# 2740/2745 Digitizer User Manual

64 Channel 16 bit 125 MS/s Digitizer

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.
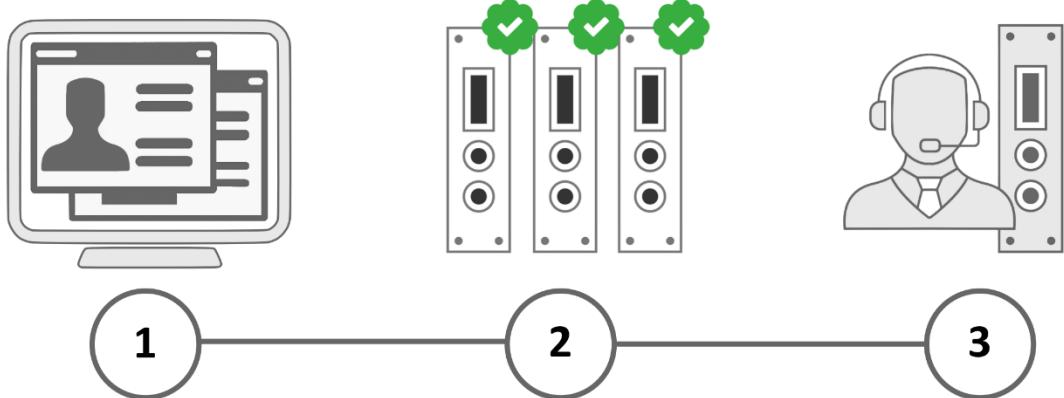
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Purpose of the Document

This User Manual contains all the instructions for the hardware installation of the 2740 and 2745 digitizers, the description of the Web Interface service utility (v1.3.2 or higher), and a getting started section to get waveforms from the device in a few steps by using the Scope firmware and the WaveDump2 DAQ software.

Change Document Record

Date	Revision	Changes
March 30th, 2021	00	Initial release.
May 6th, 2021	01	Updated Chap. **9** and Chap. **10**.
October 18th, 2021	02	Introduced DT2740 support. Removed "Preliminary" and updated the cover page. Removed "coming soon" for the WaveDump2 User Manual in the references. Updated **Tab. 3.1**. Updated Chap. **5** and Chap. **9**
December 6th, 2021	03	Added new sections: **Manufacturer Contacts**, **Limitation of Responsibility**. Added new chapters: Chap. **2**, Chap. **6**, Chap. **7**, Chap. **13**, Chap. **14**, Chap. **15**. Updated Chap. **1**, Chap. **3**, Chap. **10**. Support extended to the 2745 Digitizers.
January 3rd, 2022	04	Updated Sec. **10.1**
February 24th, 2022	05	Updated Chap. **7**. Updated Sec. **10.4** and Sec. **10.4.1**. Added Sec**. 10.4.2**.
May 27th, 2022	06	Revised the index structure. Updated back cover and Chap **1**, Chap. **2**, Sec. **5.1**, Chap. **7**, Chap. **8**, Chap. **10**, Chap. **16**
May 11th, 2023	07	Added Chap**.11.**
May 15th, 2023	08	Updated Chap. **2**. Updated Chap **10**. Removed old "PUC Removal" section.
March 07th, 2024	09	Updated Sec. **Reference Documents**. Updated **Tab.3.2**. Updated Chap. **7**. Added a note in Secc. **9.2, 10.2**. Updated Chap. **10**. Added Secc. **10.5.2, 10.9, 10.10**
May 21st, 2024	10	Updated Chap. **2**, **Tab. 10.5**, Sec**. 10.10**, **Fig. 10.12**
September 19th, 2024	11	Updated Chap. **2**. Added references to the new CAEN Toolbox software utility in Sec. **10.11** and Sec. **10.11.1**
January 20th, 2024	12	Revised document title. Updated Chap **2**. Added 10-kΩ input impedance personalization for single-ended models and ICMR specifications for differential models. Updated **Tab. 10.2**
April 10th, 2025	13	Updated Environmental specifications in Chap. **2**. Updated USB and Ethernet part descriptions in **Tab. 3.1**. Fixed wrong descriptions of A372x adapters in Sec. **12.1**
September 23rd, 2025	14	Updated technical specifications in Chap. **2**. Added Sec. **10.12.1**

Symbols, Abbreviated Terms, and Notations

BIOS	Basic Input-Output System
DAQ	Data Acquisition
DPP	Digital Pulse Processing
NDIS	Network Driver Interface Specification
PID	Product Identifier
PUC	Product Unlock Code

Reference Documents

[RD1]   DS7783 – 2740/2745 Digitizer Data Sheet
[RD2]   DS7923 – A372x Adapters Data Sheet
[RD3]   UM7934 – Wavedump2 User Manual
[RD4]   GD9764 – CAEN FELib Library User Guide
[RD5]   UM11111 – CAEN Toolbox User Manual

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

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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 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

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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 products 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).

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1 Safety Notices

N.B. Read carefully the "Precautions for Handling, Storage and Installation" document provided with the product before starting any operation.

The following HAZARD SYMBOLS may be reported on the unit:

⚠	Caution, refer to the product manual
⚡	Caution, risk of electrical shock
⏚	Protective conductor terminal
⏚	Earth (Ground) Terminal
∿	Alternating Current
3∿	Three-Phase Alternating Current

The following symbol may be reported in the present manual:

⚠	General warning statement

The symbol could be followed by the following terms:

- **DANGER**: Indicates a hazardous situation that, if not avoided, will result in serious injury or death.
- **WARNING**: Indicates a hazardous situation that, if not avoided, could result in death or serious injury.
- **CAUTION**: Indicates a situation or condition that, if not avoided, could cause physical injury, or damage the product and/or its environment.

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GENERAL:

CAUTION: Avoid potential hazards.

⚠ **USE THE PRODUCT ONLY AS SPECIFIED.**

ONLY QUALIFIED PERSONNEL SHOULD PERFORM SERVICE PROCEDURES

CAUTION: Avoid Electric Overload.

⚠ **TO AVOID ELECTRIC SHOCK OR FIRE HAZARD, DO NOT POWER A LOAD OUTSIDE OF ITS SPECIFIED RANGE**

CAUTION: Avoid Electric Shock.

⚠ **TO AVOID INJURY OR LOSS OF LIFE, DO NOT CONNECT OR DISCONNECT CABLES WHILE THEY ARE CONNECTED TO A VOLTAGE SOURCE**

CAUTION: Do Not Operate in Wet/Damp Conditions.

⚠ **TO AVOID ELECTRIC SHOCK, DO NOT OPERATE THIS PRODUCT IN WET OR DAMP CONDITIONS**

CAUTION: Do Not Operate in an Explosive Atmosphere.

⚠ **TO AVOID INJURY OR FIRE HAZARD, DO NOT OPERATE THIS PRODUCT IN AN EXPLOSIVE ATMOSPHERE**

⚠ **THIS DEVICE SHOULD BE INSTALLED AND USED BY A SKILLED TECHNICIAN ONLY OR UNDER HIS SUPERVISION**

⚠ **DO NOT OPERATE WITH SUSPECTED FAILURES.**
IF YOU SUSPECT THIS PRODUCT TO BE DAMAGED, PLEASE CONTACT THE TECHNICAL SUPPORT

VME MODELS:
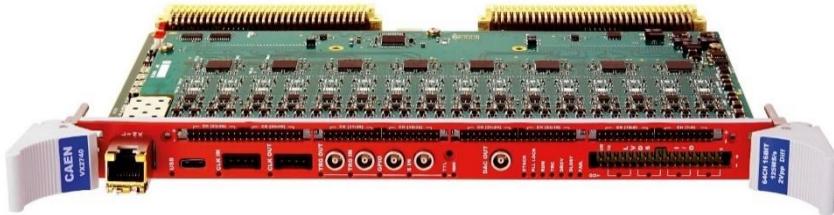
CAUTION: This product needs proper cooling.

USE ONLY CRATES WITH FORCED COOLING AIR FLOW SINCE OVERHEATING MAY DEGRADE THE MODULE PERFORMANCES!

THE V2740 CANNOT BE OPERATED WITH VME8001 CAEN CRATES

CAUTION: This product needs proper handling.

THE VME DIGITIZER DOES NOT SUPPORT LIVE INSERTION (HOT-SWAP)! REMOVE OR INSERT THE BOARD WHEN THE CRATE IS POWERED OFF!

ALL CABLES MUST BE REMOVED FROM THE FRONT PANEL BEFORE EXTRACTING THE BOARD FROM THE CRATE!

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DESKTOP MODELS:

DANGER: This product has high voltage inside. Opening the device exposes parts under high voltage.

TO AVOID ELECTRIC SHOCK OR FIRE HAZARD, DO NOT OPERATE THIS PRODUCT WITH COVERS OR PANELS REMOVED!

