CAEN
Tools for Discovery

Electronic Instrumentation

User Manual UM2092

CAENSCOPE

CAEN Digitizer Oscilloscope Tool

Rev. 1 – 23 June 2015

Purpose of this Manual

This User Manual contains the full description of the CAENSCOPE software rev.1.0, the CAEN Digitizer Oscilloscope Tool.

Change Document Record

Date	Revision	Changes
23 April 2015	00	Initial release
23 June 2015	01	Updated CAENSCOPE logo in the cover picture. Updated: § **2**; **Cursors and Region of Interest (ROI)** section in § **9**

Symbols, abbreviated terms and notation

AMC	ADC Mezzanine Card
CPU	Central Processing Unit
DPP	Digital Pulse Processing
GPIO	General Purpose Input Output
LED	Light Emitting Diode
OS	Operating System
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect express
ROC	ReadOut Controller
ROI	Region Of Interest
USB	Universal Serial Bus

Reference Documents

[RD1] GD2783 – First Installation Guide to Desktop Digitizers & MCA

[RD2] GD2512 – CAENUpgrader QuickStart Guide

[RD3] UM1935 – CAENDigitizer User & Reference Manual

[RD4] AN2472 - CONET1 to CONET2 migration

All documents can be downloaded at: *http://www.caen.it/csite/LibrarySearch.jsp*

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1 Introduction

The CAENSCOPE software has been designed as a User friendly interface putting the acquisition power of digitizers at the fingertips of Users concerned with the simultaneous and synchronized acquisition of transient waveforms from multiple channels systems. The selected format recalls the familiar operation of a Digital Oscilloscope, although with some differences, namely in the front-end section, which will be indicated in this manual.

The CAENSCOPE software supports a wide range of CAEN Digitizers in different architecture formats, provided that they run the standard firmware. Currently, the CAEN DT57XX Series(Desktop Digitizers), CAEN V17XX Series (VME Modular Digitizers) and N67XX Series (NIM Modular Digitizers) indicated in **Tab. 1.1** are supported.

Digitizer Series
720
724
730
751

Tab. 1.1: Supported digitizer series

The CAENSCOPE software DOES NOT support the CAEN Digitizers when equipped with any version of the DPP (Digital Pulse Processing) Firmware.

How to check and identify the firmware currently running on the target digitizer is reported in the next paragraph.

Firmware Compatibility

The CAENSCOPE software can be used with the Standard version of the Digitizers Firmware only, and DOES NOT support the CAEN Digitizers when equipped with any version of the DPP (Digital Pulse processing) Firmware.

To verify the firmware version installed on your CAEN digitizer, please download and install the CAENUpgrader software (see **[RD2]** for the CAENUpgrader Installation details). You can so verify the firmware release with the following procedure:

- Connect your CAEN digitizer to the computer through one of the supported communication links, then run the CAENUpgrader software.
- Select the option *Get Firmware Release* In the "Board Upgrade" tab. Then, select your board model and set the connection parameters. Some explicative hardware connection options are described in **Tab. 1.2** with the relevant connection parameters.

Connection chain	Conn. Type	Conn. Parameters		
		Link Nr	Board Nr	VME Base Address
PC –> **USB** –> DT57xx/N67xx	USB	0	not required	not required
PC –> **USB** –> V1718 –> **VME** –> V17xx	USB	0	not required	32100000(1)
PC –> **USB** –> DT57xx/N67xx(2)	USB	1	not required	not required
PC –> **PCI** –> A2818 –> **CONET** –> DT57xx/N67xx(3)	OPTLINK	0	0	not required
PC –> **PCI** –> A2818 –> **CONET** –> V17xx(3)	OPTLINK	0	0	0
PC –> **PCI** –> A2818 –> **CONET** –> V2718 –> **VME** –> V17xx(3)	OPTLINK	0	0	32100000(1)
PC –> **PCI** –> A2818 –> **CONET** –> V17xx(3)(4)	OPTLINK	0	1	0

(1) *This VME base address is only as an example. In order to know the correct VME base address to be used, please refer to the Digitizer's User Manual*
(2) *It is supposed that at least two USB ports are used by the PC to communicate with as many digitizers (see the examples at the end of **[RD3]**)*
(3) *The same applies if using the A3818 PCIe card*
(4) *The Digitizer is intended to be part of an optical Daisy chain (see the examples at the end of **[RD2]**)*

Tab. 1.2: Examples of hardware connections and relevant communication parameters

- Press the *Get Fw Rel* button and look at the pop up window (see **Fig. 1.1**). The typical Standard firmware release has the following format:

  XX.YY_WW.ZZ

  where XX.YY is major/minor revision number of the mainboard (ROC) FPGA firmware and WW.ZZ is the major/minor revision number of the channel (AMC) FPGA firmware.

  Instead, a DPP firmware release format features a major revision number greater than 128 for the AMC FPGA, identifying the kind of DPP algorithm, typically in the following format:

  XX.YY_www.ZZ

In event of a DPP firmware is loaded, you can use CAENUpgrader to upload the board with a Standard firmware version (refer to **[RD2]** for instructions). The Standard firmware updates are available for free download (**login is required**) on CAEN website ate the digitizer webpage in the *Software/Firmware* tab.

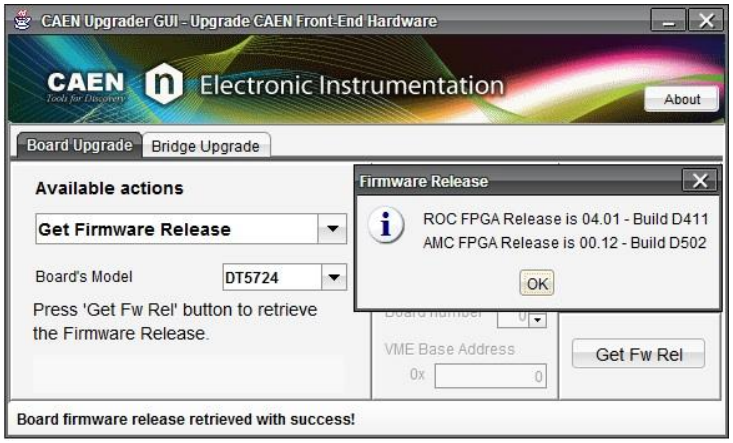

Fig. 1.1: CAENUpgrader's *Get Firmware Release* option

2 Installation

CAENSCOPE software supports both Linux and Windows platforms.

Before installing the CAENSCOPE software:

- **Make sure** that your **hardware** (Digitizer and/or Bridge, or Controller) is **properly installed** (refer to the related User Manual for hardware installation instructions) and the relevant **communication cable** (optical fiber or USB cable) is **properly connected**.
- **Make sure** you **have installed** the **driver** for your OS and for the communication link to be used (see § **Drivers**).
- **Make sure** you have installed the required additional packages, if working with Linux OS:
  - ***sharutils***
  - ***libXft***
  - ***libXss*** (specifically for Debian derived distribution, e.g. Debian, Ubuntu, etc.)
  - ***libXScrnSaver*** (specifically for RedHat derived distributions, e.g. RHEL, Fedora, Centos, etc.).

Drivers

Basing on the CAEN hardware in the setup, the User must install the driver required by the communication link being used and compliant to the OS and the CPU architecture.

CAEN provides the drivers for all the different types of physical communication channels:

- **USB 2.0.** Supported directly by Desktop and NIM Digitizers, or through the V1718/VX1718 Bridges by VME64/VME64X Digitizers.
- **CONET Optical Link.** Managed by the A2818 PCI card or A3818 PCIe card. Supported directly by all form factors (Desktop, NIM, VME64 and VME64X Digitizers).
- **VME bus.** Restricted to VME64 and VME64X Digitizers and accessed by the V1718 and V2718 bridges.

Some explicative hardware connection options are described in **Tab. 2.1** with the relevant required drivers.

HW connection chain	Comm. Link	Drivers
PC –> **USB** –> DT57xx/N67xx	USB	Driver for DT/NIM digitizers
PC –> **USB** –> V1718 –> **VME** –> V17xx	USB	Driver for V1718 Bridge
PC –> **PCI** –> A2818 –> **CONET** –> DT57xx/N67xx/V17xx	OPT	Driver for A2818 Controller
PC –> **PCIe** –> A3818 –> **CONET** –> DT57xx/N67xx/V17xx	OPT	Driver for A3818 Controller
PC –> **PCI** –> A2818 –> **CONET** –>V2718 –> **VME** –> V17xx	OPT	Driver for A2818 Controller
PC –> **PCIe** –> A2818 –> **CONET** –>V2718 –> **VME** –> V17xx	OPT	Driver for A3818 Controller

Tab. 2.1: Example of hardware setup and driver requirements

The drivers are available for free download (**login is required**) on CAEN website, www.caen.it:

- Driver for DT/NIM digitizers in the *Software/Firmware* tab at

  *Home / Products / Modular Pulse Processing Electronics / **<FORM FACTOR>** / Digitizers / **<DIGITIZER>***

- Driver for V1718 Bridge in the *Software/Firmware* tab at

  Home / Products / Modular Pulse Processing Electronics / VME / Controller (VME) / V1718

- Driver for A2818 or A3818 Controller in the *Software/Firmware* tab at

  *Home / Products / Modular Pulse Processing Electronics / PCI/PCIe / Optical Controllers / **<CONTROLLER>***

Documentation on driver installation can be found in the V1718, A2818, A3818 User Manuals, downloadable from the *Documentation* tab. **[RD1]** can be referred to for the installation of the USB driver with Desktop and NIM digitizers.

Software

After having installed the drivers for the specific communication link to be used, follow the steps guide to the CAENSCOPE software installation:

Download the CAENSCOPE installation package according to your Operating System from the *Downloads* tab on www.caen.it (**login required**) at:

Home / Products / Firmware/Software / Digitizer Software / Readout Software / CAENSCOPE

For **WINDOWS** Users:

Unpack the compressed file to your host PC and run the program installer following the installation wizard.

Run CAENSCOPE.exe from the destination folder or link, if you made one.

For **LINUX** Users:

Create a new “scope” directory and unpack the compressed file in it.

Run: *~/scope/bin/scope*

Uninstallation

In **WINDOWS** OS: select CAENSCOPE in the “Program and Functionalities” list in the *Control Panel*, then execute “uninstall”.

3 Initialization

System Initialization

Upon launching the CAENSCOPE software, the following display will appear, consisting of an upper MenuBar and of a graphical area display (the CAEN logo will appear only temporarily upon start-up).

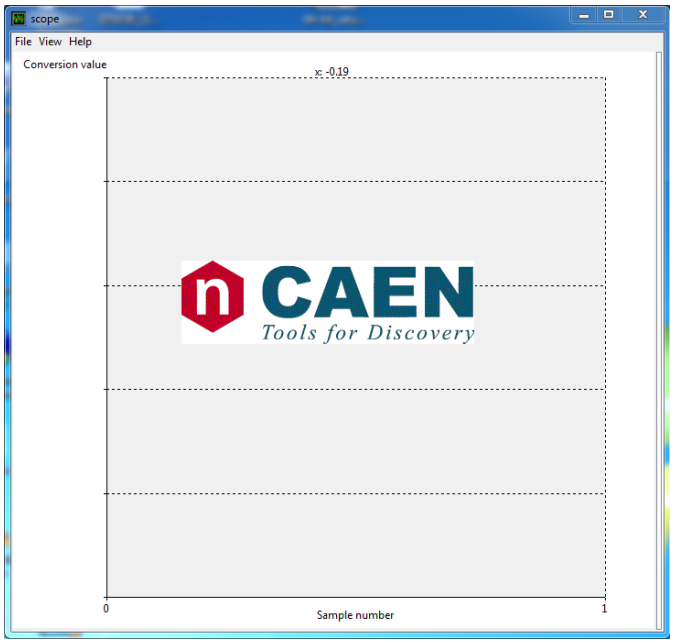

Fig. 3.1: CAENSCOPE Start up Screen

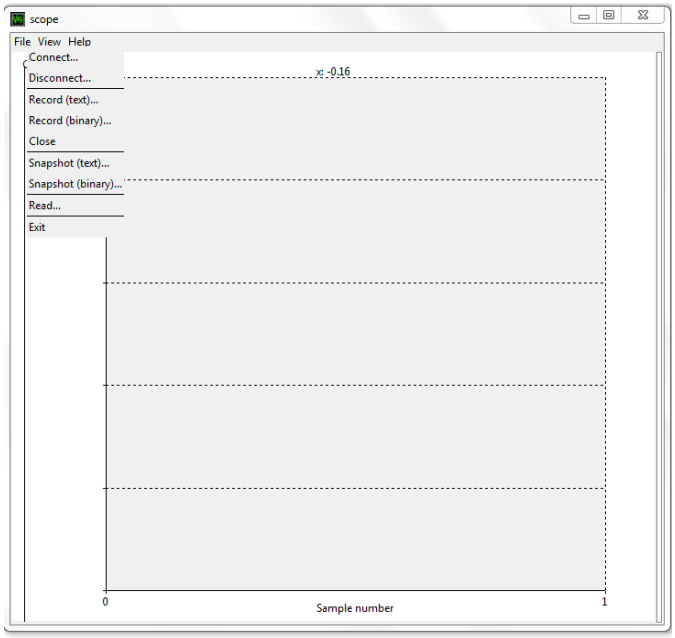

Fig. 3.2: CAENSCOPE Start-up Screen –File Pull Down Menu

Menu Bar

The Menu bar is always present at the top of the CAENSCOPE main window, just below the window's title bar. The User can access the menu items, as shown in **Fig. 3.3** below.

