.0 setup:

- In the V1725s setup, each board is programmed to start the acquisition on TRG-IN connector. A software trigger is issued to the master that propagates it to the TRG OUT and gives a logic signal high as input in the external logic OR. Finally, all boards turn in run mode at the same time when the output of the logic unit is received on TRG IN.
- In the VX2740s setup, the master starts the run by software command, then the run signal is propagated to the slave in daisy chain. The slave will start the run with a fixed delay

Timestamps: Considering the same events (i.e. same event ID) coming from the two boards, the timestamps should ideally be identical but:

- In the V1725s setup, they effectively are identical minus a jitter (±1 trigger clock hit) that could be present if the connection cables differ in length.
- In the VX2740 setup, there is a run delay and a jitter that could be present only in case of cables of different length. The run delay can be compensated at the firmware level making the master to propagate the run signal with a programmable delay value that depends on the specific setup.

26.4.1Digitizer 2.0

Sync Preset Files:

Sync_OR_channel_triggers.wconf

which calls

Sync_OR_channel_triggers.wset

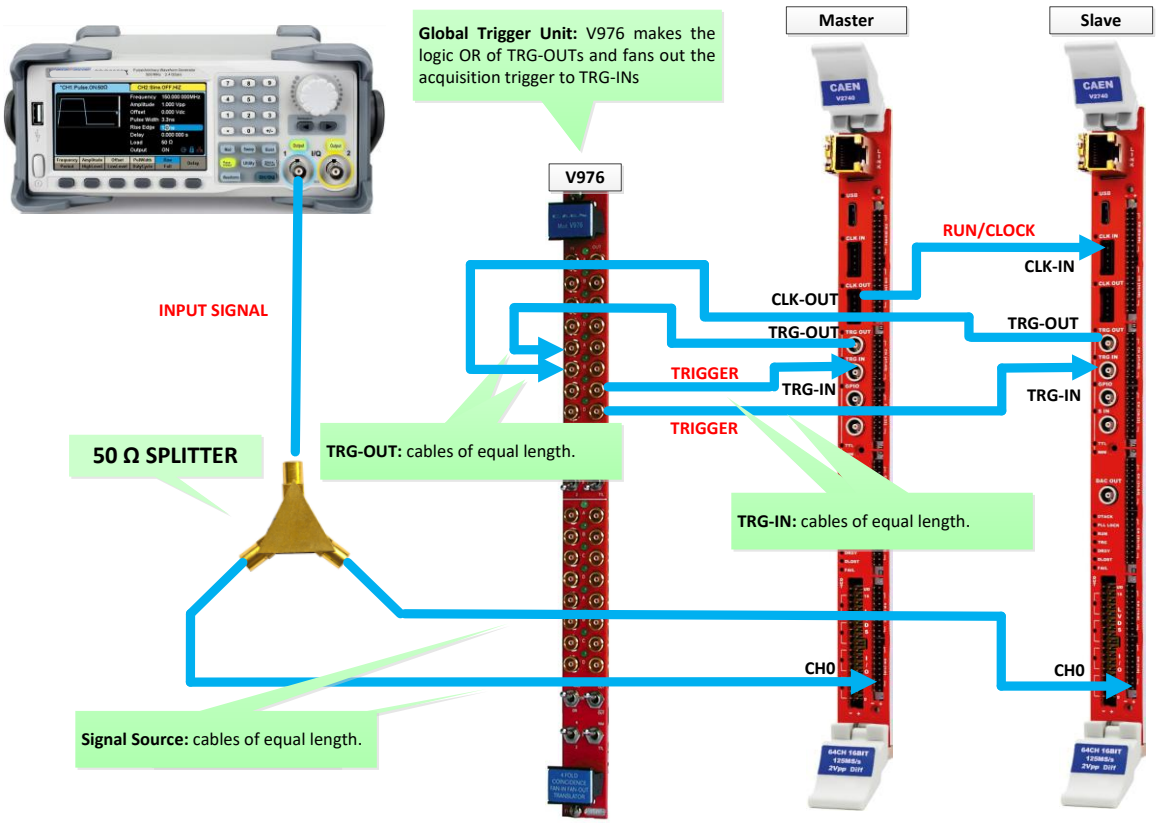


Fig. 26.5: Trigger from external logic unit setup with VX2740 digitizers

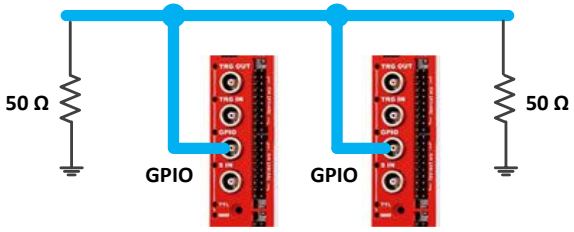
Clock: Daisy chain of CLK-OUT / CLK-IN by the A319A CAEN cable.