2 Technical Specifications

ANALOG INPUTS	**Number of Channels**
	▪ 64
	▪ Differential on 274x version
	▪ Single-ended on 274xB version
	
	Full-Scale Range
	▪ 2740: 2 V_{pp}
	▪ 2745: 4 V_{pp}
	
	Gain
	▪ 2740: Fixed x1
	▪ 2745: Sw programmable x1 ÷ x100 in steps of 0.5dB independently on each 16-channel group
		Impedance
		▪ 274xB:
		  - 50 Ω default
		  - 10kΩ personalization available by ordering code
		▪ 274x: 100 Ω
		
		DC Offset
		Adjustable in the ±1.25V (2740) or ±2.5V (2745) range independently on each channel
		
		ICMR (Input Common-Mode Range)
		Differential models only
		2740: ± 8 Vdc referred to GND
		2745: ± 12 Vdc referred to GND
			Connector
			▪ Four 2mm 40-pin header male
			▪ Input adapters available
			
			Bandwidth
			▪ 2740: 50 MHz
			▪ 2745: 20 MHz guaranteed for all Gain settings

DIGITAL CONVERSION	**Resolution** 16 bits	**Sampling Rate** ▪ 125 MS/s (simultaneously on each input) ▪ Scalable by 2n decimation factor, n = 1 to 10 (Scope firmware only)	
SYSTEM PERFORMANCE	**ENOB (Typ.)** ▪ 2740: 11.7 ▪ 2745: 12.0 (@5 MHz, -3dB, Gain x1)	**RMS (Typ.)** ▪ 2740: 3.9 LSB (~ 120 µV) ▪ 2745: 3.6 LSB RMS (@Gain x1)	

DIGITAL I/O	**CLK-IN/CLK-OUT**
	▪ Two differential pairs:
	  - CLK, reference clock signal
	  - SYNC, synchronization signal (start/stop, T0, etc.)
	▪ 2.54mm 4-pin AMPMODU Mod II male connector
	▪ CLK-IN: AC-coupled LVDS, ECL, PECL, LVPECL, CML (Zdiff = 100 Ω)
	▪ CLK-OUT: LVDS
	▪ Daisy chainable for multiboard synchronization with sw programmable CLK-OUT delay shift
	
	LVDS I/O
	▪ 16 differential pairs
	▪ Sw programmable I/O function (individual self-trigger outputs, trigger validations, Veto, Busy, Start, Stop, Pattern Input, etc.)
	▪ LVDS
	▪ Z_{diff} = 100 Ω (when set as inputs)
	▪ 2.54mm 34-pin AMPMODU Mod II male connector
		TRG-IN/TRG-OUT/GPIO/S-IN
		▪ General-purpose digital I/Os
		▪ Sigle-ended TTL/NIM
		▪ LEMO 00 male connector
		▪ Sw programmable function (trigger, veto, busy, etc.)
		  - TRG-IN/S-IN: internally terminated with 50 Ω (Zin = 50 Ω)
		  - TRG-OUT requires Rt = 50 Ω
		  - GPIO as Input must be terminated with 50 Ω
		  - GPIO as TTL Output requires Rt = 50 Ω
		  - GPIO as NIM Output requires Rt = 50 Ω or 25 Ω	

ANALOG OUTPUT	▪ Sw programmable DAC output for signal inspection, pulse generation, majority level ▪ 14-bit Digital-to-Analog Converter (DAC) ▪ 125 MS/s Update Rate ▪ LEMO 00 connector ▪ ±1 V @ 50Ω load ▪ ±2 V @ hi-Z load Output Range		
ACQUISITION MEMORY	▪ 2.5 GB total DDR4 memory size (20.971 MS/ch) divisible in multiple buffers ▪ Maximum record length: ~ 84 ms @ 125 MS/s (total memory size divided by 2)[1]		
COMMUNICATION INTERFACES	**1 GbE** ▪ Copper RJ45 or optical LC connector on SFP+ transceiver ▪ Protocol: TCP ▪ Transfer rate: 110 MB/s	**10 GbE**[2] ▪ Copper RJ45 or LC optical connector on SFP+ transceiver ▪ Protocol: UDP ▪ Transfer rate: 850 MB/s **USB 3.0** ▪ USB-C type connector ▪ Protocol: USB 3.1 GEN1 ▪ Transfer rate: 280 MB/s	

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[1] *Value referred to the Scope firmware (minimum of two buffers admitted)*

[2] *Contact CAEN Support for information*

ACQUISITION MODES AND TRIGGER	**Triggered Mode** All the channels fire simultaneously upon a global trigger generated by the Central Logic Unit receiving the trigger source signals; zero suppression function is available **Streaming Readout Mode** Each channel autonomously identifies the ROI and uses the local trigger to get events independently on the other channels; validation logics can be configured for correlated acquisition (coincidence/anticoincidence)	**Trigger Sources** ▪ Software by register writing ▪ External upon the leading edge of TRG-IN signal (TTL/NIM) ▪ Local (self-trigger) upon the channel discriminator with programmable threshold	**Trigger Time Stamp – Scope FW** ▪ Resolution: 8 ns coarse ▪ Counter range: 48 bits ▪ Full-scale range: ~625 h **Trigger Time Stamp – DPP FW** ▪ Resolution: 8ns coarse, 8ps fine ▪ Counter range: 48 bits ▪ Full-scale range: ~78 h
SYNCHRONIZATION	**Clock Propagation** Typical 62.5MHz frequency distributed by: ▪ Fan-out to CLK-IN ▪ CLK-IN/CLK-OUT daisy chain with sw programmable CLK-OUT delay shift Custom frequencies can be supported upon request **Acquisition Start/Stop** Daisy chain or fan-out propagation through CLK-IN/CLK-OUT or NIM/TTL, LVDS I/Os	**Data Sync** Busy/Veto logic on LVDS I/Os or NIM/TTL I/Os for event building synchronization **Trigger Distribution** TRG-IN/TRG-OUT NIM/TTL LEMO I/Os (common trigger) or LVDS I/Os (common or individual trigger) **Trigger Time Stamp Reset** Software from START run command or Hardware from S-IN/GPIO input (Scope Firmware only)	
FPGA	▪ Xilinx Zynq UltraScale+ Multiprocessor System-on-Chip mod. XCZU19EG ▪ Processing System based on Quad-core Arm with 2GB DDR4 memory @2400 MT/s (Linux OS onboard) ▪ Programmable logic with more than 1100K system logic cells and 80Mbit memory		
CAEN FIRMWARE	Developed by CAEN, stored in the onboard Flash Memory and live rebootable by Web Interface		
	DPP Firmware (Shareware) Pay firmware working in streaming readout mode and implementing digital pulse processing algorithm: ▪ DPP-PHA: Pulse Height Analysis ▪ DPP-PSD: Charge Integration, Pulse Shape Discrimination, CFD for fine timestamp ▪ DPP-ZLEplus: Data compression based on Zero Length Encoding License purchase needed to unlock full-time working	**Scope Firmware (Freeware)** Working in triggered mode and designed for waveform recording	**Upgrades (Free)** Web available CUP files for Scope and DPP firmware upgrade via Web Interface or CAEN Toolbox software
USER FIRMWARE (OPEN FPGA)	**SCI-Compiler (Shareware)** Pay graphical tool for User Firmware generation and compiling with CAEN Programmable Boards		
	Scope Personalization Customizable features of the Scope firmware: ▪ Common trigger ▪ Simultaneous waveform recording on management on 64 channels ▪ Trigger logic ▪ Wave processing	**DPP Personalization** Customizable features of the DPP firmware: ▪ Individual trigger and channel acquisition management ▪ DPP algorithm ▪ Trigger logic ▪ Event data information	
SOFTWARE	**Readout SW for CAEN Firmware (Freeware)** ▪ CoMPASS spectroscopy software (DPP firmware only) ▪ WaveDump2 (Scope firmware only) **SDK and Tools (Freeware)** General-purpose libraries (C/Phyton) with demo samples for host Windows® and Linux® PC, and embedded Arm processor	**SCI-Compiler for Open FPGA (Shareware)** Automatic generation of drivers (USB, ethernet), libraries, and demo software for Windows®, Linux® **Web Interface** Firmware management (e,g. upgrades and on-the-fly selection of the firmware to run), board information, PLL and Ethernet configuration, board status monitoring	

		Form Factor	Weight	Dimension
MECHANICAL	**V2740/V2740B** **V2745 / V2745**	1-uni wide VME64	642 g	6U x 160 mm
	VX2740/VX2740B **VX2745/VX2745BB**	1-unit wide VME64X	642 g	6U x 160 mm
	DT2740/DT2740B **DT2745/DT2745B**	Desktop Desktop-rack	3120 g 3170 g	337 W x 96 H x 295 L mm³ (including connectors) 19" rack mount

ENVIRONMENTAL	Environment	Indoor use		
	Operating Temperature	0°C to +40°C		
	Storage Temperature	-10°C to +60 °C		
	Operating Humidity	10% to 90% RH non condensing		
	Storage Humidity	5% to 90% RH non condensing		
	Pollution Degree	2		
	Overvoltage Category	II		
	EMC Environment	Commercial and light industrial		
	IP Degree	Enclosure (desktop models), not for wet location		

REGULATORY COMPLIANCE	EMC		Safety	
	CE 2014/30/EU Electromagnetic Compatibility Directive		CE 2014/35/EU Low Voltage Directive	

POWER REQUIREMENTS		+12V	+5V	+3.3V
	V2740/V2740B	1.1 A (Typ.)	6.2 A (Typ.)	-
	VX2740/VX2740B	1.1 A (Typ.)	2.7 A (Typ.)	4.9 A (Typ.)-
	V2745/V2745B	1.4 A (Typ.)	9.0 A (Typ.)	-
	VX2745/VX2745B	1.4 A (Typ.)	5.3 A (Typ.)	4.9 A (Typ.)
	DT2740x/DT2745x	Mains Powered (Max. 130 Watt @ 110/220V)		

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3 Packaging and Compliancy

The DT2740/DT2745 digitizer is available as a Desktop module housed in a metal case and two external rubber frames, one on the front and one on the rear panel, providing standings legs (module dimensions: 337 W x 96 H x 278 L mm³ excluding the connectors).

The V/VX2740-45 digitizer is available in 1-unit wide VME 6U x 160mm form factor.

The device is inspected by CAEN before the shipment, and it is guaranteed to leave the factory free of mechanical or electrical defects.

The content of the delivered package standardly consists of the part list shown in the table below (**Tab. 3.1**).

Part	Description	Qt
x2740/x2745	64 Channel 16 bit 125 MS/s Digitizer	x1
Power supply cable (**Desktop modules only**)	Standard C13 Power Supply cord, L=2MT	X1
USB cable	USB-C to USB-A 3.1 GEN 1 cable, L=1.8MT (Mod. UTC-C-A-3.1-Gen 1-6FT-GRY by Amazon basics)	x1
Ethernet cable	Cat6 SSTP patch cable, L=2MT, RJ45 connector (Mod. A-MCSSP6200-R by ASSMANN)	x1
1Gb Ethernet transceiver (mounted)	GLC-T compatible, 1000Base-T copper SFP Transceiver, 1Gbps data rate (RJ45 connector)	x1
10GbE Optical transceiver (Included as spare)	10Gb/1Gb Ethernet, 850nm, SFP+ Transceiver	x1
Rack kit (**Desktop modules only**)	2 metal brackets for rack mount (19" rack compatible) with 4 screws (type TPS 4X10 CROSS INOX DIN 965) and 4 safety black hole plugs included	-
Documentation	UM7897 – 2740/2745 Digitizers User Manual DS7783 – 2740/2745 Digitizers Data Sheet	-

Tab. 3.1: Delivered kit content

CAUTION: to manage the product, consult the operating instructions provided.