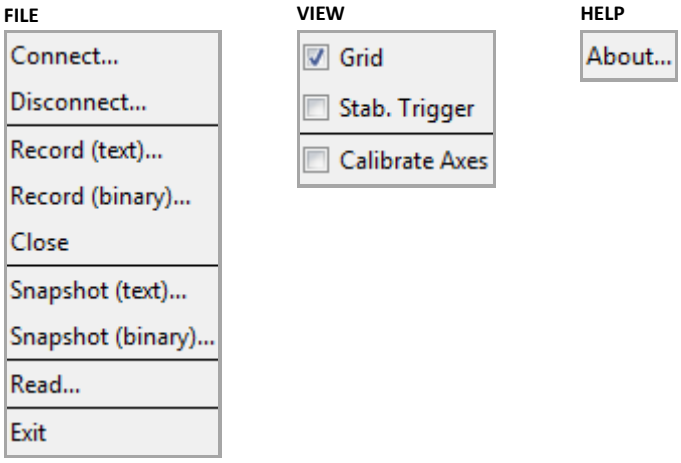

Fig. 3.3: CAENSCOPE Menu bar items and relevant sub menu

Menu Bar items : File / View / Help

By left clicking on the Menu Bar items, Pull-down Menus is displayed, indicating the availability of the following functions:

1. "**File**" Pull-down Menu:

   Connect / Disconnect / Record (text)/ Record (binary) / Close/ Snapshot (text) / Snapshot (binary) / Read/ Exit

   - **Connect**: Allows the set-up and enabling of the digitizer connection to the computer.
   - **Disconnect**: Disables the digitizer connection to the computer.
   - **Record (text)**: Enables the recording of waveforms -being acquired by the digitizer- into a text file.
   - **Record (binary)**: Initiates the recording of waveforms -being acquired by the digitizer- into a binary file.
   - **Snapshot (text)**: Opens a Windows pop-up directory allowing the User to record in a selectable folder the waveform being displayed on the screen to a text file. The snapshot file format is: "namefile.xml".
   - **Snapshot (binary)**: Opens a Windows pop-up directory allowing the User to record in a selectable folder the waveform being displayed on the screen to a binary file for SQLite database. The snapshot file format is: "namefile.db".
   - **Close**: Closes the pull down menu.
   - **Read**: Allows the User to recall a recorded waveform, either from text (.xml) file or from binary (.db) file, and to display it on the screen.
   - **Exit**: Exits the CAENSCOPE program.

2. "**View**" Pull-down Menu:

   Grid / Stab.Trigger

   - **Grid**: Enables the display of grid lines on the graphic area.
   - **Stab.Trigger**: Enables/disables the trigger stabilization by software. Since the trigger is clocked in with the FPGA clock which is generally not as fast as the digitizer clock, trace trigger positions will jitter somewhat in time. When enabled, **Stab. Trigger** stabilizes the trigger position by shifting the trigger to the average trigger position over the last several events.
   - **Calibrate Axes**: When selected, this command changes the X-axis units from "Samples" to "nanoSeconds". The corresponding graph indications and knob descriptive units will be toggled from uncalibrated (raw digital) units to calibrated (engineering) units.

3. "**Help**" Pull-down Menu:

About…

- **About…**: A pop-up dialog box displays the CAENSCOPE software Release Version, author and copyright information.

Acquisition System Set Up

To operate the system, in the upper left Menu Bar left click on "**File**" and select "**Connect**" by left clicking on it in the pull-down menu.

The following Dialog Window will appear:

Fig. 3.4: Digitizer to Host Computer Link USB (default) selection and connection prompt box

Now you can select (left click) and set the **USB** or the **pciOptical (Optical link)** connection, according to the digitizer port being used. The operation can be aborted at any time by left clicking on the "Cancel" button.

To use the **USB link**, select "usb" from the Connection pull down menu. The dialog box will appear as in **Fig. 3.4**. Then**,** type the Link address of the digitizer ("0" is the default value). For VME digitizers only, type the board's VME base address in the VME Base Address Box only if you're accessing the digitizer through the V1718 USB-to-VME CAEN Bridge. Please, refer to the digitizer's User Manual to know how to retrieve the VME base address information.

To use the **pciOptical link**, select "pciOptical" in the Connection pull down menu. The dialog box will appear as in **Fig. 3.5**.

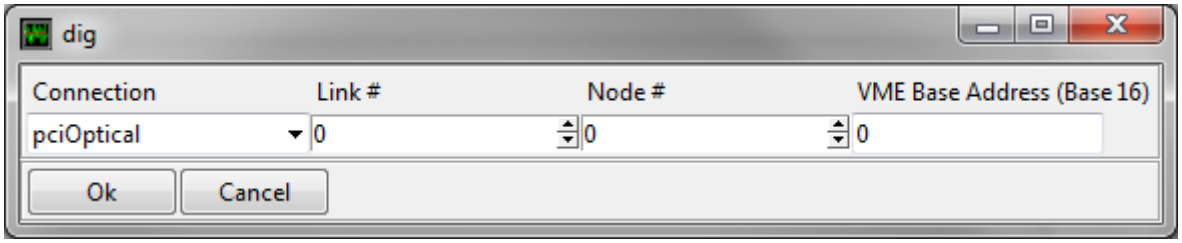

Fig. 3.5: Digitizer to Host Computer Link Optical Link selection and connection prompt box

Type the Link address of the digitizer ("0" is the default value). Set the Node Address of the digitizer ("0" is the default value). For VME digitizers only, type the board's VME base address in the VME Base Address Box only if you're accessing the digitizer through the V2718 Optical-to-VME CAEN Bridge. Please, refer to the digitizer's User Manual to know how to retrieve the VME base address information.

To disconnect the unit, click on the "Disconnect" item in the File pull down menu. A pop-up dialog box will appear as in **Fig. 3.6**.

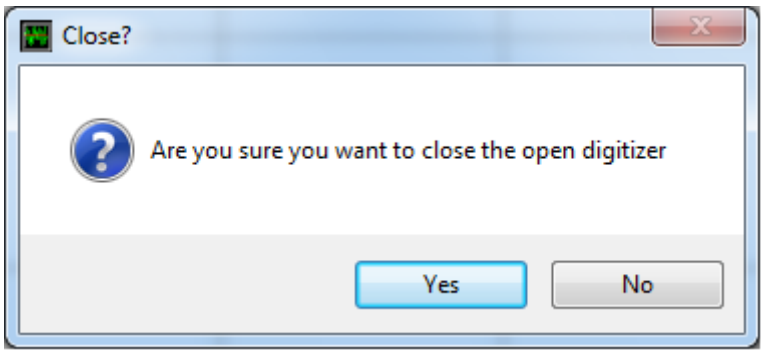

Fig. 3.6: Digitizer Disconnection Dialog Box

Click on the "Yes" key to disconnect the unit. Click on the "No" key to abort the disconnection operation.

Once selected and set the link, click on the button Ok. The CAENSCOPE display will appear as in **Fig. 3.7**, where, by default, the channel Ch0 is enabled.

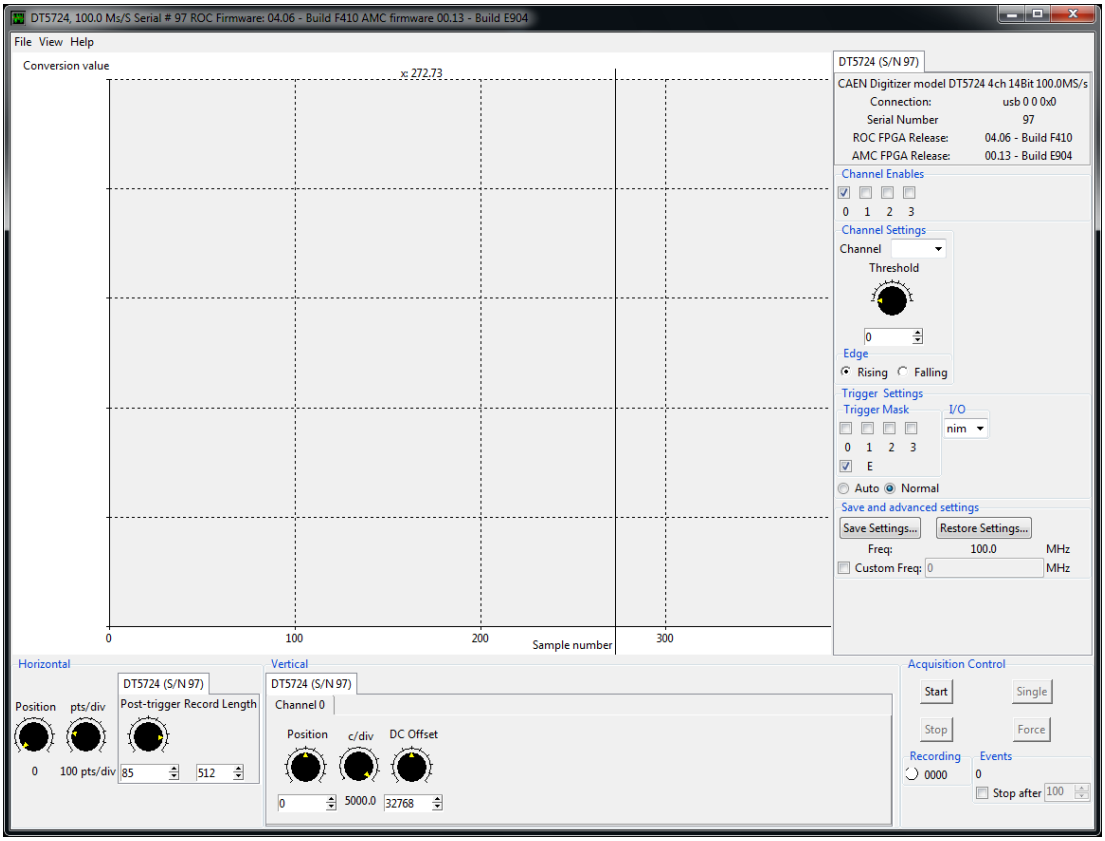

Fig. 3.7: CAENSCOPE Main Screen after connecting to a digitizer

Digitizer Info Section

In the top right corner of the screen, a tab system is shown. Each tab displays a connected digitizer Model Number and Serial Number, along with text box.

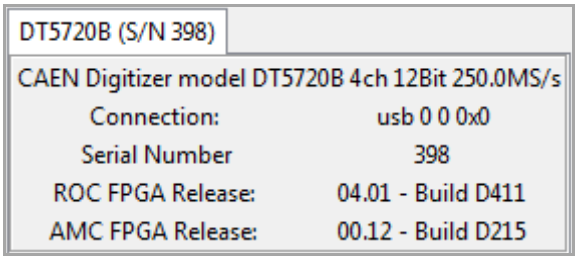

Fig. 3.8: Digitizer info section

There is a first line with a short description of the digitizer features (Number of analog input channels, digital resolution and nominal sampling rate). The second line of the box shows the connection type and the other connection parameters, as configured in the connection prompt box. The third line shows the digitizer serial number. The fourth line of the box shows the ROC FPGA release and build date (e.g. D411 stands for 11 of April, 2014). The fifth line of the box shows the AMC FPGA release and build date (e.g. D215 stands for 15 of February, 2014).

4 Commands

The Knob, Entry & Up/Down Controls

Many of the controls use a knob widget that looks like the picture below:

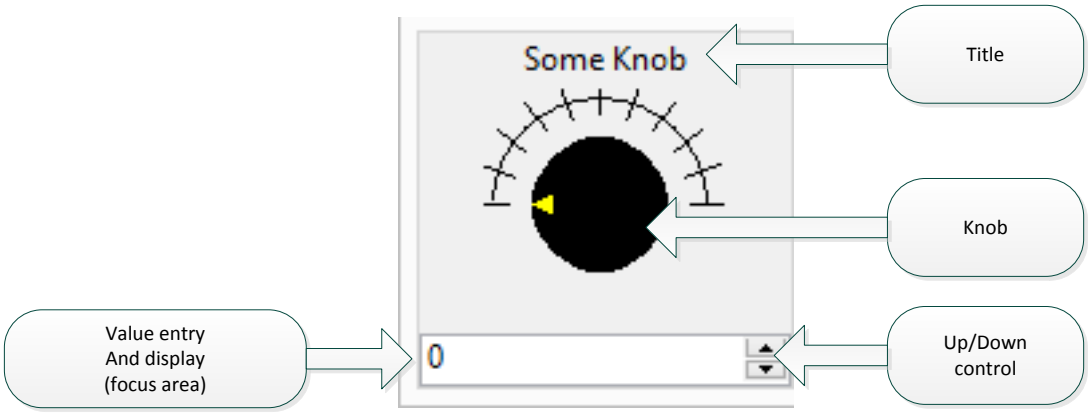

Fig. 4.1: Control knob widget for continuous variables

The knob **Title** describes the function being controlled.