Run: Daisy chain of CLK-OUT / CLK-IN by the A319A CAEN cable.

Analog Input: Fan-in of the externally generated pulse to CH0 of master and slave. LEMO-to-MCX cables of equal length needed.

Trigger: TRG-OUTs connected to CAEN V976 inputs by LEMO-to-LEMO cables of equal length. TRG-INs connected to CAEN V976 outputs by LEMO-to-LEMO cables of equal length.

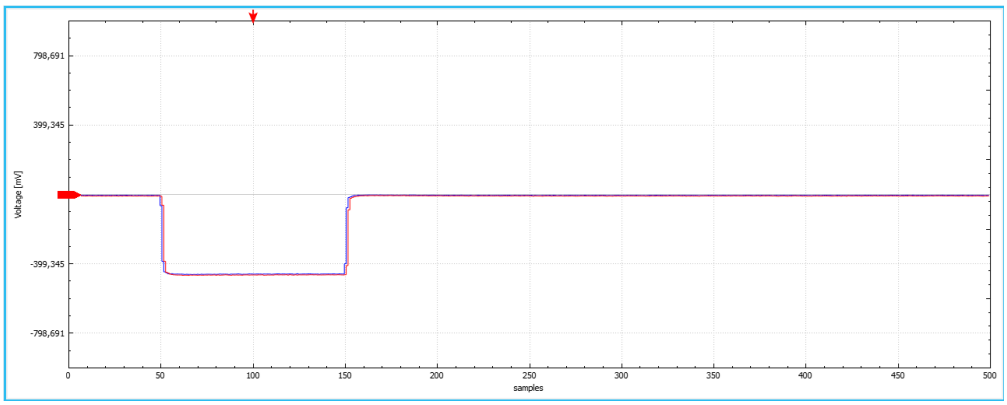
Busy/Veto (high rates): GPIO connection with 50-Ohm termination on both sides. This wired OR configuration is valid only for NIM signals.



Run delay: The start acquisition is synchronous on master and slave, so no run delay compensation is needed.

Trigger timestamps: WaveDump2 applies a software algorithm in the plot to align the pulse edges compensating the jitter, if any. However, data saved to the output file are not compensated (check the *SyncTestFile.txt* in *C:\Users\<USER>\WaveDump2*).

Synchronized waves:



26.4.2Digitizer 1.0

Sync Preset Files:

Sync_OR_channel_triggers-Dig1.wconf

which calls

Sync_OR_channel_triggers-Dig1.wset

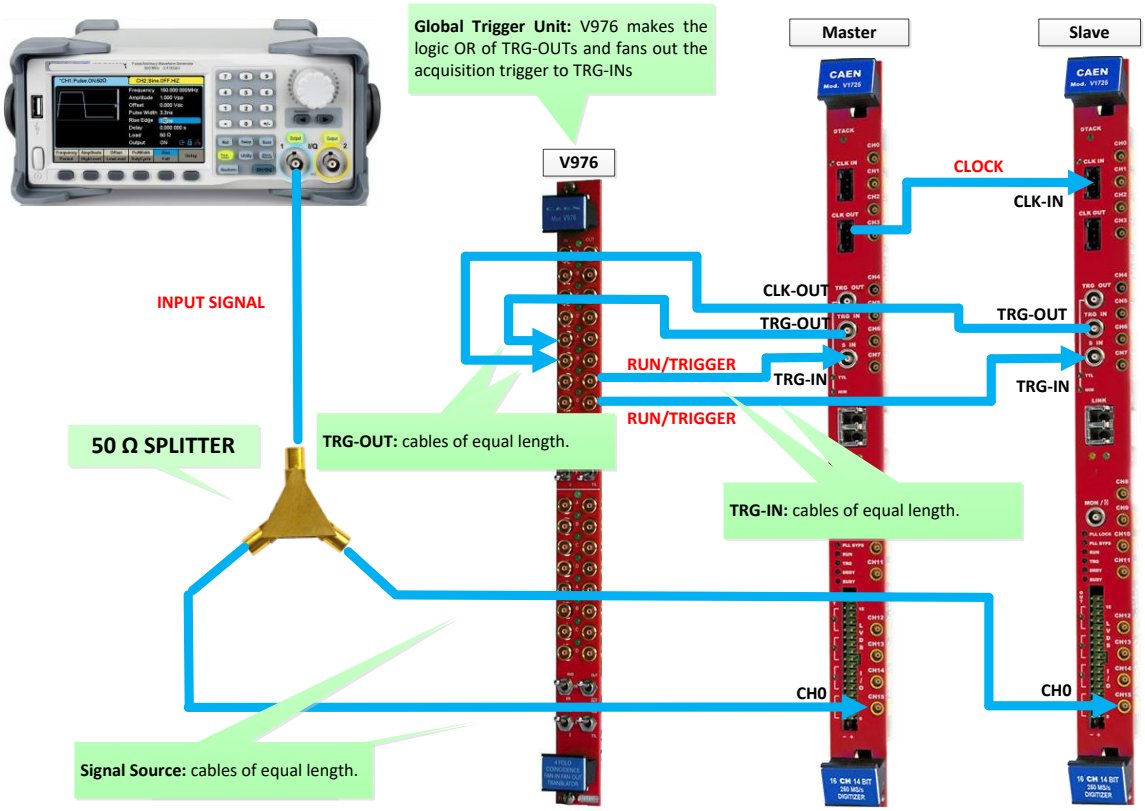
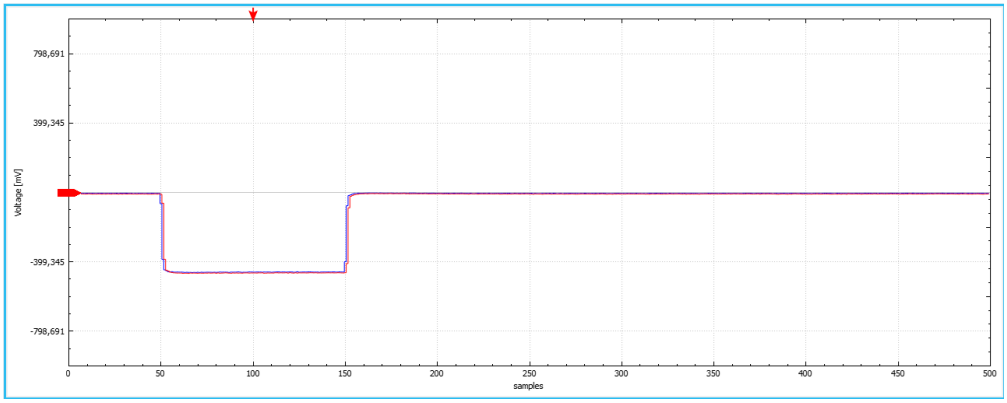


Fig. 26.6: Trigger from external logic unit setup with V1725 digitizers

Clock:	Daisy chain of CLK-OUT / CLK-IN by the A317 CAEN cable.
Run:	Fan-in from CAEN V796 outputs to TRG-IN connectors. LEMO-to-LEMO cables of equal length needed.
Analog Input:	Fan-in of the externally generated pulse to CH0 of master and slave. LEMO-to-MCX cables of equal length needed.
Trigger:	TRG-OUTs connected to CAEN V976 inputs by LEMO-to-LEMO cables of equal length. TRG-INs connected to CAEN V976 outputs by LEMO-to-LEMO cables of equal length
Busy/Veto (high rates):	LVDS I/Os daisy chain (not managed by the software GUI and not tested yet). Please, contact CAEN for more information (Chap. **25**).
Run delay:	The start acquisition is synchronous on master and slave, so no run delay compensation is needed.
Trigger timestamps:	WaveDump2 applies a software algorithm in the plot to align the pulse edges compensating the jitter, if any. However, data saved to the output file are not compensated (check the *SyncTestFile.txt* in *C:\Users\<USER>\WaveDump2*).

Synchronized waves:

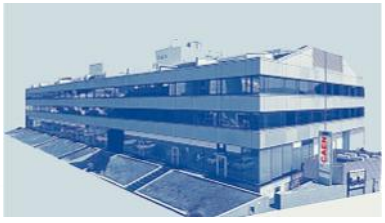


CAEN GmbH
Brunnenweg 9
64331 Weiterstadt
Phone +49 (0)212 254 4077
Mobile +49 (0)151 16 548 484
info@caen-de.com
www.caen-de.com

CAEN Technologies, Inc.
1 Edgewater Street - Suite 101
Staten Island, NY 10305
USA
Phone: +1 (718) 981-0401
Fax: +1 (718) 556-9185
info@caentechnologies.com
www.caentechnologies.com

CAEN S.p.A.
Via Vetraia 11
55049 - Viareggio
Italy
Phone +39 0584 388 398
Fax +39 0584 388 959
info@caen.it
www.caen.it

CAENspa INDIA Private Limited
B205, BLDG42, B Wing,
Azad Nagar Sangam CHS,
Mhada Layout, Azad Nagar, Andheri (W)
Mumbai, Mumbai City,
Maharashtra, India, 400053
info@caen-india.in
www.caen-india.in



UM7934 - WaveDump2 User Manual rev. 7 - April 17th, 2025 00107/17:2740.UMX/07