When receiving the unit, the user is strictly recommended to:

- Inspect containers for damage during shipment. Report any damage to the freight carrier for possible insurance claims.

- Check that all the components received match those listed on the enclosed packing list as in **Tab. 3.1**. (CAEN cannot accept responsibility for missing items unless we are notified promptly of any discrepancies.)

- Open shipping containers; be careful not to damage contents.

- Inspect contents and report any damage. The inspection should confirm that there is no exterior damage to the unit such as broken knobs or connectors and that the front panel and display face are not scratched or cracked. Keep all packing material until the inspection has been completed.

- If damage is detected, file a claim with the carrier immediately and notify CAEN service.

- If equipment must be returned for any reason, carefully repack equipment in the original shipping container with original packing materials if possible. Please, contact CAEN service.

- If equipment is to be installed later, place equipment in the original shipping container and store it in a safe place until ready to install.

⚠️ **DO NOT SUBJECT THE ITEM TO UNDUE SHOCK OF VIBRATIONS**

⚠️ **DO NOT BUMP, DROP OR SLIDE SHIPPING CONTAINERS**

⚠️ **DO NOT LEAVE ITEMS OR SHIPPING CONTAINERS UNSUPERVISED IN AREAS WHERE UNTRAINED PERSONNEL MAY MISHANDLE THE ITEMS**

⚠️ **USE ONLY ACCESSORIES WHICH MEET THE MANUFACTURER'S SPECIFICATIONS**

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Official documentation, firmware updates, software tools, and accessories are available on the CAEN website *www.caen.it* is on the Digitizer web page. The download is free after login.

Document	Content	Location
DS7783 – 2740/2745 Digitizer Data Sheet	General information and full technical specifications	*Digitizer Webpage* ↓ *Downloads button* ↓ *Documentation tab* ↓ *Data Sheets category*
UM7897 – 2740/2745 Digitizer User Manual	Hardware installation, Getting Started with WaveDump2 software, and Web Interface description	*Digitizer Webpage* ↓ *Downloads button* ↓ *Documentation tab* ↓ *Manuals category*
GD9764 – FELib Library User Guide	Full description of the new CAEN FELib SDK for CAEN Digitizers	*Digitizer and FELib Webpages* ↓ *Downloads button* ↓ *Documentation tab* ↓ *Guides category*
x2740-45 Scope (doc-develop) x2740-45 DPP-PSD (doc-develop) x2740-45 DPP-PHA (doc-develop) x2740-45 DPP-ZLE (doc-develop) x2740-45 Open Scope (doc develop) x2740-45 Open DPP (doc develop)	Description of the FELib library parameters for all the supported firmware (including Open FPGA)	*Digitizer Web Interface* ↓ *Parameters tab*
UM7934 – WaveDump2 User Manual	Description of CAEN DAQ software supporting the Scope firmware	*WaveDump2 Webpage* ↓ *Downloads button* ↓ *Documentation tab* ↓ *Manuals category*
UM5960 – CoMPASS User Manual	Description of CAEN DAQ software supporting the DPP firmware	*CoMPASS Webpage* ↓ *Downloads button* ↓ *Documentation tab* ↓ *Manuals category*
Documentation on 10 Gb Ethernet	How to manage CAEN 10 GbE interface	*Available on request on CAEN cloud*

Tab. 3.2: Table of web available official documentation

4 PID (Product Identifier)

PID is the CAEN product identifier, an incremental number greater than 10000 that is unique for each product. The PID is on a label affixed to the product (**Fig. 4.1** and **Fig. 4.2**) and it is even stored in an on-board non-volatile memory readable by the Web Interface (Chap. **10**).
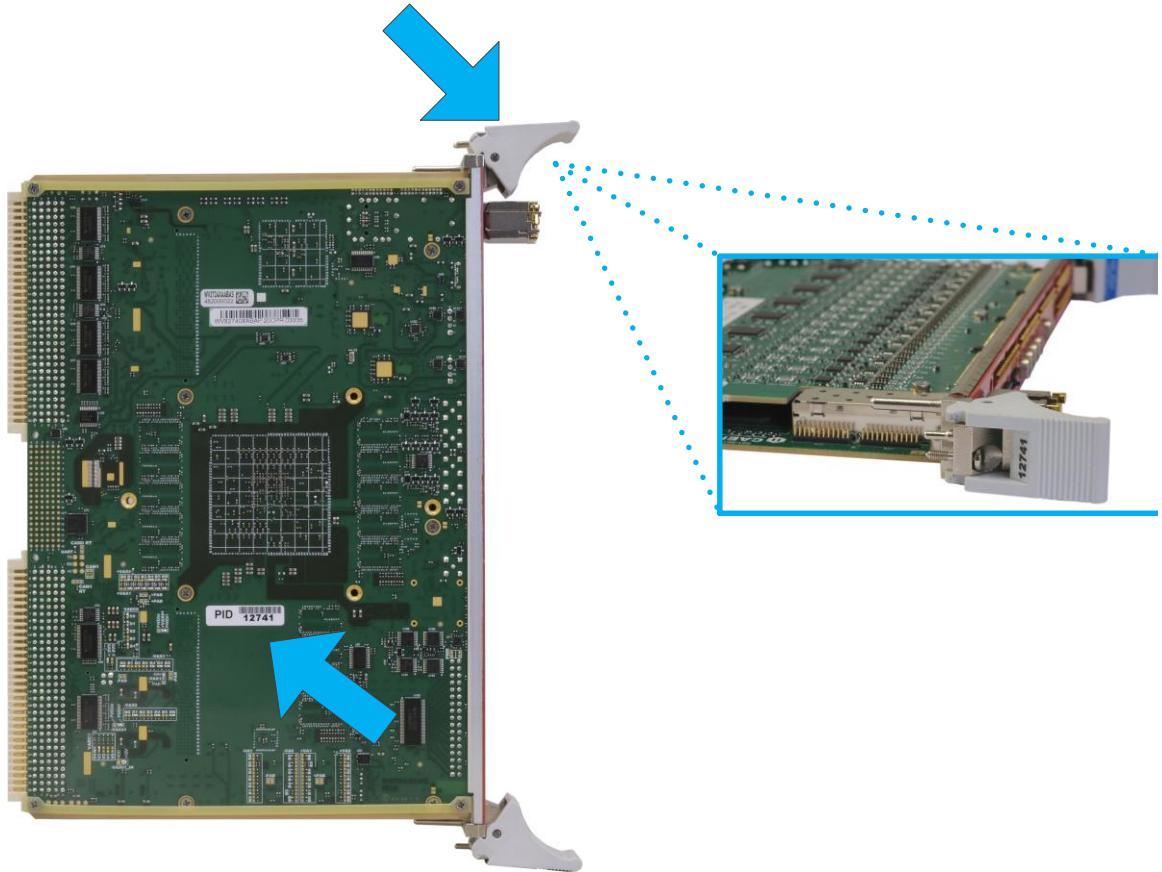

**Fig. 4.1**:PID location on V/VX2740 / V/VX2745 (the number in the picture is purely indicative)

Fig. 4.2:PID location on DT2740 / DT2745 (the number in the picture is purely indicative)

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5 Power Requirements

5.1 VME Models

The V/VX2740 / V/VX2745 Digitizers power requirements are described in **Tab. 5.1**.

MODULE	SUPPLY VOLTAGE		
	+12 V	+5 V	+3.3 V
VX2740	1.1 A (Typ.)	2.7 A (Typ.)	4.9 A (Typ.)
V2740	1.1 A (Typ.)	6.2 A (Typ.)	-
VX2745	1.4 A (Typ.)	5.3 A (Typ.)	4.9 A (Typ.)
V2745	1.4 A (Typ.)	9.0 A (Typ.)	-

Tab. 5.1: VME64 and VME64X Digitizers power requirements

5.2 Desktop Models

The DT2740/DT2745 Digitizers are powered by an internal 100/240V ~ 50 / 60Hz AC/AC stabilized power supply (130W max.) The power supply cord is included in the delivered kit (see **Tab. 3.1**) and it is connected to equipment using an IEC C14 connector on the rear panel. The power cord is a standard wall IEC C13.

MODULE	POWER SUPPLY
DT2740 / DT2745	100/240V ~ 50 / 60Hz (130W max.)

Tab. 5.2: Desktop digitizers mains power specifications

6 Cooling Management

The 2740 / 2745 Digitizer can operate in environment with temperature range of 0° ÷ +40°C **[RD1]**.

Desktop models (DT2740 / DT2745) are equipped with airflow fans installed onboard. The VME models (V2740 / VX2740 and V2745 / VX2745) must be operated in ventilated crates as recommended in Chap. **1**.

⚠	**EXTERNAL FANS MUST BE USED WHEN THE BOARD IS INSTALLED IN A SETUP WITH POOR AIRFLOW**

The User must take care to provide proper cooling to the board with an external fan if the board is used in an enclosure or if the board is installed in a setup with poor airflow.
Excessive temperature will, in the first instance, reduce the performance and the quality of the measurements and can also damage the board.

If the board is stored in a cold environment, please check for water condensation before powering on.

6.1 Cleaning Air Vents

CAEN recommends to occasionally cleaning the air vents on all vented sides of the board. Lint, dust, and other foreign matter can block the vents and limit the airflow. Be sure to power off the board and disconnect it from the power by physically detaching the power cord before cleaning the air vents and following the general cleaning safety precautions.

⚠	**IT IS UNDER THE RESPONSIBILITY OF THE CUSTOMER A NON-COMPLIANT USE OF THE PRODUCT**

![CAEN Electronic Instrumentation logo]

7 Temperature Protection

To preserve hardware damages, the Digitizer implements automatic protection from over-temperature events. The temperatures of the critical components can be constantly monitored by the Web Interface (see Sec. **10.5.4**) or in the software **[RD3]**.