To activate a control, left click on the focus area (**Value entry and display** rectangle in **Fig. 4.1**) of the control you want to operate.

To quit operating the last activated control, left click on a different control focus area or mark or unmark any check box.

The **Knob** can be fast adjusted by holding down the left mouse button and moving the pointer inside the rectangle that holds the control. The pointer on the knob (yellow triangle in **Fig. 4.1**) will point towards the mouse pointer. A finer control can be obtained by using the mouse wheel. Rotating the mouse wheel forward will turn the knob clockwise and rotating the mouse wheel backwards will turn the knob counterclockwise.

The knob for continuous variables features also:

- The **Up/Down control** can be clicked on to increment or decrement the controlled value by a preset amount. This can also be accomplished via the up/down arrow keys on the keyboard, or by rotating the mouse wheel. Rotating the mouse wheel forward will increase the control value and rotating the mouse wheel backwards will decrease it
- The **Value entry And display** part of the control displays the current value selected by the knob. You can also type a new value and move the knob to that value by hitting the “Enter” key, or by shifting keyboard focus out of the entry widget (quitting the control).

The knob for discrete variables (see **Fig. 4.2**) is neither provided with Up/Down control nor Value entry And display, but it can only go to the position of its tick-marks. The actual value of the relevant parameter is displayed accordingly in a dynamic label placed underneath the knob. With the keyboard focus active, the up and down arrow keys can increase/decrease the knob value by one tick mark.

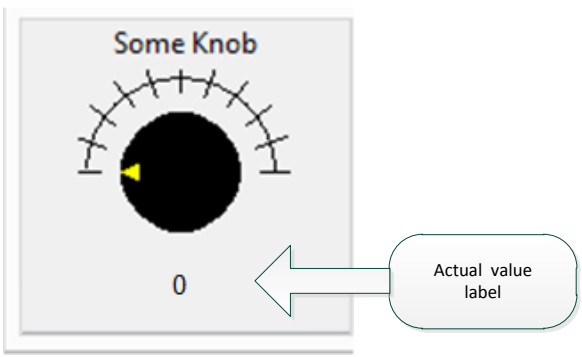

Fig. 4.2: Control knob widget for discrete variables

5 Horizontal Section

This section is always present on the CAENSCOPE display once at least one digitizer unit has been connected to the host computer.

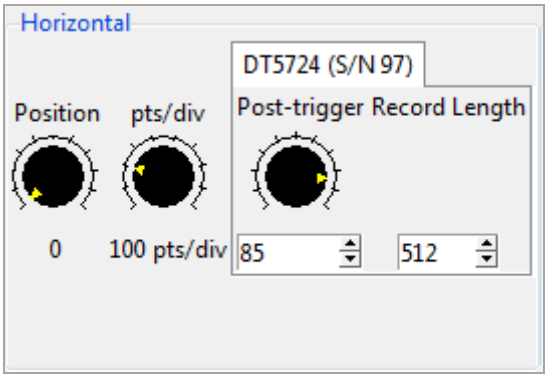

Fig. 5.1: Horizontal settings section

X-Axis Display Options

Horizontal Position (Graphical)

This is a digital setting, not affecting the hardware settings. The **Position** knob is a display feature which allows the current trace to be scrolled horizontally to the left or to the right on the grid. The **Position** graphical function can be operated by rotating the relevant knob. This control ranges from "0" up to "10" in steps of 1, i.e. 500 points.

Horizontal Scale (Zoom)

This knob controls the time expansion of the traces. It is a pure software zoom.

Without the X-axis calibration: the time base is scaled in pts/div, indicating the sampled points/division. The left most position of the knob represents a 10 points/div scale value. Taking the 724 digitizer family as reference, the scale ranges from 10 to 5000 pts/div in 10 steps.

With the X-axis calibration: the time base is scaled in time-unit/division. Taking the 724 digitizer family as reference, the horizontal scale can be selected with the following values : 1,5,10,50,100,500 nsec/div, 1,5,10,50,100,500 µsec/div, 1 msec/div.

Post-trigger

The **Post-trigger** setting controls the hardware post-trigger configuration, which is common to all the enabled channels of a digitizer. The Post-trigger is set as the record desired percentage (i.e. % of the total **Record Length**) the User wants to visualize after the trigger point. This is obtained by generating, after the trigger is received, a delayed command to stop the acquisition. The delay corresponds to the post-trigger value, i.e. the percentage of the full waveform record time value to be recorded after the trigger point. If the **Post-Trigger** is = 0, then the waveform is acquired till the trigger point occurs. If the **Post-trigger** is = 100, then the point sampled at Trigger time is the first point of the record.

This control ranges from 0 (%) to 100 (%) of **Record Length** and can be set in a fine way through the relevant knob or typing the value in the text box (in steps of 1 % of the **Record Length**), and in a coarse one by the up/down arrows aside the text box (in steps of 5 % of the **Record Length**). The post-trigger function is operative also on custom defined record lengths.

Record Length

The **Record Length** Value Box entry controls the hardware record length setting, which is common to all channels of a digitizer. This determines the number of samples each digitizer channel will take for each record. The up/down arrows move between the pre-defined record lengths defined for the digitizer in its buffer organization register (refer to the relevant digitizer User Manual for details). The User can, however, use a custom record length by simply typing a new value in the entry to the left of the up/down arrows and confirming the entry with the "Enter" keyboard command. If the Value Box entry has input focus, the up/down keyboard arrows act as alternative to the up/down arrows on the right of the Value Box. The minimum and maximum record length depend, in general, on the Digitizer model and memory size version.

6 Vertical/Acquisition Section

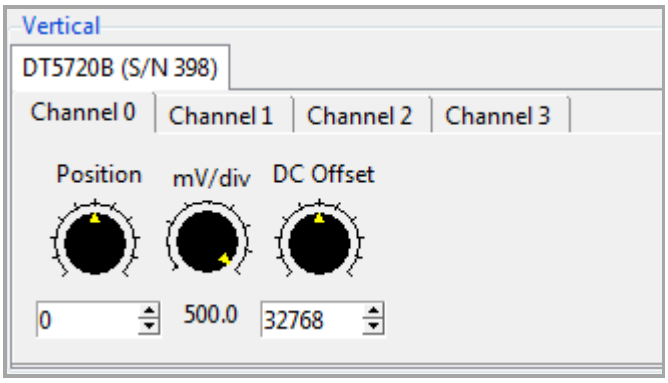

Fig. 6.1: Vertical Settings Section

Y-Axis Display Options

To enable the vertical section, one or more of the "Channel Enables" checkboxes in the Trigger section must be selected (see **Fig. 7.2**). When a "Channel enable" checkbox is selected, it adds to the vertical section a Tab marked with the corresponding activated channel number. Each tab allows the Vertical Position, Scale (Vertical Zoom) and DC Offset to be controlled for the specified channel.

Vertical Position (Graphical)

The **Vertical Position** knob/entry performs software control that adds a constant software offset to the vertical position of a channel trace. This allows for positioning traces vertically without any risk of truncating the signal (as it might happen if the **DC Offset** control is used). Vertical position range goes from -100 to +100 in steps of 5 (arbitrary unit).

Vertical Scale (Zoom)

The **Vertical Scale** knob/entry performs a software control that changes the effective volts or counts per vertical division of the trace. This is a purely software expansion. This parameter ranges from 0.5 to 5000 c/division (with **Calibrated Axis** disabled) or from 0.05 to 500 mV/division with **Calibrated Axis** enabled).

DC Offset

This control affects the hardware. Each analog input stage (i.e. channel) of the digitizer is provided with a 16-bit DAC for the DC offset adjustment (refer to the digitizer User Manual for a more detailed description). This knob adjusts the DC offset added to the channel being set (range: 0 up to 65535 counts).

7 Channel &Trigger Panel

This Tab includes a section allowing the User to enable the individual channels acquisition (*Channel Enables*). Then, there is a trigger section where the User can define, whenever allowed by the hardware, the trigger conditions for the individual channel (*Channel Settings*) and the Trigger Mask condition (*Trigger Mask*) as well as the signal logic level of the digitizer's front panel GPIO connectors (*GPO – TRG IN – GPI for NIM and Desktop boards, S IN – TRG IN – TRG OUT for VME boards)*). A further section allows the User to modify and store the current settings of the board (*Save and advanced settings*). At the bottom, the information about the nominal sampling frequency of the digitizer is reported and a dedicated section is provided, where the User can type the sampling frequency value to be used exclusively for the X-axis calibration in case the hardware has been programmed to work to a customized frequency value.

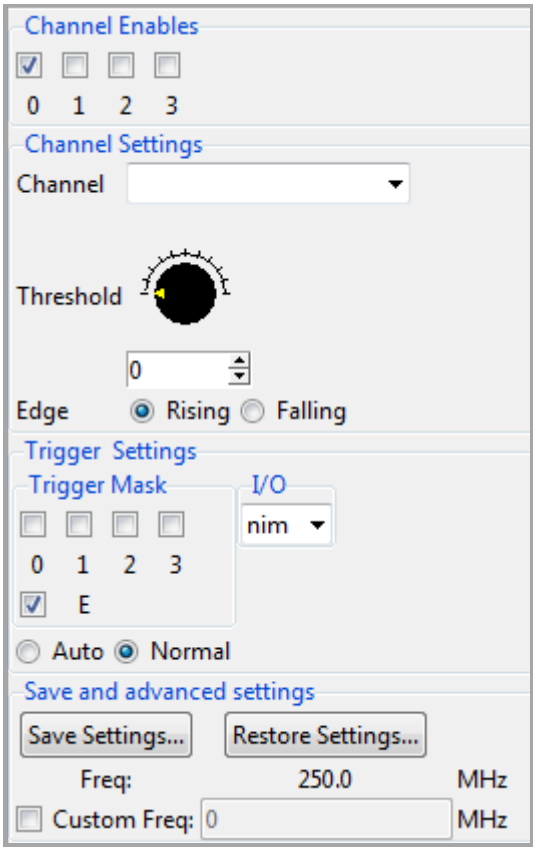

Fig. 7.1: Channel and Trigger Settings sections

Channel Enables Section

The "**Channel Enables"** Section includes as many checkboxes as the available acquisition channels of the digitizer. By marking a channel check box, the correspondent channel will be enabled for the acquisition. While all channels of the hardware will be acquiring data, only the enabled channels will transmit the acquired data to the CAENSCOPE for display and data recording. On the display, to each enabled channel trace is assigned by default a different identifying color.

Note: CAENSCOPE manages the simultaneous displaying of a maximum of 13 traces.

Channel (Normal Trigger) Settings

This Section is part of the Trigger Section. It is operative only when the Normal Trigger operation is selected in the Trigger Settings section (see below), and is related to the Trigger Mask enabled channels.

When Trigger is set to Normal, Trigger conditions can be set for each triggering channel. To set the trigger parameters, unmark all channels in the Trigger Mask. Select the trigger channel to be set, marking its check box. The number of the channel will be added to the "Channel" pull down menu in the Channel Settings tab. The User can then select the trigger channel being set amidst the ones available in that pull down menu.

Threshold Setting

The parameter that can be set for every trigger channel is the threshold level. The value can be modified by left clicking in the Threshold entry box or on the knob widget. The value can then be typed in the Threshold Entry box, or adjusted thru the knob widget or increased or decreased with the up/down arrows or by rotating forwards or backwards the mouse wheel.

The definitive value will be set once the User left clicks on a successive panel command. Once set, the threshold will be memorized until the end of the measurement session or until further changes made by the User during the same session. The set Threshold value can be recalled in the Threshold Entry box by unmarking all channels except the one of interest.

The trigger channel being set can be recognized by the small vertical grey marker to the right of the active channel check box.

Note: For digitizers whose trigger management is based on groups of channels (such as 740 series), the Threshold is common to all the channel in the group.

Edge Setting

The User can select the triggering condition to be on the "Rising " or on the "Falling" edge of the signal, by selecting the correspondent button above the channel check boxes line. The Edge setting is common to all the channels.

Trigger Settings

The "**Trigger Settings**" section allows the User to:

- Select which channels can trigger data taking.
- Enable/disable the External trigger.
- Select the type of logic signal (NIM or TTL) accepted as External Trigger (on the front panel relevant connector) or presented at the Trigger output of the digitizer (on the front panel relevant connector).
- Select the trigger mode *Auto* or *Normal*.

Trigger Sources

A row of check boxes numbered according to the digitizer channels allows the User to select which corresponding acquisition channel will be the trigger source. A check box marked "*E*" is available for the External Trigger selection.

Trigger Mask

The Trigger Channels are enabled by marking the desired channels check box and disabled by unmarking it. Every enabled Trigger Channel contributes as an OR source to the Digitizer Trigger Mask, i.e. the digitizer will be triggered by the trigger signal generated by the first of the enabled trigger channels receiving a valid trigger event.

Upon marking a channel as a trigger originator, at the upper left corner of the display the trigger origin information will be added in the format : " > SN (serial number of the digitizer), (channel number) ". Each triggering channel reference will be identified by a different color, matching the selected display color of the referenced channel.

Note: CAENSCOPE manages the simultaneous enabling of a maximum of 13 Trigger Channels.