In case of excessive overheating (temperature thresholds are fixed in the firmware), the following protocol is automatically executed by the firmware:

- The FAIL red LED on the device front panel is turned on **[RD1]**;
- 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).

During the over-temperature condition, the communication with the Digitizer is still possible just for diagnostics:

Errors flags	
Power Status	🟢
Board Init	🟢
SI5341 PLL Lock	🟢
SI5395 PLL Lock	🟢
LMK04832 PLL Lock	🟢
JESD204B Lock	🔴
DDR4 PL Bank0 Calibration	🟢
DDR4 PL Bank1 Calibration	🟢
DDR4 PS Calibration	🟢
FPGA Configuration	🟢
BIC Check	🟢
ADC Temp	🟢
Air Outlet Temp	🟢
FPGA Temp	🔴
DC/DC Temp	🟢
Clock In	🟢
ADC Shutdown	🔴

Fig. 7.1: Example of error flags status in the Web Interface for the overtemperature condition

The event is also signaled if using CAEN software **[RD3]**.

⚠️ **IN THE EVENT OF OVERTEMPERATURE, TRY TO REMOVE ANY POSSIBLE EXTERNAL CAUSE OF OVERHEATING.**

CONTACT CAEN IF THE CONDITION PERSISTS.

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

8 Hardware Installation

Before installing the hardware, please pay attention to the here listed warnings.

⚠️ **ONLY QUALIFIED PERSONNEL SHOULD PERFORM INSTALLATION OPERATIONS**

⚠️ **DO NOT INSTALL THE EQUIPMENT SO THAT IT IS DIFFICULT TO ACCESS THE BACK PANEL FOR DISCONNECTING THE DEVICE**

⚠️ **IT IS RECOMMENDED THAT THE SWITCH OR CIRCUIT-BREAKER IS NEAR THE EQUIPMENT**

⚠️ **THE SAFETY OF ANY SYSTEM THAT INCORPORATES THE DEVICE IS UNDER THE RESPONSIBILITY OF THE ASSEMBLER OF THE SYSTEM**

8.1 VME Models

- Insert the Digitizer into the crate:
    - V2740 and V2745 fit into 6U VME crates.
    - VX2740 and VX2745 require VME64X compliant crates.
- Power up the crate.

8.2 Desktop Models

- Connect the power cord to the mains input on the rear of the Digitizer **[RD1]**.
- Push on "I" the rear button to enable the mains input.
- Press the front power ON/OFF button **[RD1]**.

Rack Mounting

In few simple steps, the DT2740 and DT2745 can be used in 19" racks by applying the provided metal brackets (**Tab. 3.1**).

Fig. 8.1: Rack mount kit

Procedure:

- By a Phillips screwdriver, remove the eight fixing screws (type: TPC 4X10 INOX CROSS BURNISHED), four from the front and four from the rear rubber frame of the module. Then, remove the two frames.

- Apply the two couples of safety black hole plugs (**Tab. 3.1**) in the centre of the front and rear panel.

- Apply the two metal brackets, one on each side of the module, and fix them with screws type TPS 4X10 CROSS INOX DIN 965 (**Tab. 3.1**).

- Insert the module in a 19" rack and fix it.

- Turn on the module as described in Sec. **8.2**.

Fig. 8.2: Rack version

8.3 Power-on Status

Power-on takes a few seconds during which the front panel LEDs may flash and the fans are activated, in the case of Desktop modules.

After power-on, the module is in the following status:

- The Output Buffer is cleared.

- Registers are set to their default configuration.

- Only NIM and PLL LOCK LEDs must stay on (see **Fig. 8.3**).
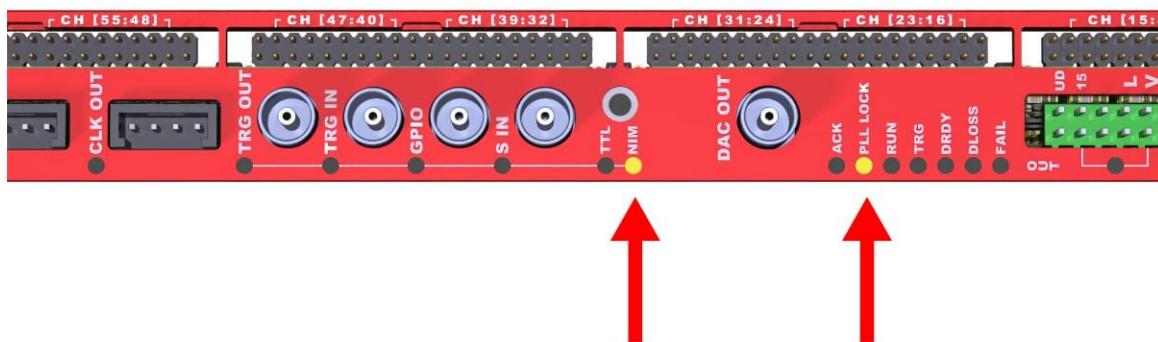
Fig. 8.3: LED status after power-on

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9 Hardware Detection

It is required to install the driver provided by CAEN only in the case of a USB connection in Linux OS (see Sec. **9.2**).

The Digitizer is factory provided with the default IP address **192.168.0.254** and a hostname that is **caendgtz-ETH-PID** (where PID is the unique product identifying number described in Chap. **4**) and can be changed by the User in the Web Interface (Chap. **10**). For the USB connection, the hostname is fixed, and it is **caendgtz-USB-PID**.

9.1 Ethernet Configuration

It is possible to connect the Ethernet interface of the Digitizer through a server or a point-to-point connection with a PC. In the latter case, the connection can be done using either a crossed cable, a switch or a computer with a Gigabit Ethernet port.

9.1.1 Windows OS

Point-to-point configuration instructions are here described for Windows® 10.

| |
|---|
| **1.** |
| • Power on the Digitizer and the PC.
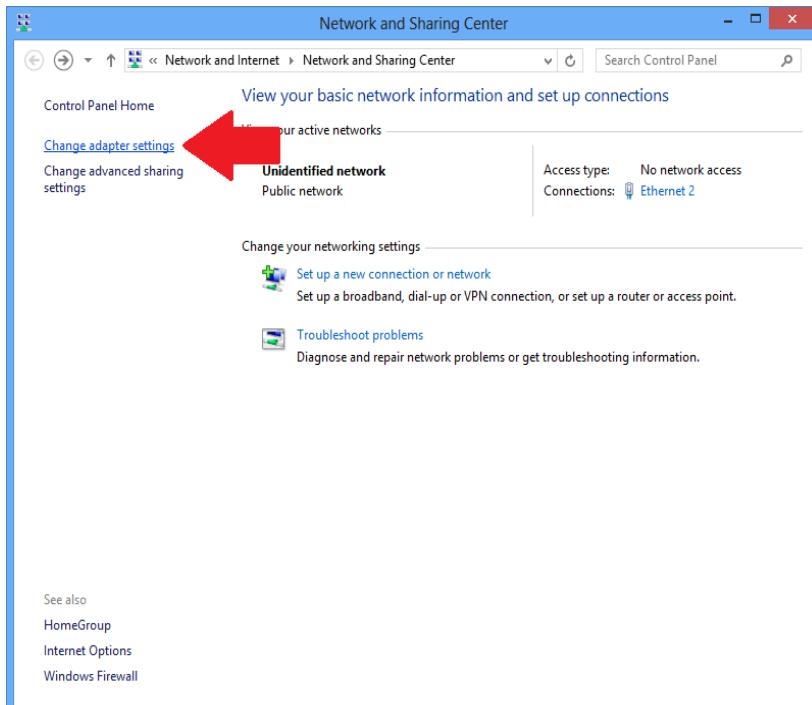
• Connect the Ethernet cable between the Digitizer and the host PC.

• Open the Windows path:

      Control Panel -> Network and Internet -> Network and Sharing Center

• Click on "Change adapter settings". |

2.

- Right-click on the Ethernet icon and select "Properties".
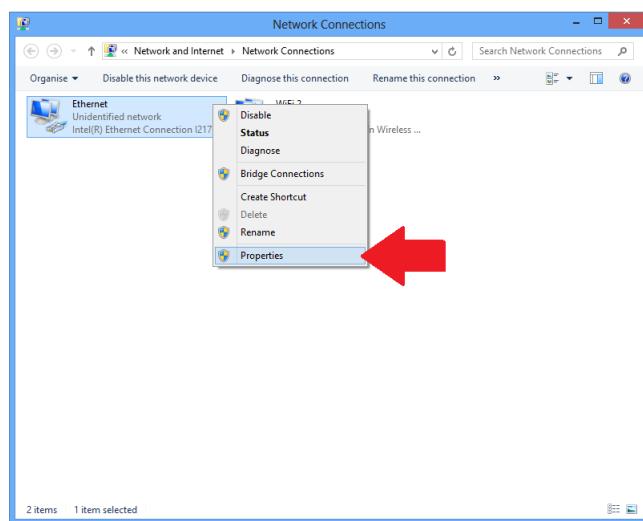
3.

- Click on "Internet Protocol Version (TPC/IPv4)" and select "Properties".
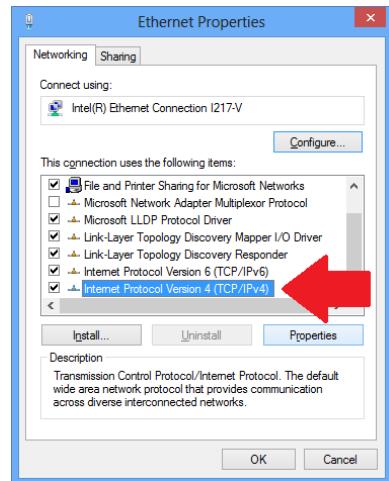
4.

- Type in the IP address, where the network part is fixed and specifies the unique number assigned to your network, while the host part must be customized to identify the machine in your network. The next figure shows an IP address example.

- Type in the subnet mask as 255.255.255.0.