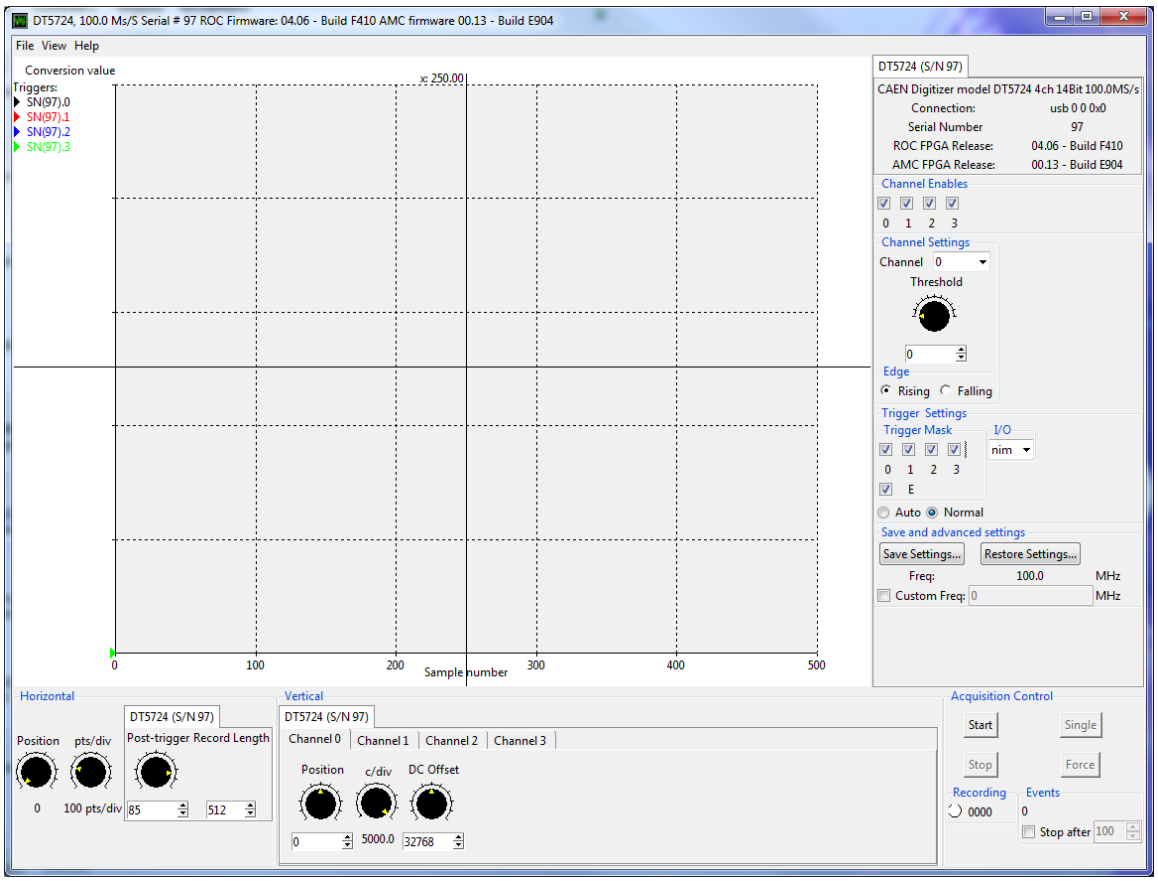

Fig. 7.2: CAENSCOPE Main Screen with Channel Enabled and Trigger Mask Enabled Channel

Trigger Type

- **Normal:** In Normal mode, only hardware triggers generated as ORs of the marked channels indicated in the trigger mask will initiate the events recording condition.
- **Auto:** In Auto mode, when the digitizer is running, periodic software triggers are provided if no hardware triggers are received. This allows the User to observe the baseline level of the digitizer so that the DC offset and trigger level can be better set.
- **External:** The selection of the "External" (E) Trigger check box will allow the digitizer to record data only if an logic External Trigger signal is received at the TRIG IN input of the digitizer. The accepted External Trigger Logic levels can be selected as NIM or TTL in the "*I/O*" pull down menu.

  The External trigger can be ORed with the hardware triggers if enabling simultaneously "E" and one or more channels in the Trigger Mask.

Save and Advanced Settings

In this section, by clicking on the “Save Settings…” key, the User can select a Windows Directory path to save the current settings of the Acquisition & Trigger configuration as an XML file to a folder.

By clicking on the “Restore Settings…” key, the User can recall a previously recorded setting file in XML format from a folder in a Windows Directory to restore a set of settings of the Acquisition & Trigger configuration recorded from a previous test.

A CAENSCOPE Settings XML file example is shown below:

<?xml version="1.0"?>

<caendigitizer>

<digitizer serial="19" version="17" family="xx724" id="9D80864ED42BCEE672B65F496FAC53CA">

<channels value="4"/>

<resolution bits="14"/>

<frequency hz="100000000.0"/>

<maxsamples maxsamples="524288"/>

<channelgroups capable="0"/>

<zerosuppression capable="0"/>

<inspection capable="0"/>

<dualedge capable="1"/>

<voltagerange hi="5.0" low="-5.0"/>

<windows>

<window size="256"/>

<window size="512"/>

<window size="1024"/>

<window size="2048"/>

<window size="4096"/>

<window size="8192"/>

<window size="16384"/>

<window size="32768"/>

<window size="65536"/>

<window size="131072"/>

<window size="262144"/>

</windows>

</digitizer>

<settings id="2" digitizer="9D80864ED42BCEE672B65F496FAC53CA">

<dcoffsets>

<dcoffset value="32768" channel="0"/>

<dcoffset value="32768" channel="1"/>

<dcoffset value="32768" channel="2"/>

<dcoffset value="32768" channel="3"/>

</dcoffsets>

<trigger external="disabled" mask="12" direction="rising">

<level value="9091" channel="0"/>

<level value="8250" channel="1"/>

<level value="2150" channel="2"/>

<level value="360" channel="3"/>

```
</trigger>
<window size="1024"/>
<posttrigger value="34.0%"/>
<channels mask="3"/>
</settings>
</caendigitizer>
```

Acquisition Control Settings

The "**Acquisition Control**" section is located at the bottom of the CAENSCOPE screen, to the right of the Horizontal and Vertical Sections. It contains the following four keys :

- **"Start"**: this key starts the data taking in the mode selected in the Trigger Settings tab.
- **"Stop"**: this key stops the data acquisition on all channels.
- "**Single"**: this trigger button takes the digitizer out of data taking mode after the next trigger. If the digitizer is already stopped, it is started and again runs until the next trigger occurs.
- **"Force"**: this key performs a single software trigger of the module. This function is useful to help the User to locate the trace when the trigger conditions have not yet been set properly.

At the bottom left of the section there is a "Recording" status LED indicator. The LED turns green when the Recording function is enabled (see § **Data Recording**). In this condition, every valid event will be recorded to the currently selected record file.

To the right of the LED an event counter indicates the number of waveforms that were recorded to the Record file since the "Record" was given in the "File" pulldown menu. The LED stays green indicating that all incoming records will be written to the selected file until the "Close" command will be clicked in the "File " pull down menu. The file event counter will remain frozen to its last value upon recording closure. It will be reset to zero if the User changes the destination Record File name or if the User exits the CAENSCOPE program. To the right of the Recording Event Counter a "current acquisition" counter indicates the number of waveforms (events) that were recorded since the last "Start" command was given. Starting the acquisition resets the current acquisition event counter to 0.

A check box marked "Stop after" allows the User (by checking it) to enable a data acquisition stop condition. This is possible by setting the number of events to be recorded before stopping the acquisition in the "Stop after" text box (press enter to activate the typed value).

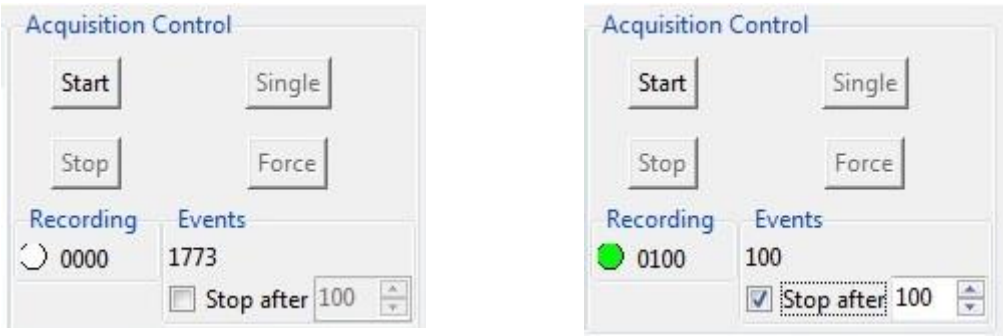

Fig. 7.3: Acquisition Control section and active event-driven Recording

8 Data Acquisition and Recording

Data Acquisition

To understand the Data Acquisition and Recording procedures, it is important to remember that each Digitizer Board channel memory operates as a circular buffer. To display a waveform on the screen, the selected number of acquisition points is read and displayed, then the data are overwritten upon the successive trigger by the next waveform sampling. Thus, the waveforms displayed on the screen are not recorded to a file unless the Data Recording function is enabled.

While all hardware channels are digitizing data upon a valid trigger reception, only the Enabled Channels Data are sent to the CAENSCOPE program and made available for display and for recording. Of those data, only the ones belonging to the channels whose Record Data file has been enabled will be permanently recorded to a *.XML or a *. db file.

Thus, if data have to be recorded, a Record File has to be created or enabled thru the process indicated below.

Data Recording

In order to enable a Data Recording session, before to start the acquisition, in the “File” pull down menu of the Menu Bar, the User must left click on the “Record (text)” option or the “Record (binary)” one. According to this selection, data can be recorded either as *namefile.xml* files or as *namefile.db* files. Upon activation of the recording function, all eligible events recorded from the enabled channels by the digitizer will be appended to a db or to an XML file till the acquisition is stopped.

With the “Record (binary)” or “Record (text)” option selected, the “Recording” LED turns on green.

The “Close” option in the “File” pull down menu allows then to disable the Data Recording setting (“Recording” LED lights off) and closes the generated output file making it available to be read.

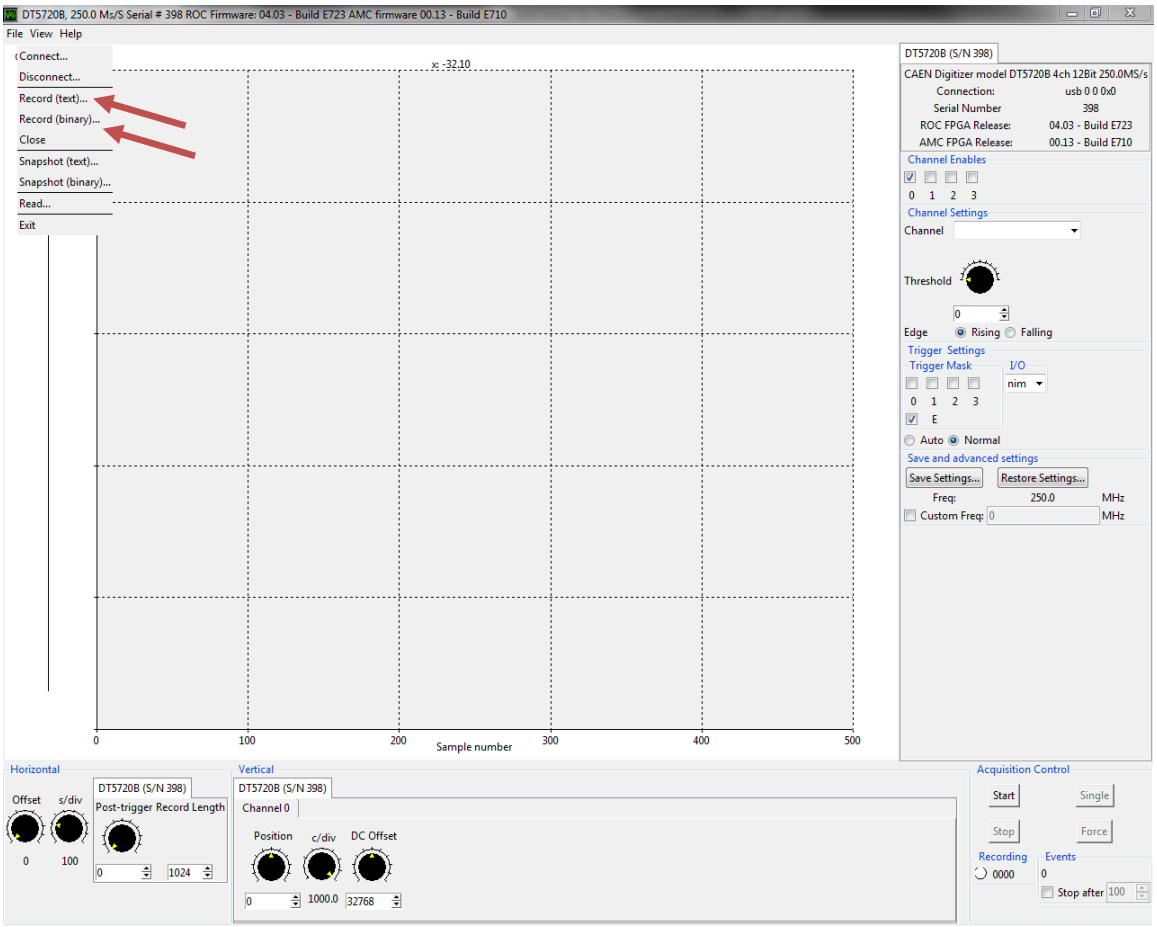

Fig. 8.1: CAENSCOPE Recording activation

SQLite Data Base Recording

In the Menu Bar, select “File”, then “Record (binary)” as indicated in **Fig. 8.1**. A Windows Directory window will open, allowing the User to create a SQLite db record file into the desired folder. By creating the file the data recording is enabled. Events will be appended to the file as they are recorded by the digitizer and numbered sequentially. Simultaneous event records from different channels will be tagged with the same sequential number, in each channel.

Start the data acquisition with the “Start” key in the Acquisition Control section. (If the Record db file is created while the acquisition is already running, the CAENSCOPE will start recording already from the first available complete event record successive to the file creation).

Stop the acquisition by using the “Stop” key in the Acquisition Control section.

The display will show the last current signals recorded as in the picture below:

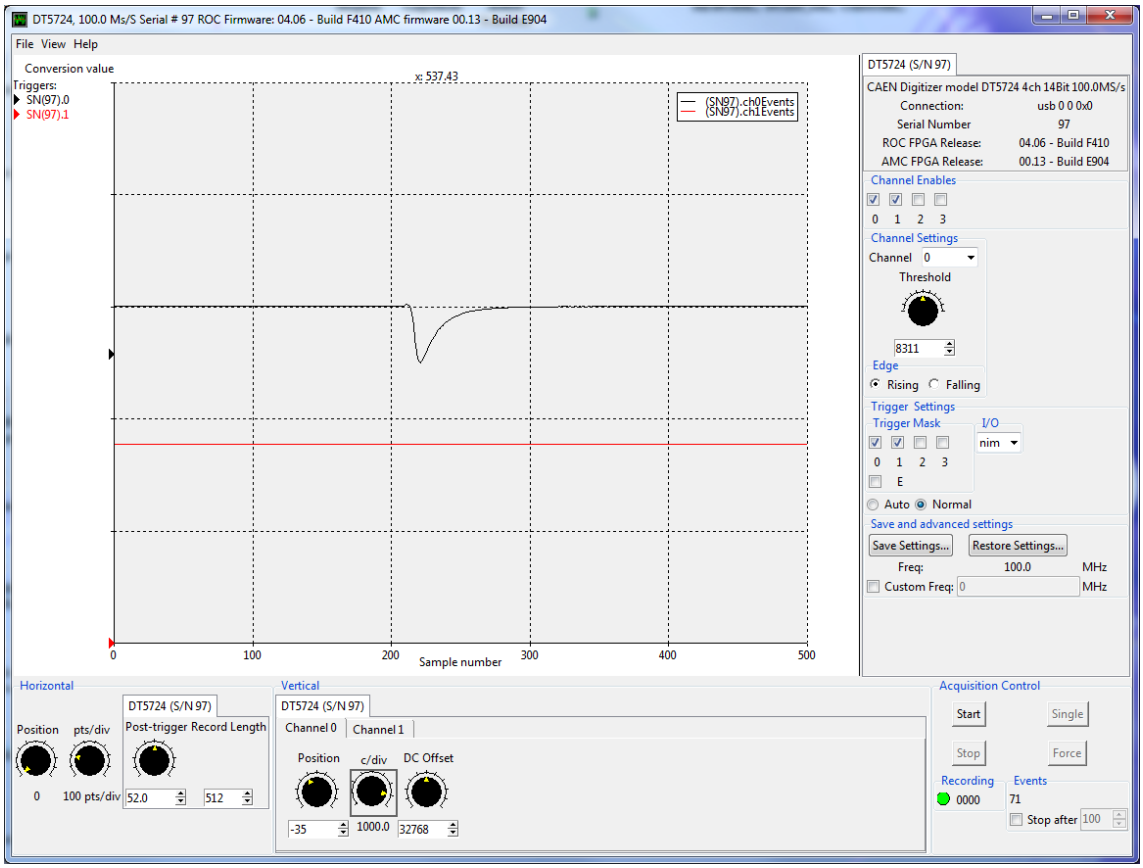

Fig. 8.2: CAENSCOPE Main Screen with live signals on CH0 and CH1

From the Menu Bar, select the “File” item , then the “Read” item. A Recorded Events File Tab will appear to the right upper corner of the screen. Click on the tab to access the recorded data display as in the picture below:

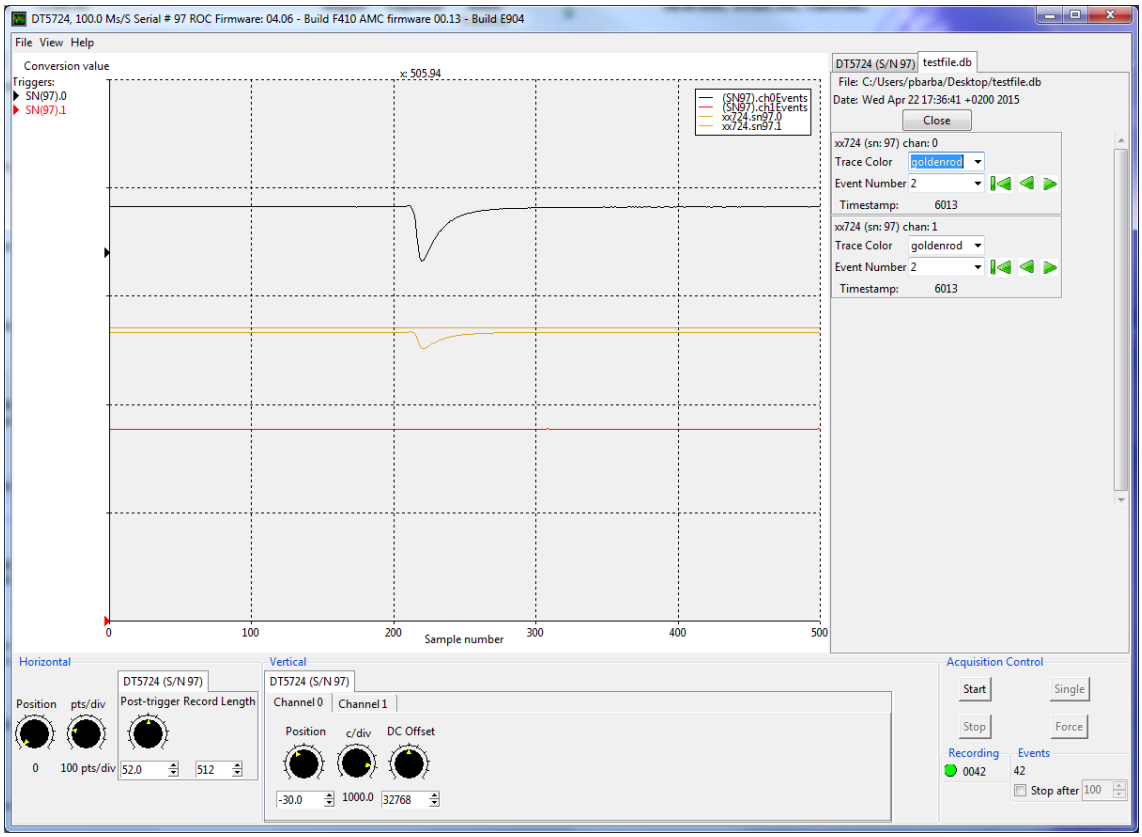

Fig. 8.3: CAENSCOPE Main Screen with recalled recorded signals from CH0 and CH1

The Recorded Events Tab is identified by the *filename.db* record path and the date of the Acquisition File Creation. It presents as many channel sections as the number of channels which were recorded simultaneously.

The User can scroll each channel independently and visualize the correspondent event on the display. Each section is tagged with the Digitizer Model Number, Serial Number and Number of the channel. Each channel trace can be identified on the display by a specific Trace Color, selectable in the corresponding pull down menu.

Events from different channels with the same event number have been recorded at the same trigger time.

By clicking on the Digitizer Tab, it is possible to restart the data acquisition while still displaying the selected recorded events (See **Fig. 8.4**).

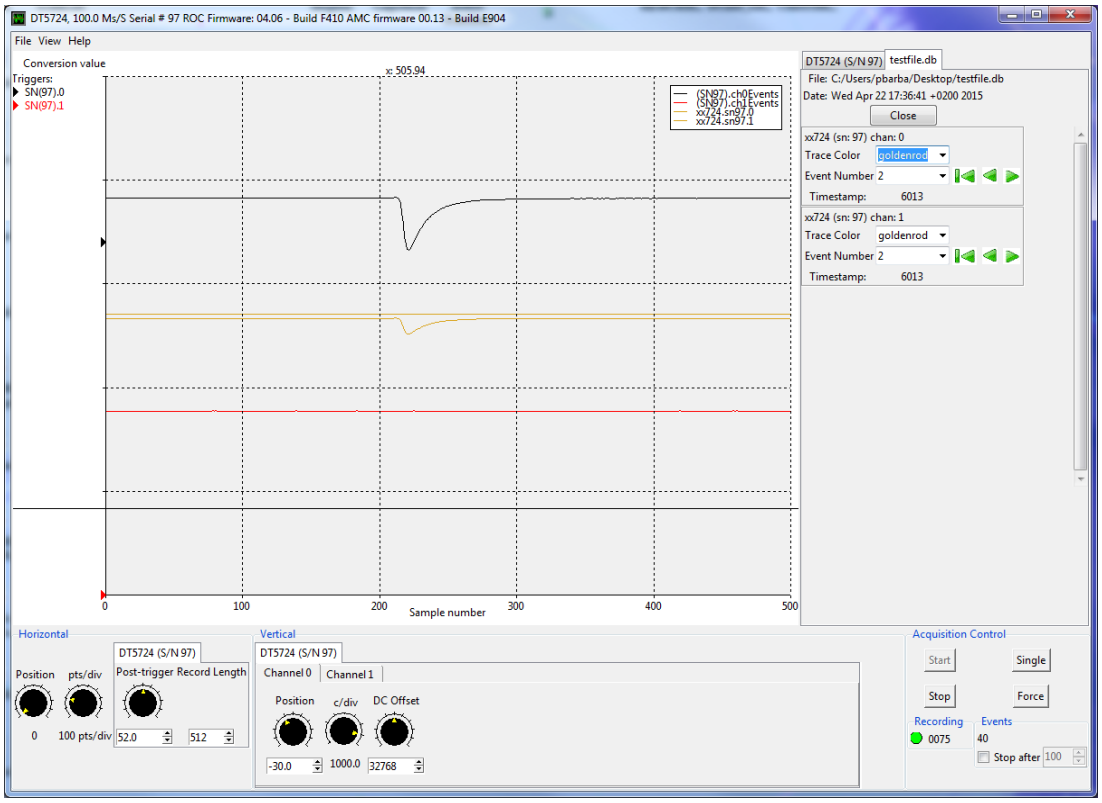

Fig. 8.4: CAENSCOPE Main Screen with live signals on CH0 and CH1 and selected recorded events from db file

The Recorded Event File can be read also when no digitizer is connected. Upon initialization of the CAENSCOPE program as in § **3**, the User can recall the Event files by accessing the Menu Bar item “File” and then“ Read” (see the picture below):

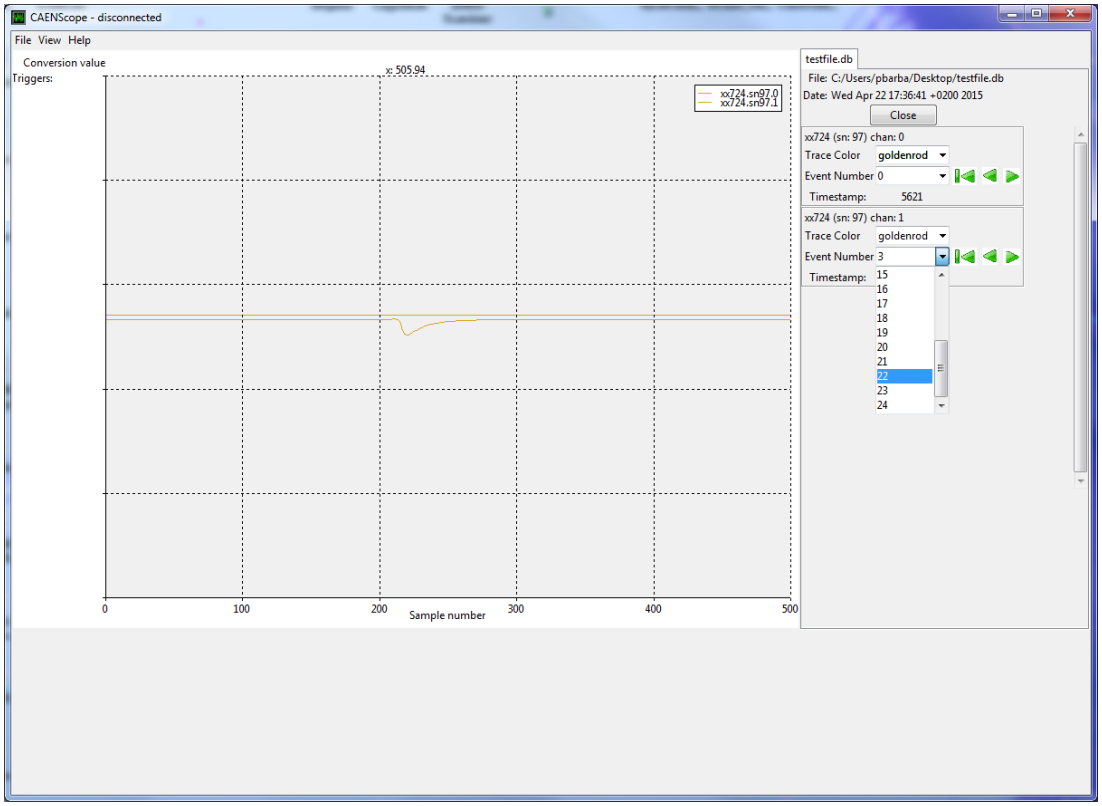

Fig. 8.5: CAENSCOPE Main Screen with recorded events from db file

In **Fig. 8.5** the event number 2 of the CH0 records and the event number 68 of the CH1 records are shown for comparison.