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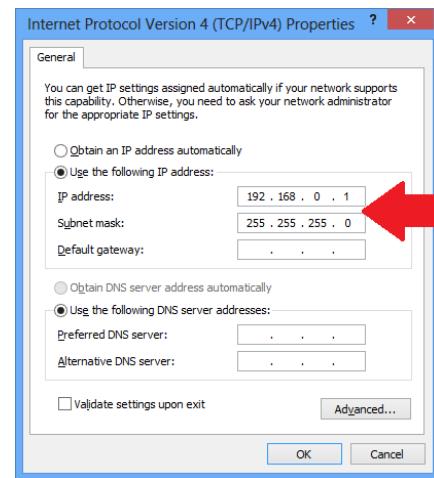
9.1.2 Linux OS

A similar procedure is foreseen with point-to-point configuration on Linux®, as following described for Ubuntu Linux 18.04.

1.
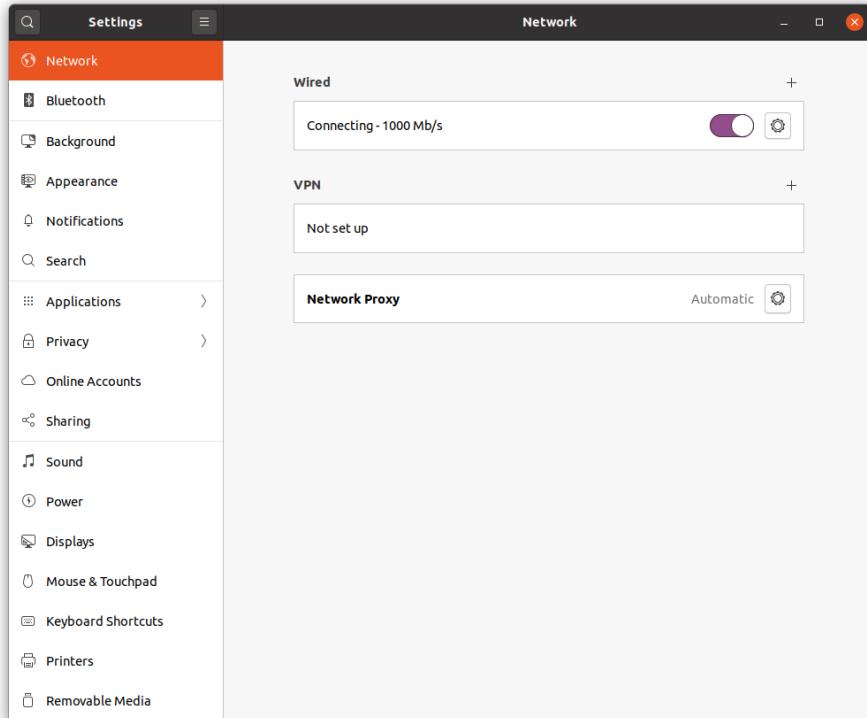
- Power on the Digitizer and the PC.
- Connect the Ethernet cable between the Digitizer and the host PC.
- Click on the top-right Network icon or access the Network activity, then open the path:

Wired Connection -> Wired Settings

2.
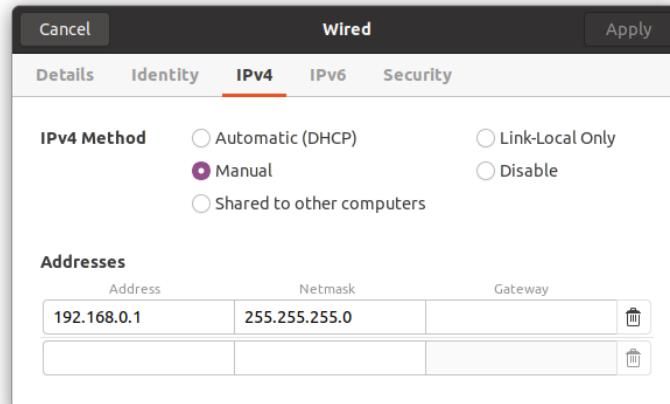
- Click on the settings icon, select the IPv4 tab, select Manual method, configure IP Address and Netmask, and apply. The figure above shows a typical setting example.

9.2 USB Configuration

The USB-3.0 interface of the Digitizer is based on the IPv6 protocol. Make sure to enable the protocol required to communicate with the device.

9.2.1 Windows OS

1.

- Power on the digitizer and the PC.

- Connect the USB cable between the Digitizer and the host PC.

- The new hardware will be automatically detected as "Remote NDIS Compatible Device #n" in Windows Device Manager under Network Adapters.
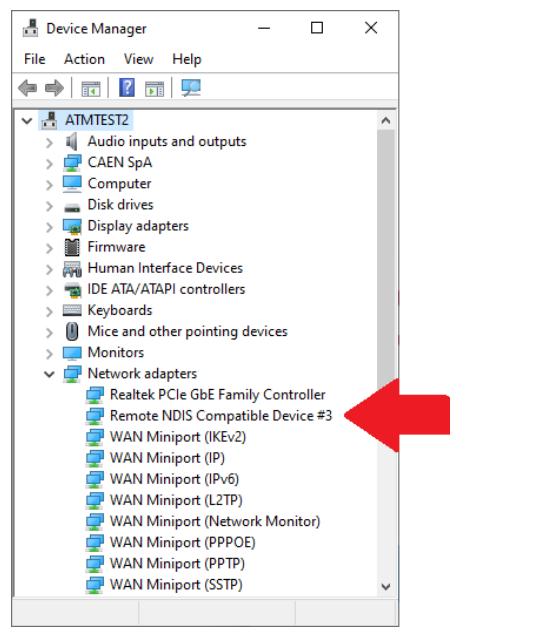
9.2.2 Linux OS

1.

- Download the driver for Linux from the Digitizer web page and unpack it.

- Execute: *sudo ./install.sh* (as reported in the README file). The script file will properly configure the system to manage the USB connection by the hostname (see Sec. **10.1**).

- Connect the USB cable between the Digitizer and the host PC.

- Power on the digitizer and the PC.

- The new hardware will be automatically detected.

- Issue the *lsusb* command to list the connected USB peripherals and look for the "CAEN SpA VX2740" voice in the results.

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10 Web Interface

The Digitizer is provided with a web interface that manages a set of service operations both via USB and Ethernet interface. The following descriptions refer to the release **1.1.8** of the Web Interface.

The Web Interface is organized into different pages accessible by a simple menu always in the foreground (**Fig. 10.1**).
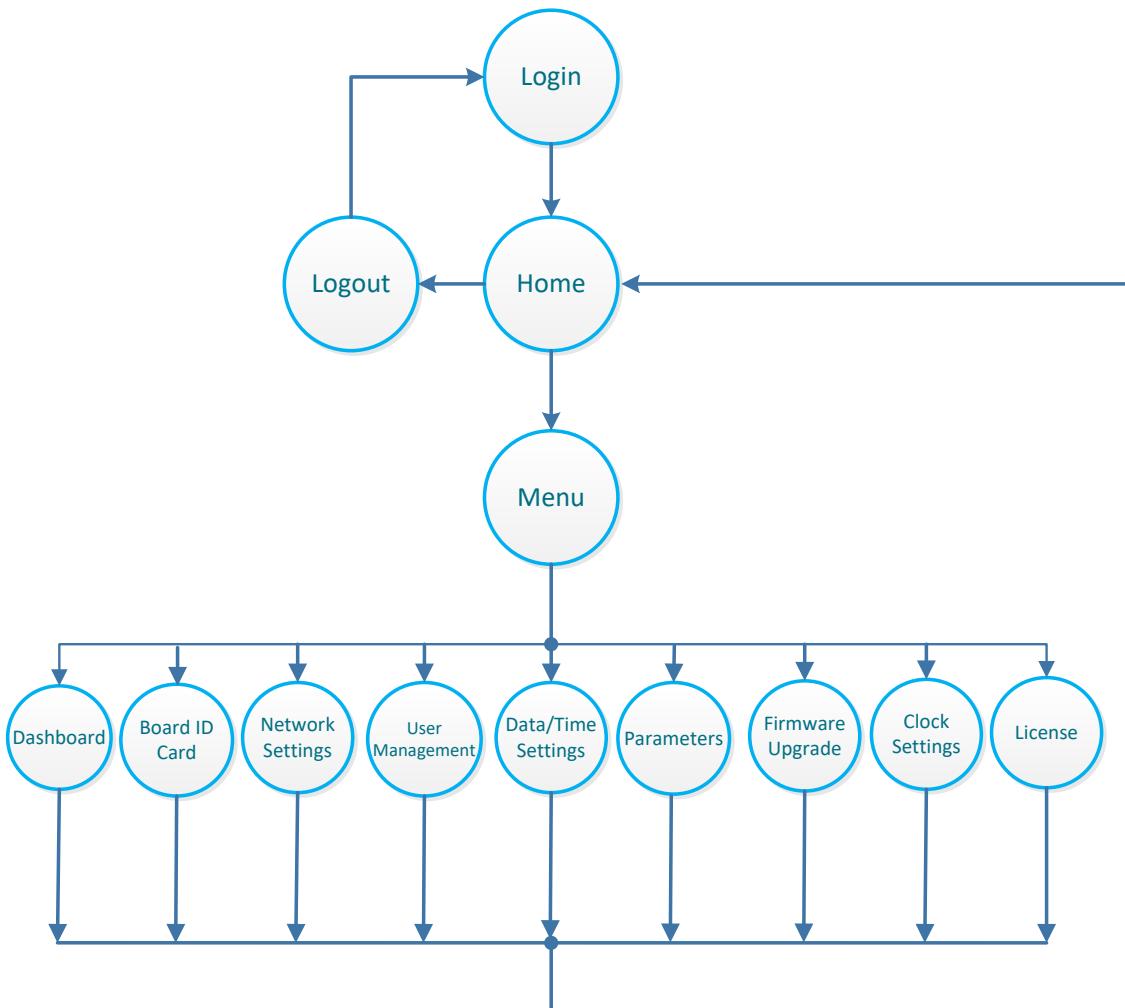

Fig. 10.1: Flow Diagram of the Web Interface

10.1 First Access by USB

To perform the first access by USB, open your browser and digit:

http://caendgtz-usb-{PID}

where the {PID} is the number reported on your Digitizer (see Chap. **4**).

Note: There might be Linux distributions that are not able to automatically retrieve the Digitizer USB name (caendgtz-USB-{PID}). In this case, the web browser returns an error when trying to access the digitizer using its USB name. This issue can be resolved by connecting the Digitizer to a PC USB port (there must be only one CAEN device at a time connected!) and then executing the "regPID" script file (./regPID.sh) that is included in the Linux driver packet of the Digitizer (see Chap. **9**). The connected digitizer will be so registered on the PC. In presence of multiple digitizers, the same procedure must be repeated for each device.

10.2 First Access by Ethernet

To perform the first access by Ethernet, open your browser and digit:

http://192.168.0.254

where 192.168.0.254 is the factory IP address of the board (see Chap. **9**).

Note: since the IP address of the Digitizer can be changed by the user (see Sec. **10.7**), it is strongly suggested to check the IP address of the Digitizer in the web interface by connecting via USB link, first of all.

Note: Instead of the IP address, the connection is even possible by using the hostname (CAEN-ETH-PID, where PID is defined in Chap. **4**). This option cannot be used in a point-to-point connection. To be able to use this option, the network in which the digitizer is connected must provide a DHCP and DNS service. In case of any doubts, it must be checked with your IT department that an 'A record' is present in your DNS server.

10.3 Login

To log in to the Web Interface, two account levels are defined: Administrator and User. The default credentials are reported in the table below.

ACCOUNT	CREDENTIALS
Administrator	Username = *admin* Password = *admin*
User	Username = *user* Password = *user*

Tab. 10.1: Default account credentials
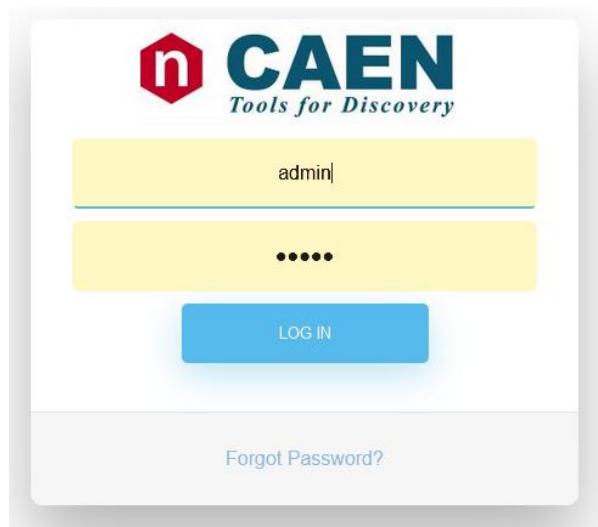
Fig. 10.2: Login dialog

It is possible to reset the password of the Administrator account by contacting CAEN Technical Support (see Chap. **16**) after clicking on the "Forgot Password?" link.

Note: To reset the password of a User account, please contact your administrator.

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10.4 Home Page

The home page includes the Menu with the entries to access the different pages of the web interface, some general information like date and hour, the Web Interface release version and copyright, the target digitizer model, and identification number (PID). The Menu is always in the foreground unless the User decides to hide it by the Toggle Menu button.

It is possible to go back to the home page from any other page of the web interface just by clicking on Home.
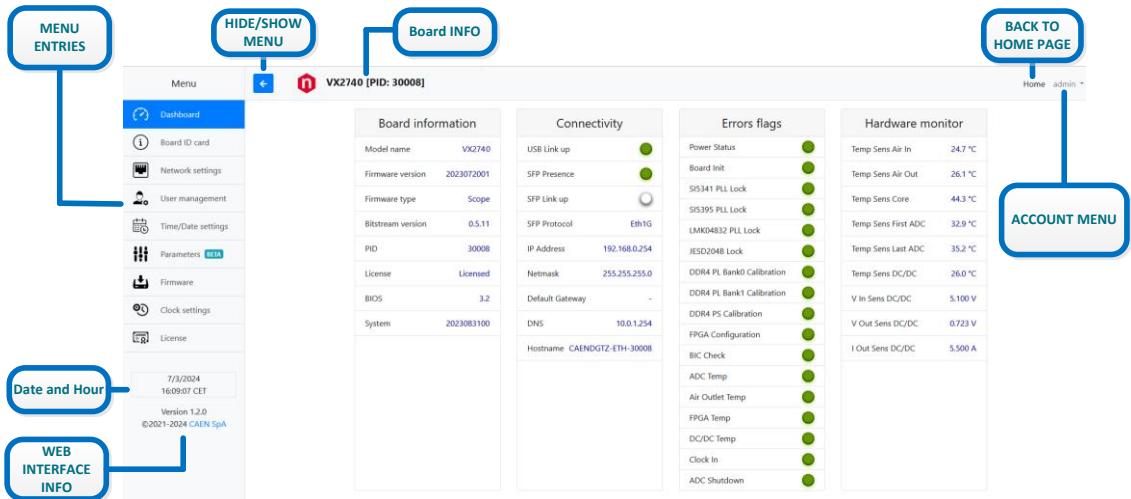
Fig. 10.3: Home page

10.4.1 Account Menu

On the top right of the home page, the slide menu makes available a set of functions for the current account (see **Fig. 10.4**).
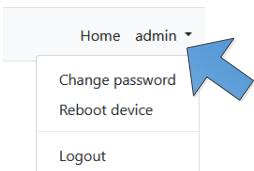
Fig. 10.4: Admin account functions

- "Change Password" allows modifying the password of the account. To protect the privacy, it is recommended to change the password after the first access (see **Fig. 10.5**).
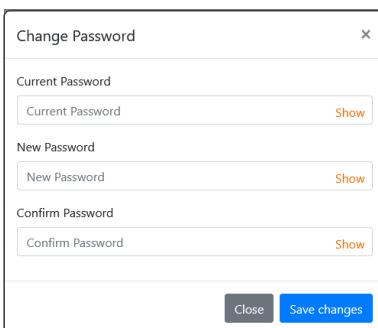
Fig. 10.5: Change Password dialog

- Reboot device" triggers the embedded operating system reboot. It is useful after a firmware upgrade (see Sec. **10.8**), particularly when the device is not physically accessible.

- "Logout" permits to quickly log out of the web interface.

10.4.2   Alert Indicator

In case of failure, the alert indicator ❗ appears on top of the Web Interface frame (see **Fig. 10.6**), which stays always in the foreground.

The indicator blinks for a few seconds and stops. It disappears if the failure is removed.

From any other page of the Web Interface, just clicking on the indicator forwards to the Dashboard to have a quick sight at the diagnostics (see Sec. **10.5.3**).

Fig. 10.6: Alert indicator on top of the Web Interface

10.5 Dashboard Page

The Dashboard page shows three categories of information: Error Flags, Board Information, and Hardware Monitor.

The "Error Flags" is a list of light indicators of the hardware status (see Sec. **10.5.3**). The "Board Information" provides the main information retrieved from the board, like model, firmware versions, PID, active link, etc. (see Sec. **10.5.1**). The "Hardware Monitor" displays the actual values of a set of critical hardware parameters (see Sec. **10.5.4**).

Board information		Connectivity		Errors flags		Hardware monitor	
Model name	VX2740	USB Link up	●	Power Status	●	Temp Sens Air In	31.1 °C
Firmware version	2023072001	SFP Presence	●	Board Init	●	Temp Sens Air Out	40.8 °C
Firmware type	Scope	SFP Link up	○	SI5341 PLL Lock	●	Temp Sens Core	66.5 °C
Bitstream version	0.5.11	SFP Protocol	Eth1G	SI5395 PLL Lock	●	Temp Sens First ADC	43.9 °C
PID	30008	IP Address	192.168.0.254	LMK04832 PLL Lock	●	Temp Sens Last ADC	57.8 °C
License	Licensed	Netmask	255.255.255.0	JESD204B Lock	●	Temp Sens DC/DC	38.0 °C
BIOS	3.2	Default Gateway	-	DDR4 PL Bank0 Calibration	●	V In Sens DC/DC	5.125 V
System	2023083100	DNS	10.0.1.254	DDR4 PL Bank1 Calibration	●	V Out Sens DC/DC	0.723 V
		Hostname	CAENDGTZ-ETH-30008	DDR4 PS Calibration	●	I Out Sens DC/DC	6.125 A
				FPGA Configuration	●		
				BIC Check	●		
				ADC Temp	●		
				Air Outlet Temp	●		
				FPGA Temp	●		
				DC/DC Temp	●		
				Clock In	●		
				ADC Shutdown	●		

Fig. 10.7: Dashboard page

10.5.1   Board Information

Board Information	Description	Options
Model name	The name of the digitizer model	V2740, V2740B, VX2740, VX2740B, DT2740, DT5724B, V2745, V2745B, VX2745, VX2745B, DT2745, DT2745B
Firmware version	The firmware version of the current CUP	See Sec. **10.8**
Firmware type	The category of the current CUP	DPP_PHA (CAEN firmware for Pulse Height Analysis) DPP_PSD (CAEN firmware for Pulse Shape Discrimination) DPP_ZLE (CAEN firmware for Zero Length Encoding) Scope (CAEN firmware for waveform recording) DPP_OPEN (User DPP firmware) Scope_OPEN (User Scope firmware)
Bitstream version	The version of the FPGA firmware	X.Y.ZZZ X = major, Y = minor, ZZZ = build
PID	The product identification number of the Digitizer	Incremental decimal number > 10000
License	The license status referred to the FPGA firmware (see Sec. **10.13**)	Not Licensed = DPP firmware and SCI-Compiler firmware (Open FPGA) trial version. Licensed = Scope firmware, DPP firmware, and SCI-Compiler firmware unlocked version.
Trial Time Left	Timebomb for firmware trial versions	30-minute reverse counter. Appears only if a DPP firmware or SCI-Compiler firmware is running in trial version (see Sec. **10.13**).
BIOS	The firmware version of the BIOS	See Sec. **10.8**.
System	The firmware version of the operating system	
LAN/USB Link up	Light indicators of the active link	Green = active Red = not active