Multiple Recorded Event Tabs can be recalled, both in Live or Recorded Sessions, each one will be identified by the *filename.db* indication on the corresponding Tab, as well as by the Date of the creation of the Record File

To close the Recorded Events Tab, use the "Close" key.

XML File Recording

In the Menu Bar select "File" then "Record(text). A Windows Directory window will open, allowing the User to create an XML record file into the desired folder. By creating the file the data recording is enabled. Events will be appended to the file as they are recorded by the digitizer and numbered sequentially. Simultaneous event records from different channels will be tagged with the same sequential number, in each channel.

The acquisition and recording is stopped by using the Stop key in the Trigger and Acquisition Section.

Readout operation is similar to that of the db files, however the XML files need to be first converted to db files before display is available. This may take some time, depending on the XML file Size.

For example, without connecting the digitizer, it is possible to recall a recorded XML file. After the conversion time is elapsed the Main Screen will appear as in the following **Fig. 8.6**.

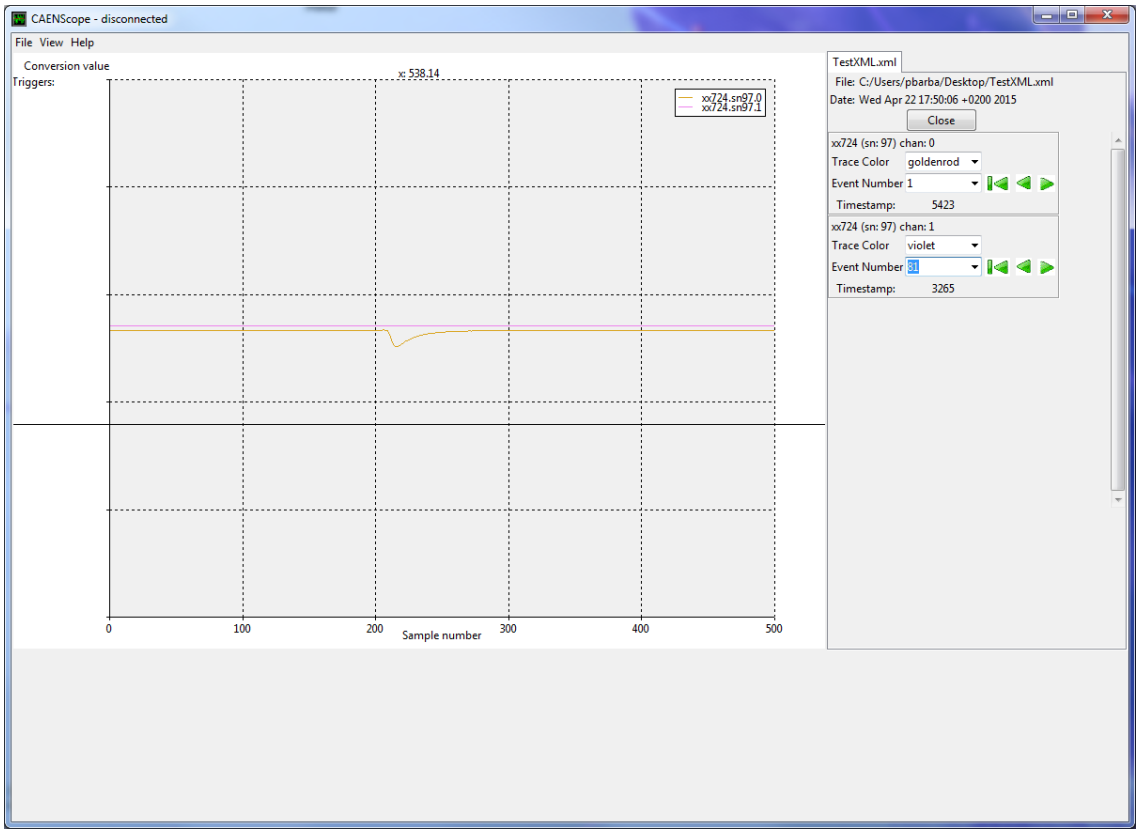

Fig. 8.6: CAENSCOPE Main Screen with recorded events from XML file

9 Display Utilities

Cursors and Region of Interest (ROI)

The CAENSCOPE plot can be swept by cursors moving with the mouse pointer. The x-axis value is dynamically displayed at the top of the plot area (see **Fig. 9.1**).

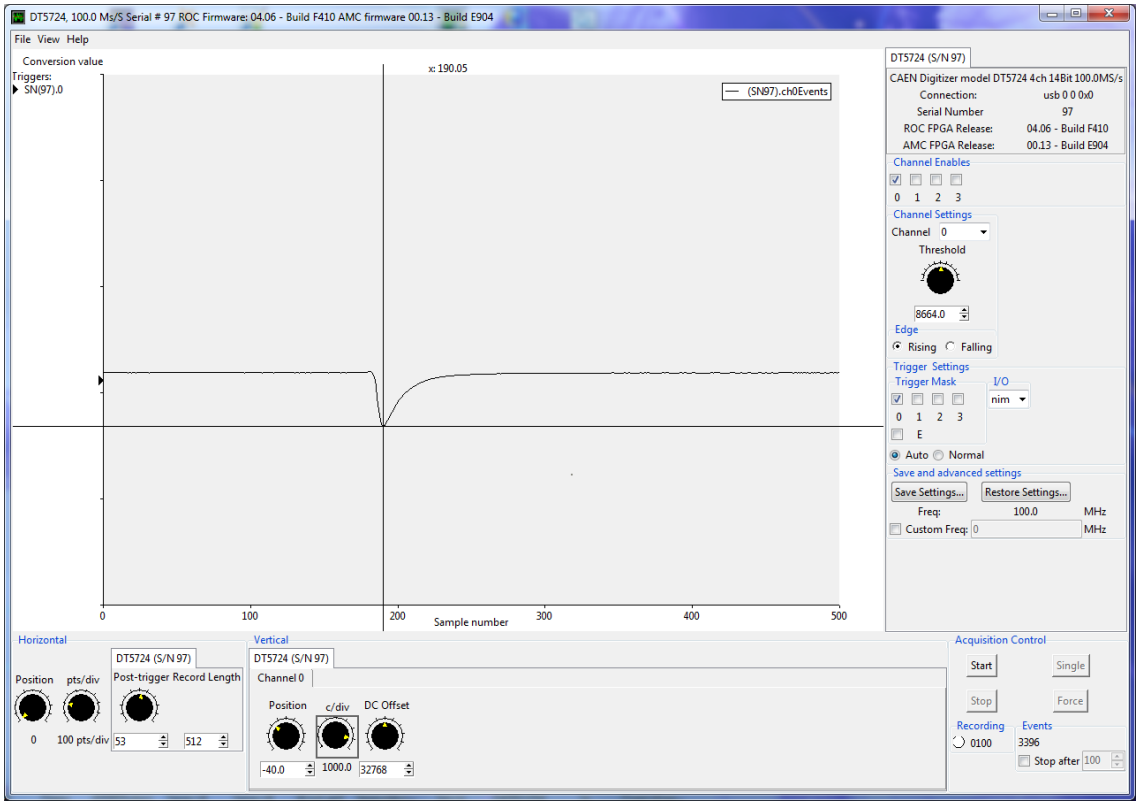

Fig. 9.1: CAENSCOPE plot cursors

It is further possible to select a Region Of Interest (ROI) on the plot. Just hold down the left mouse button and drag the pointer to define the desired ROI (see **Fig. 9.2**). At the top of the plot area, the ROI sample number range and the ROI width (in samples) is given. By right clicking, the y-axis value and range of the ROI are displayed for user convenience (see **Fig. 9.3**).

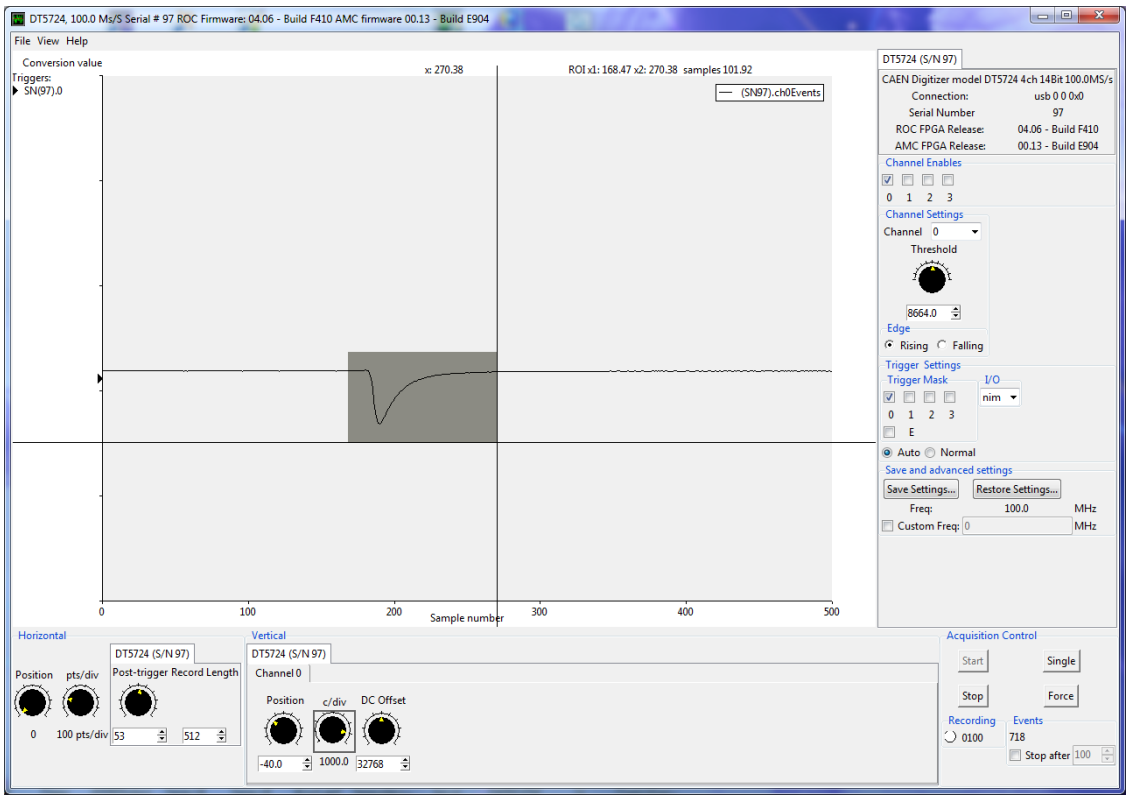

Fig. 9.2: CAENSCOPE ROI selection

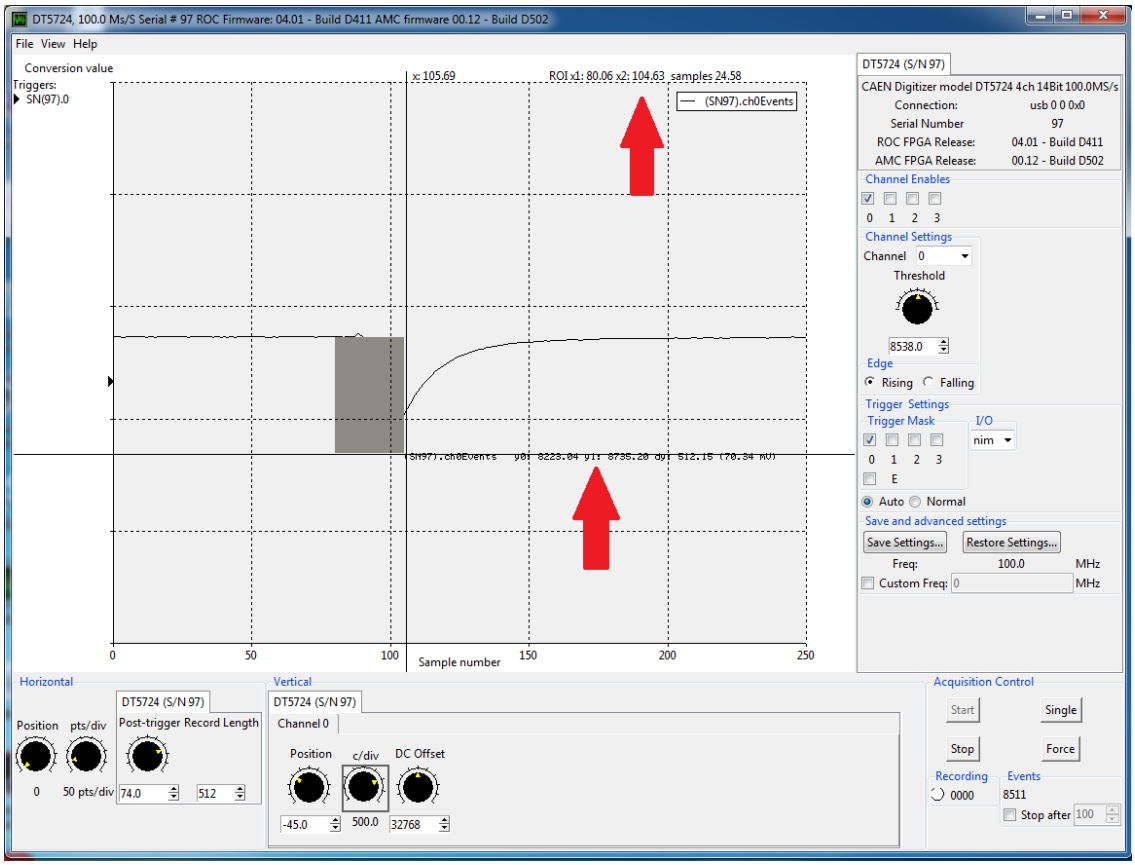

Fig. 9.3: CAENSCOPE ROI information

ROI selection is possible with imported traces as well.