Tab. 10.2: Board Information table

10.5.2   Connectivity

Connectivity info	Description	Value	Notes
USB link up	Indicates if the USB link is active	Green = active White = not active	
SFP Presence	Indicates if a SFP transceiver is plugged	Green = plugged White = not plugged	
SFP Link up	Indicates if the SFP link is active	Green = active White = not active	
SFP Protocol	Indicates the protocol of the SFP link	Eth1G (1 Gigabit Ethernet) Eth10G (10 Gigabit Ethernet) CONET (CAEN proprietary optical link)	It is not correlated to the SFP Presence, but related to the CUP type (See Sec. **10.9**)
IP Address	Host identification number used for proper communication between devices		
Netmask	Mask used to distinguish the subnet part of the IP address, as well as the part that is the host address of that subnet		Network interface parameters echoed from the Network Settings page (Sec. **10.7**)
Default Gateway	Network device that acts as an entry point from one network to others		
DNS	DNS (Domain Name System) service used to change public (external) IP addresses from numeric to a domain format		
Hostname	Domain name assigned to the device on the network	Default: caendgtz-eth-{PID}	

Tab. 10.3: Connectivity table

⚠️ **LIVE INSERTION (HOT SWAP) OF THE SFP TRANSCEIVER IS NOT SUPPORTED!**

10.5.3   Error Flags

| Flag	Description	Value	Notes
Power Status	Status flag of the power supply of the board	GREEN = Normal RED = Power Supply fail	
Board Init	Status flag of the board initialization procedure	GREEN = Normal RED = Initialization fail	
SI5341 PLL Lock	Status flag of the SI5341 PLL component	GREEN = Normal RED = PLL unlocked	When in fail status, there could be a hardware problem or something wrong in the user settings
SI5395 PLL Lock	Status flag of the SI5341 PLL component	GREEN = Normal RED = PLL unlocked	
LMK04832 PLL Lock	Status flag of the LMK04832 PLL component	GREEN = Normal RED = PLL unlocked	
JESD204B Lock	Status flag of the ADC output bus	GREEN = Normal RED = Bus unlocked	When in fail status, the acquired data are corrupted
DDR4 PL Bank0 Calibration	Status flag of the first FPGA memory bank calibration	GREEN = Normal RED = Calibration fail	When in fail status, there is a problem with the memory
DDR4 PL Bank1 Calibration	Status flag of the second FPGA memory bank calibration	GREEN = Normal RED = Calibration fail	
DDR4 PS Calibration	Status flag of the processor memory calibration	GREEN = Normal RED = Calibration fail	
FPGA Configuration	Status flag of the FPGA configuration	GREEN = Normal RED = Configuration fail	In case of failure, the processor could not load the firmware on the FPGA. The board enters the factory mode for a new configuration attempt
BIC Check	Status flag of the Board ID Card information check	GREEN = Normal RED = Check fail	When in fail status, there could be a problem with the FLASH memory storing the Board ID Card information
ADC Temp	Status flag of the Analog-to-Digital converters' temperature	GREEN = Normal RED = Temperature out of range	This flag is correlated to the Temp Sens First ADC and Temp Sens Last ADC parameters in the Hardware Monitor section (**Tab. 10.5**)
Air Outlet Temp	Status flag of the board cooling	GREEN = Normal RED = Cooling fail	This flag is correlated to the Temp Sens Air In and Temp Sens Air Out in parameters in the Hardware Monitor section (**Tab. 10.5**)
FPGA Temp	Status flag of the FPGA temperature	GREEN = Normal RED = Temperature out of range	This flag is correlated to the Temp Sens Core parameter in the Hardware Monitor section (**Tab. 10.5**)
DC/DC Temp	Status flag of the temperature of the FPGA main power supply	GREEN = Normal RED = Temperature out of range	This flag is correlated to the Temp Sens DC/DC parameter in the Hardware Monitor section (**Tab. 10.5**). In case of failure, check the value of the Temp Sens DC/DC, V In Sens DC/DC, V Out Sens DC/DC, and I Out Sens DC/DC parameters
Clock In	Status flag of the internal reference clock	GREEN = Normal RED = Clock fail	In case of a failure with the reference clock set on External (Sec. **10.12**), a clock signal could be missing on the CLK-IN connector. In case of a failure while the reference clock is set on Internal, there could be a hardware problem
ADC Shutdown	Status flag of the ADC shutdown	GREEN = No shutdown RED = Shutdown occurred	This flag signals that the ADCs were shut down for overheating to prevent damage

Tab. 10.4: Error Flags table

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10.5.4   Hardware Monitor

Hardware Parameter	Description	Notes
Temp Sens Air In	Temperature monitoring of the inlet/outlet air flow	These parameters are correlated to the Temp Outlet Air indicator in the Dashboard section (**Tab. 10.4**)
Temp Sens Air Out		
Temp Sens Core	Temperature monitoring of the FPGA	This parameter is correlated to the FPGA Temp indicator in the Dashboard section (**Tab. 10.5**)
Temp Sens First ADC	Temperature monitoring of the Analog-to-Digital converters	These parameters are correlated to the ADC Temp indicator in the Dashboard section (**Tab. 10.4**)
Temp Sens Last ADC		
Temp Sens DC/DC	Temperature monitoring of the FPGA main power supply	This parameter is correlated to the DC/DC Temp indicator in the Dashboard section (**Tab. 10.4**)
V In Sens DC/DC	Input voltage monitoring of the FPGA main power supply	The value of these parameters should be checked in case the Temp DC/DC error flag is on fail
V Out Sens DC/DC	Output voltage monitoring of the FPGA main power supply	
I Out Sens DC/DC	Output current monitoring of the FPGA main power supply	
Speed Sens Fan #1 and #2	Monitoring of the onboard fan speed	Available only in the case of Desktop digitizer or VME digitizer plugged into CAEN µCrate

Tab. 10.5: Hardware Monitor table

10.6 Board ID Card (BIC) Page

The Board ID Card page contains a set of information identifying the Digitizer. The User can save the page content to a PDF file by the "Download" button.

BIC

[Download]

Model Code
WV2740XAAAAA

PB Code
WA40BXAAAAAA

Model Name
V2740

Form Factor
VME

Family Code
2740

PID
16218

PCBrev MB
0

PCBrev PB
0

PCB PB Patch
0

ADC Resolution (bit)
16

ADC Sampling Rate (MS/s)
125

Number of Channels
64

Input Range (Vpp)
2

Input Type
Differential

Input Impedance (Ohm)
100

OUI
0040E6

MAC
00:12:5E:00:13:66

Fig. 10.8: Board ID Card page

10.6.1   BIC Information

Board ID Card Information	Description	Notes
Model code	CAEN product code	
PB code	CAEN code of the digitizer PiggyBack	
Model name	The name of the digitizer model	Same information as on the Dashboard page (**Tab. 10.2**)
Form factor	The code identifying the digitizer form factor	0 = VME 1 = VME64X 2 = Desktop
Family code	The code identifying the digitizer family	It is 2740 or V2745 (common to all the digitizer versions: VME, VME64X, Desktop, SE/DIFF inputs, etc.)
PID	The product identification number of the digitizer	Same information as on the Dashboard page (**Tab. 10.2**)
PCBrev MB	The PCB revision number of the digitizer MotherBoard	
PCBrev PB	The PCB revision number of the digitizer PiggyBack	
PCB PB Patch	Additional revision number related to the patch on the PCB PiggyBack (CAEN use only)	0 = no patch present
ADC Resolution (bit)	The ADC resolution in bits	Must be 16 (16-bit) for 2740-45 series
ADC Sampling Rate (MS/s)	The sampling frequency of the ADCs in MS/s	Must be 125 (125 MS/s) foer 2740-45 series
Number of Channels	The maximum number of supported analog input channels	Must be 64 for 2740-45 series
FPGA Type	The model of the on-board FPGA	Must be 1 (XCZU19)
Input Range (V_{pp})	The full-scale range of the analog input channels in peak-to-peak Volts	Must be 2 (V_{pp}) for 2740 and 4 (V_{pp}) for 2745
Input Type	The type of the input channels	DIFF = Differential SE = Single-ended
Input Impedance (Ohm)	The input impedance value of the analog channels in Ohm	Must be 100 for differential input type Must be 50 for single-ended input type
OUI	The 3-byte IEEE Organizationally Unique Identifier	Must be 0040E6
MAC	The factory MAC address of the Digitizer	

Tab. 10.6: Board ID Card table

10.7 Network Settings Page

On this page, the User can manage the network settings of the Digitizer. The MAC Address is fixed and given by the manufacturer. The default IP Address, the address Method (Manual/DHCP), and the other settings can be configured in this section according to the characteristics of the end user's network. Press Apply to confirm the changes.

If necessary, the hostname for the ethernet connection, *caendgtz-ETH-{PID}*, can be changed in this section.

LAN Link up ◯

MAC Address

00:12:5E:00:1A:07

Method

Manual ⌄

IP Address

192.168.0.254

Netmask

255.255.255.0

Default Gateway

DNS

10.0.1.254

Hostname

CAENDGTZ-ETH-30004

Apply

Fig. 10.9: Network Settings page

🖉   **Note:** The values of the network parameters here configured are echoed in the Dashboard page (Sec. **10.5.2**).

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10.8 User Management Page

Two different access roles are defined: admin and user. The administrator (admin) can control all the functions of the Web interface. The user access is limited to the Dashboard and Board ID Card pages.

The user is also allowed to reboot the board and change the password.

Fig. 10.10: User Management page

10.9 Time/Date Settings Page

In this section, the User can change the time and date settings. Disabling the NTP synchronization option, the hour, date, and time zone can be manually inputted. It is also possible to synchronize the digitizer hour and date with computer clock. When connected by the ethernet link, hour and date can even be synchronized to an external NTP server after enabling the NTP synchronization option (the Debian servers are set by default).
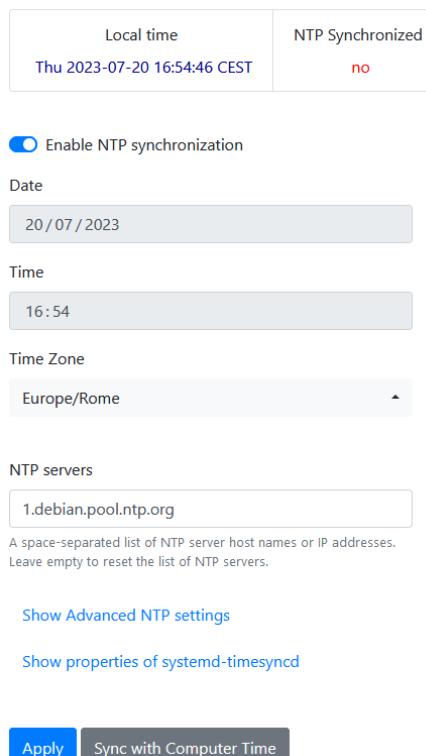
Fig. 10.11: Time/Date Settings page

✎   **Note:** Please, refer to systemd-timesyncd documentation for the description of the Advanced NTP settings.