10 Exiting the CAENSCOPE

To Exit the CAENSCOPE, from the Menu Bar access the item “File” then the Item “Exit”. It is also possible to use the Standard Windows closing button in the upper right corner of the window (see **Fig. 10.1**).

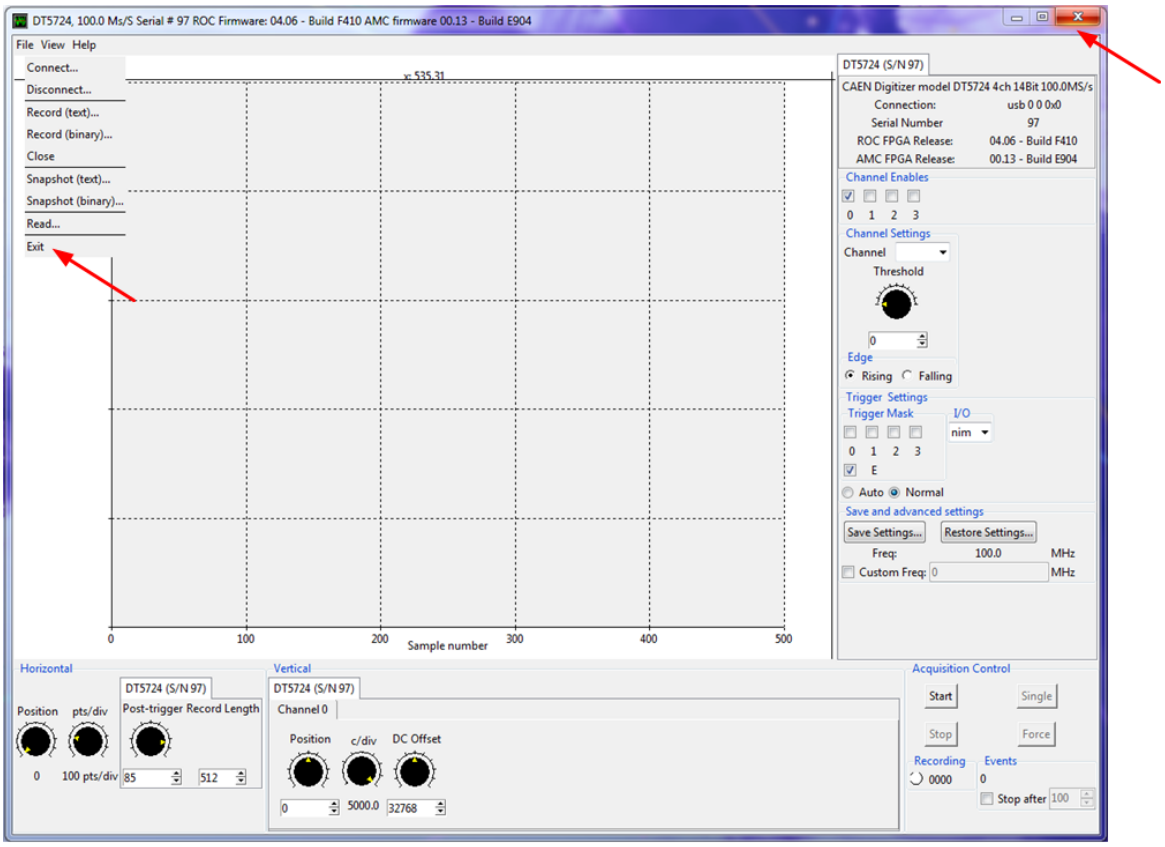

Fig. 10.1: CAENSCOPE Exit options

11 CAENSCOPE Output Files

CAENSCOPE Output File Formats

CAENSCOPE can produce three types of output files:

- **Saved settings files**
- **Text event log files**
- **Binary event log files**

This chapter describes the format of these three files.

Saved Settings Files

These files capture the settings of a digitizer at an instant in time. These files are textual and are in XML. At present there is no DTD against which a validating parser can validate these files. The root tag of the document is <caendigitizers>. All data in this file are encapsulated in a single top level <caendigitizers> element.

Within the <caendigitizer> element there are two elements:

- <digitizer> which describes the digitizer and its capabilities
- <settings> which capture the settings of a digitizer at an instant in time.

In theory the file can have several <digitizer> tags and several <settings> tags. The <settings> tags have an attribute **digitizer** that refers to the **id** attribute of the <digitizer> tag to which it applies. This format naturally allows for several digitizers each with several settings snapshots to coexist in a single settings file.

`<digitizer>`

The contents of a <digitizer> tag describe a digitizer and its capabilities. The tag itself has the following attributes:

- **id –** Identifies the digitizer. The **id** is chosen to be a hash that is unique and reproducible for a specific digitizer module.
- **family –** Identifies the family of the digitizer e.g. x724 is used for the V1724, N6724 and the DT5724 modules.
- **Version –** contains the board version number.
- **serial –** Contains the module serial number.

The body of the <digitizer> tag contains the following elements:

`<channels>`

This element has no body. It has the attribute value whose **value** is the number of input channels the digitizer has. Note that for the SCA digitizers this value does not count the TR0 input

`<resolution>`

This element has no body. It has the attribute **bits** whose value is the number of bits of resolution the digitizer offers. For example: <resolution bits="12" /> means the digitizer sample values are in the range [0,4095].

`<frequency>`

This element has no body. It has the attribute **hz** whose value is the sampling frequency of the digitizer.

Note: in the future this may need to be expanded to correctly handle multi-sampling frequency devices like the SCA digitizers.

`<maxxamples>`

This element has no body. Its attribute **maxsamples** gives the maximum number of samples the digitizer can acquire in one event for one channel**.**

`<channelgroups>`

This element has no body. The attribute **capable** describes whether or not the digitizer groups its channels. If 0 the digitizer does not group channels. If nonzero, this is the number of channels in a channel group.

`<zerosuppression>`

This element has no body. If the **capable** attribute is non-empty, the digitizer can return waveforms in a zerosuppressed format.

<inspection>

This element has no body. If the **capable** attribute is non-empty, the digitizer has an inspection output to which signals can be routed.

<dualedge>

Empty element whose **capable** attribute indicates whether or not the digitizer can be switched into the frequency doubling dual edge sampling mode.

<voltagerange>

Empty element with the following attributes:

- **low** the lowest input voltage accepted by the digitizer.
- **High** the highest input voltage accepted by the digitizer.

Note that for CAENSCOPE, these values are input by the User for digitizers that have multiple input range options. This implies that these data are only as good as the User's input. Once entered for a digitizer, the value is memorized

<windows>

This tag contains one or more `<window>` tags. Each of those has an attribute **size** whose value is the number of samples per channel in an event for the pre-defined buffer organizations**.**

<settings>

This tag contains elements that describe a digitizer setting at a point in time. The following attributes are present in the `<settings>` tag:

- **id –** a unique setting id. No two settings will have the same id value.
- **digitizer –** the value of the **id** of the digitizer these settings are for.

The `<settings>` tag contains the following elements:

<dcoffsets>

This element contains a `<dcoffset>` element for each channel of the digitizer. The attributes of the `<dcoffset>` tag are:

- **channel –** the number of a channel (channels number from 0).
- **value –** The value of the DC offset register for that channel.

<trigger>

This tag has the following attributes:

- **direction –** has the value rising or falling indicating the trigger edge.
- **mask –** has as a value a mask of channels with bits set for each channel that participates in the trigger.
- **external** contains the state of the external trigger. This can be one of `acq` if the EXT input forces an acquisition, `both` if the external trigger both forces a trigger and outputs on the GPO output, `disabled` if the external trigger is disabled.

The `<trigger>` tag contains several `<level>` tags. Each of those has the attributes:

- **channel –** a channel number (numbered from 0).
- **value –** The threshold value for that channel.

<window>

Has the attribute **size** whose value is the number of samples acquired per trigger in each channel.

<posttrigger>

Has the attribute **value** which is of the form *nnn%* where *nnn* is the percentage of the widow size in the post-trigger.

<channels>

Has the attribute **mask** which contains the mask of channels enabled to take data.

Sample settings file

```
<caendigitizer>
<digitizer id="9641E17EA872CAED059B06194120AE02" family="xx740" version="80"
serial="174">
 <channels value="32"></channels>
 <resolution bits="12"></resolution>
 <frequency hz="65000000.0"></frequency>
 <maxsamples maxsamples="196608"></maxsamples>
 <channelgroups capable="8"></channelgroups>
 <zerosuppression capable=""></zerosuppression>
 <inspection capable=""></inspection>
 <dualedge capable=""></dualedge>
 <voltagerange low="0.0" hi="2.0"></voltagerange>
 <windows>
  <window size="192"></window>
  <window size="384"></window>
  <window size="768"></window>
  <window size="1536"></window>
  <window size="3072"></window>
  <window size="6144"></window>
  <window size="12288"></window>
  <window size="24576"></window>
  <window size="49152"></window>
  <window size="98304"></window>
  <window size="196608"></window>
 </windows>
</digitizer>
<settings id="1" digitizer="9641E17EA872CAED059B06194120AE02">
 <dcoffsets>
  <dcoffset channel="0" value="32768"></dcoffset>
  <dcoffset channel="1" value="32768"></dcoffset>
  <dcoffset channel="2" value="32768"></dcoffset>
  <dcoffset channel="3" value="32768"></dcoffset>
 </dcoffsets>
 <trigger direction="rising" mask="0" external="acq">
  <level channel="0" value="0"></level>
  <level channel="1" value="0"></level>
  <level channel="2" value="0"></level>
  <level channel="3" value="0"></level>
 </trigger>
 <window size="192"></window>
 <posttrigger value="5.0%"></posttrigger>
 <channels mask="0"></channels>
</settings>
```

```
</caendigitizer>
```

Text event log files

Text event log files are also XML files. As with settings files the top level tag is a <caendigitizer> tag.

Similarly there are one or more <digitizer> tags and one or more <settings> tags for the digitizers and settings in effect when data from them are recorded.

For each event, there will also an <event> tag. The <event> tag has the following attributes:

- **id** – a unique id for the event.
- **settings** – the id of the settings in effect when the event was triggered.
- **digitizer** – the id of the digitizer from which this event comes.

The <event> tag has the following contents:

<triggershift>

Has the attribute **samples** if this is non-zero then trigger stabilization was being computed when the event was triggered and the value of this is the number of samples to shift the waveform by to make the trigger condition lie at the position indicated by the post-trigger value.

<trace>

An event will have several <trace> tags. The <trace> tag will have the **channel** attribute indicating which channel the trace comes from. The body of the <trace> tag is CDATA containing a set of space separated integers that are the sample values.

Sample event file

```
<caendigitizer>


<digitizer id="ED8A092BA1293CBEB4385A00CDE69B5D" family="xx724" version="17"
serial="899">
 <channels value="8"></channels>
 <resolution bits="14"></resolution>
 <frequency hz="100000000.0"></frequency>
 <maxsamples maxsamples="524288"></maxsamples>
 <channelgroups capable="0"></channelgroups>
 <zerosuppression capable="0"></zerosuppression>
 <inspection capable="0"></inspection>
 <dualedge capable="1"></dualedge>
 <voltagerange low="-10.0" hi="0.0"></voltagerange>
 <windows>
  <window size="256"></window>
  <window size="512"></window>
  <window size="1024"></window>
  <window size="2048"></window>
  <window size="4096"></window>
  <window size="8192"></window>
  <window size="16384"></window>
  <window size="32768"></window>
  <window size="65536"></window>
  <window size="131072"></window>
  <window size="262144"></window>
```

```
 </windows>
</digitizer>
<settings id="1" digitizer="ED8A092BA1293CBEB4385A00CDE69B5D">
 <dcoffsets>
  <dcoffset channel="0" value="32768"></dcoffset>
  <dcoffset channel="1" value="32768"></dcoffset>
  <dcoffset channel="2" value="32768"></dcoffset>
  <dcoffset channel="3" value="32768"></dcoffset>
  <dcoffset channel="4" value="32768"></dcoffset>
  <dcoffset channel="5" value="32768"></dcoffset>
  <dcoffset channel="6" value="32768"></dcoffset>
  <dcoffset channel="7" value="32768"></dcoffset>
 </dcoffsets>
 <trigger direction="rising" mask="1" external="both">
  <level channel="0" value="8465"></level>
  <level channel="1" value="0"></level>
  <level channel="2" value="0"></level>
  <level channel="3" value="0"></level>
  <level channel="4" value="0"></level>
  <level channel="5" value="0"></level>
  <level channel="6" value="0"></level>
  <level channel="7" value="0"></level>
 </trigger>
 <window size="512"></window>
 <posttrigger value="5.0%"></posttrigger>
 <channels mask="1"></channels>
</settings>
<event id="1" settings="1" digitizer="ED8A092BA1293CBEB4385A00CDE69B5D">
 <triggershift samples="0"></triggershift>
 <trace channel="0">8626 8629 8628 8626 8627 8626 8627 8626 8626 8628 8628 8628 8627 8627
8627 8627 8628 8627 8629 8628 8627 8627 8627 8627 8628 8626 8627 8627 8627 8627 8628 8626
8627 8627 8629 8629 8626 8627 8628 8627 8625 8628 8627 8627 8627 8628 8629 8626 8628 8628
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8628 8627 8626 8628 8626 8625 8626 8624 8627 8627 8626 8627 8626 8625 8627 8628 8628 8627
8629 8628 8626 8627 8626 8627 8626 8627 8628 8630 8626 8629 8625 8626 8627 8626 8626 8627
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8625 8628 8628 8628 8626 8627 8626 8629 8626 8628 8628 8627 8628 8627 8636 8633 8596 8603
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 <triggershift samples="0"></triggershift>
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8627 8627 8629 8626 8626 8625 8627 8628 8626 8627 8627 8625 8626 8628 8625 8626 8627 8628
8626 8626 8627 8626 8627 8627 8627 8626 8627 8626 8629 8628 8628 8627 8626 8629 8626 8626
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 </trace>
</event>
<event id="3" settings="1" digitizer="ED8A092BA1293CBEB4385A00CDE69B5D">
 <triggershift samples="0"></triggershift>
 <trace channel="0">8627 8626 8627 8626 8627 8627 8627 8625 8625 8625 8626 8628 8626 8627
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8627 8628 8626 8626 8627 8624 8625 8627 8626 8628 8626 8627 8626 8628 8627 8627 8626 8625
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8626 8626 8628 8627 8626 8628 8626 8627 8627 8627 8625 8626 8626 8627 8625 8625 8626 8625
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8627 8627 8628 8626 8626 8627 8626 8627 8624 8624 8623 8625 8627 8627 8626 8626 8627 8626
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8627 8629 8624 8626 8627 8625 8624 8627 8626 8627 8626 8626
 </trace>
</event>
</caendigitizer>
```

Binary Event File Format

Binary files are actually SQLite3 databases. For more on SQLite3 see http://www.sqlite.org. To summarize, sqlite3 is an SQL database in a file. This section will describe the schema of this database. SQLite has bindings to many programming languages including C/C++, Python and Java. There is a very clean mapping between the XML formats described earlier and the database tables used by the binary format.

The root table is the digitizers table and its contents capture most of the information in the `<digitizer>` tag for the XML file formats. Note that data types in SQLite affinities rather than strict data types as SQLite is not a strongly typed database.

Field Name	Data Type	Contains
id	VARCHAR(32)	Contains a unique digitizer id (the same as the id in the <digitizer> tag). This is the primary key for this table.
family	VARCHAR(32)	Family name e.g. xx724
version	INTEGER	Board version
serial	INTEGER	Module serial number
channels	INTEGER	Number of channels in the module
resolution	INTEGER	Number of bits of resolution the samples have.
frequency	INTEGER	Sampling frequency of the digitizer.
maxsamples	INTEGER	Maximum number of samples a channel can have for each trace.
channelgroups	INTEGER	0 or 1 if the digitizer does not have grouped channels, otherwise this is the number channels in a channel group.
zerosuppress	INTEGER	Non-zero if the digitizer has zero suppressed waveform formats.
inspectable	INTEGER	Non-zero if the digitizer has an inspection output.
dualedge	INTEGER	Non zero if the digitizer supports dual edge sampling.
vlow	REAL	Low limit on the input voltage.
vhigh	REAL	High limit on the input voltage.

Tab. 11.1: *digitizers* table fields

You may recall that the XML format had a mechanism for storing the set of pre-defined buffer sizes for a digitizer. In the SQLite database format this is captured by the window_sizes table which has the following fields:

Field Name	Data Type	Contains
id	INTEGER	Sequentially assigned integer. This is the table PRIMARY KEY.
digitizer_id	VARCHAR(32)	Foreign key pointing back to the record in the digitizers table that describes the digitizer for which this window size is valid.
samples	INTEGER	The number of samples in a predefined buffer size.

Tab. 11.2: *window_sizes* fields

Note that in general there will be several entries in the window_sizes table for each entry in the digitizers table. That is the relationship between a digitizer and its window sizes has many.

The information in the <settings> tag is captured in a set of tables that have as a root the settings_root table. This table has the following fields:

Field Name	Data Type	Contains
id	INTEGER	Sequentially assigned unique id for the record. This is the PRIMARY KEY of the record.
digitizer_id	VARCHAR(32)	Id of the digitizer in the digitizers table for which these settings are valid. This is a FOREIGN Key to the digitizers table.
trigger_dir	VARCHAR(7)	Either 'rising' or 'falling' indicating the trigger edge.
ext_trigger	VARCHAR(10)	How the external trigger input is handled. This can be one of acq if the EXT input forces an acquisition, both if the external trigger both forces a trigger and outputs on the GPO output, disabled, if the external trigger is disabled.
window_size	INTEGER	Number of samples that will be acquired for each channel on a trigger.
post_trigger	REAL	Percent of the window_size that will be kept prior to the trigger.
trigger_mask	INTEGER	Mask of channels that are enabled to trigger.
time_stamp	INTEGER	A time stamp in seconds since January 1, 1970 00:00:00. This time indicates when this settings entry was made in the database

Tab. 11.3: *settings_root* table fields

Information in the <thresholds> tag is maintained in the settings_thresholds table which has the following fields:

Field Name	Data Type	Contains
id	INTEGER	Sequentially assigned unique id for the record. This is the PRIMARY KEY of the record.
settings_id	INTEGER	FOREIGN KEY that contains the id of the record in the settings_root table for which this record is a threshold value.
channel	INTEGER	Channel number of the digitizer.
threshold	INTEGER	Threshold value for the channel.

Tab. 11.4: *settings_thresholds* table fields

Similarly, the DC offsets for settings are maintained in the settings_dcoffsets table:

Field Name	Data Type	Contains
id	INTEGER	Sequentially assigned unique id for the record. This is the PRIMARY KEY of the record.
settings_id	INTEGER	FOREIGN KEY that contains the id of the record in the settings_root table for which this record is a DC offset value.
channel	INTEGER	Channel number of the digitizer.
offset	INTEGER	DC Offset value for the channel.

Tab. 11.5: *settings_dcoffsets* table fields

The events themselves are in a pair of tables. The events table contains an overall description of the event including linkages back to the digitizer and settings applied at the time the event was acquired. The samples table, contains the actual samples.

Field Name	Data Type	Contains
id	INTEGER	Unique integer assigned to every event (PRIMARY KEY).
digitizer_id	VARCHAR(32)	The id of the digitizer that created the event (FOREIGN KEY to the digitizers table).
settings_id	INTEGER	Id of the settings that were active when the event was acquired (FOREIGN KEY to the settings_root table).
trigger_shift	INTEGER	If trigger stabilization was enabled, how many samples to shift the waveform to place the trigger condition in the position mandated by the Pre-trigger value. If trigger stabilization was not enabled, this will be zero.
time_stamp	INTEGER	Timestamp in seconds from January 1, 1970 00:00:00 at which the event was entered in the database. Two important notes: • This is not the timestamp from the digitizer/event. • When converting XML → Binary files, this is the time the event was converted not the time it was acquired. This is because the XML files don't currently support time stamping events.

Tab. 11.6: *events* table fields

Traces are in the samples table which has the following fields:

Field Name	Data Type	Contains
id	INTEGER	Unique integer assigned to the trace (PRIMARY KEY)
event_id	INTEGER	Id of the event metadata in the events table (FOREIGN KEY into the events table).
channel	INTEGER	Channel from which the trace comes.
sampless	BLOB	List of integers that make up the trace samples.

Tab. 11.7: *samples* table fields

Given a digitizer with the id 9641E17EA872CAED059B06194120AE02 the following query will therefore return all traces from all channels of that digitizer along with settings information that was current at the time of the traces were acquired and information about the digitizer itself. (note other queries are possible as well):

```
SELECT * FROM SAMPLES S
INNER JOIN events E ON E.id = S.event_id
INNER JOIN settings_root SR ON         SR.id = E.settings_id
INNER JOIN settings_thresholds ST ON   ST.settings_id = SR.id
                                   AND ST.channel = S.channel
INNER JOIN settings_dcoffsets SDCO ON SDCO.settings_id = SR.id
                                   AND SDCO.channel = S.channel
INNER JOIN digitizsers D on            D.id = E.digitizer_id
WHERE D.id = '9641E17EA872CAED059B06194120AE02';
```

This method of starting with traces and working backwards through the joins towards the digitizer makes use of the *belongs to* relationships between the child and parentables. One could equally well work from the digitizer down through the settings and then the events/samples tables which would be making use of the *has* many relationships between parent and child tables. Note how the extra condition on the join with the settings_threshold and settings_dcoffsets picks out only the thresholds and offsets for the trace's channel.

12 Troubleshoting

If CAENSCOPE displays the message window shown in (**Fig. 12.1**), then one of the cases listed below could have happened.

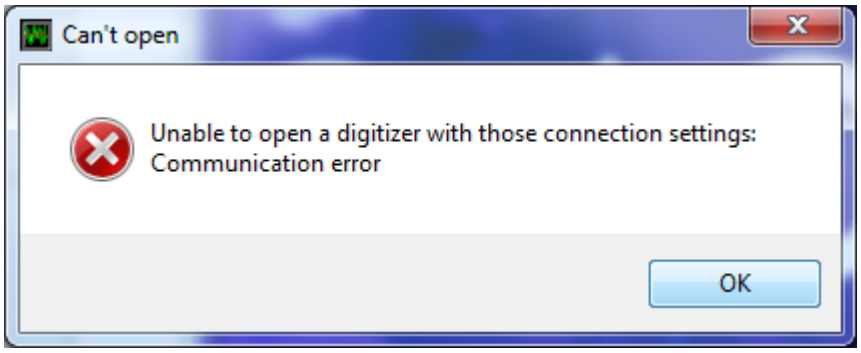

Fig. 12.1: Communication error message

- The digitizer is powered off or the communication cable is not plugged in, improperly plugged or defective.
- The driver for the communication link is not installed or not correctly installed.
- Incorrect connection parameters have been set by the User in the Connection Dialog window (see p. **12**).

The message shown in **Fig. 12.2**, instead, is displayed when the digitizer runs a firmware that is not supported by CAENSCOPE program. Refer to p. **6** for details.

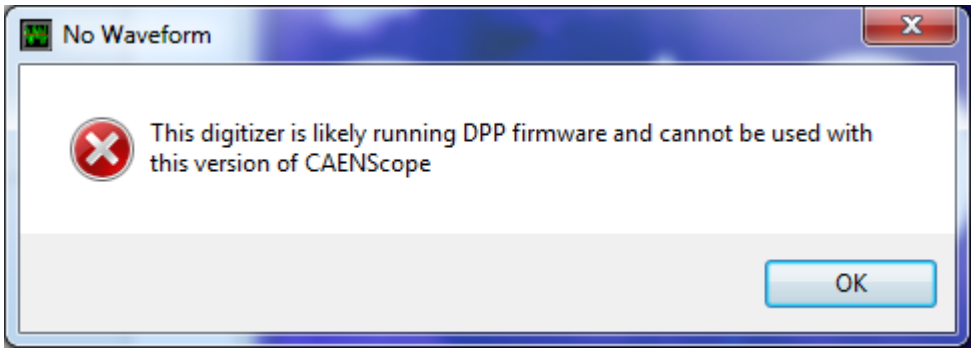

Fig. 12.2: FW compatibility error message

13 Technical support

CAEN makes available the technical support of its specialists at the e-mail addresses below:

support.nuclear@caen.it
(for questions about the hardware)

support.computing@caen.it
(for questions about software and libraries)

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