10.10   Parameters Page

In this section, the User can manage the library parameters related to the active firmware CUP revision. It is possible to browse for the description of each available parameter, command, and endpoint, and save the entire documentation to disk as PDF file. The section also provides a Manual Controller to make basic settings and monitoring for test purposes.

Fig. 10.12: Parameters page

✏️ **Note:** Make sure that the pop-up messages are enabled in the internet browser to access the parameter view.

Fig. 10.13: Parameters view from the Web Interface

10.10.1 Device Tree
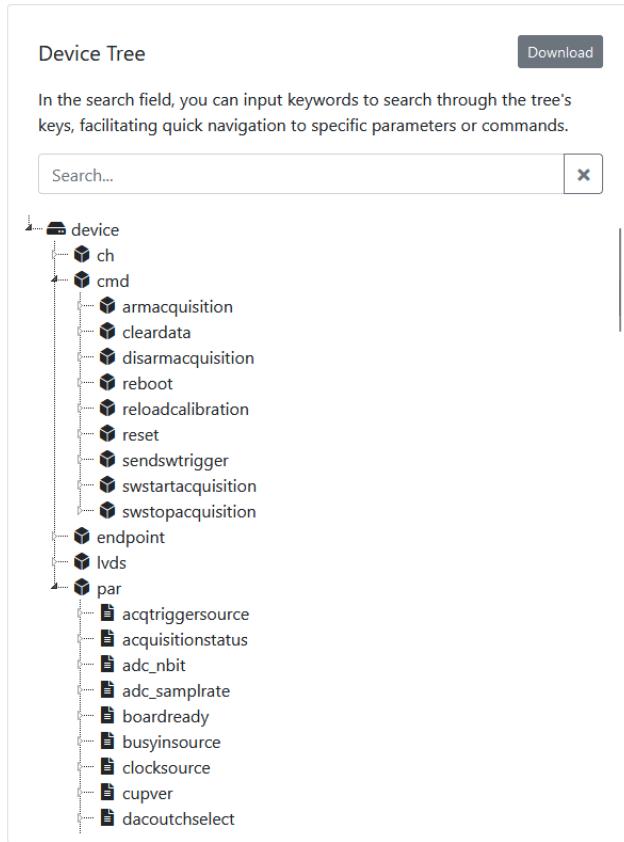
Fig. 10.14: Device Tree subsection

10.10.2 Manual Controller
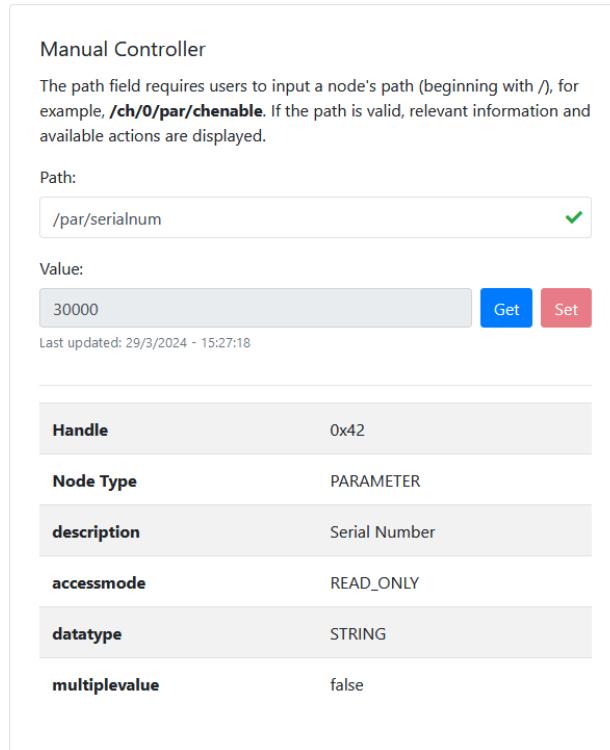
Fig. 10.15: Manual Controller subsection

Clicking on a key in the Device Tree (Sec. **10.10.1**), the path is put directly in the Path field of the Manual Controller.

10.11   Firmware Page

Four components characterize the programming status of the digitizer, whose versions are reported in the Web Interface (see Sec. **0**):

BIOS	*Is the BIOS firmware of the digitizer*
System	*Is the operating system of the digitizer*
Bitstream	*Is the FPGA firmware of the digitizer*
Firmware	*Is the current CUP file*

Firmware updates are provided by CAEN as a CUP file, which is an archive of files capable to upgrade more than a programmable component.

> *A CUP FILE COULD BE ISSUED TO UPGRADE SPECIFIC COMPONENTS SO LOADING A CUP FILE ON THE DIGITIZER NOT ALWAYS IMPLIES THAT ALL THE FIRMWARE COMPONENTS WILL BE UPDATED!*

The CUP file name is standardly:

<center>*<model>-<category>-<revision>-<eth_type>.CUP*</center>

where

model	is the digitizer model	e.g. "V2740" is common to V2740 and V2740B versions.
category	identifies the firmware category	e.g. "scope" means firmware for the waveform recording.
revision	is the CUP release number	e.g. "2022051400" means release 00 and build May 14th, 2022.
eth_type	is the kind of ethernet interface supported	e.g. "1G" means 1 Gigabit Ethernet.

The Digitizer can store multiple CUP files at once on board. Each file generates a raw in the "Firmware" page characterized by version and category (scope, DPP-PHA, etc.) as in **Fig. 10.16**.
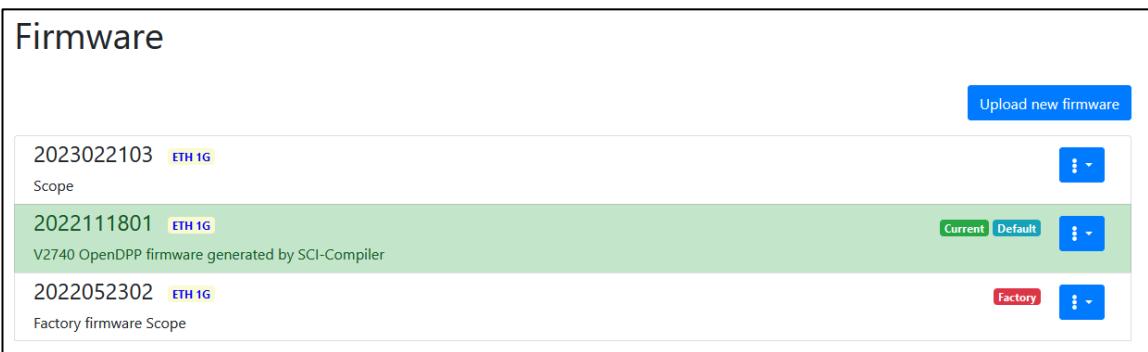

Fig. 10.16: Firmware page

In the Firmware page, it is possible to load a new CUP file (see Sec. **10.11.1**) and manage the stored ones.

The factory firmware (red label in **Fig. 10.16**) is loaded by the manufacturer and cannot be removed.

By the blue slide-menu on the right of the raw, specific settings can be applied (**Fig. 10.16**):

Apply	This function sets the CUP version as current (green label). The digitizer is programmed on the fly without needing to reboot the digitizer.
Set as default	This function sets the CUP version as default (light blue label). The digitizer is programmed after a reboot.
Delete	This function removes the CUP version from the digitizer memory.
See details	Shows what is new in the CUP file version (**Fig. 10.17**).
Delete	Removes the CUP version from the Digitizer memory

Note: The Apply, Default, and Delete functions are also supported by the CAEN Toolbox software utility **[RD5]**.
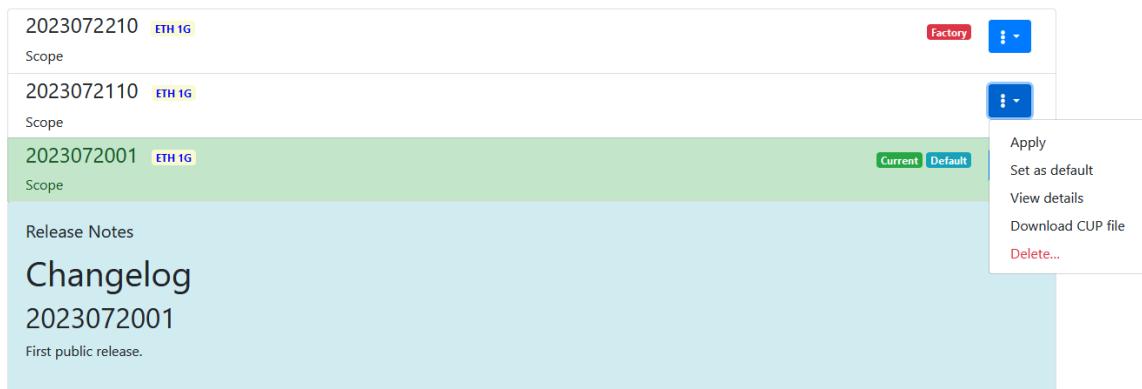
Fig. 10.17: The CUP file changelog

THE FACTORY FIRMWARE CANNOT BE DELETED!

DOWNGRADING THE CURRENT CUP VERSION DOES NOT AUTOMATICALLY MEAN THAT ALL THE FIRMWARE COMPONENTS ARE DOWNGRADED!

10.11.1   Upgrade Procedure

The following step shows how to load a CUP file on the Digitizer:

- Press the "Upload new firmware" button.

- Use the "Browse" button in the upgrade window to point to the CUP file.

- Press the "Upload" button to start the upgrade.

- Wait until the process is completed.

- The new CUP version will be automatically set as current at the end of the process (see Sec **10.8**).
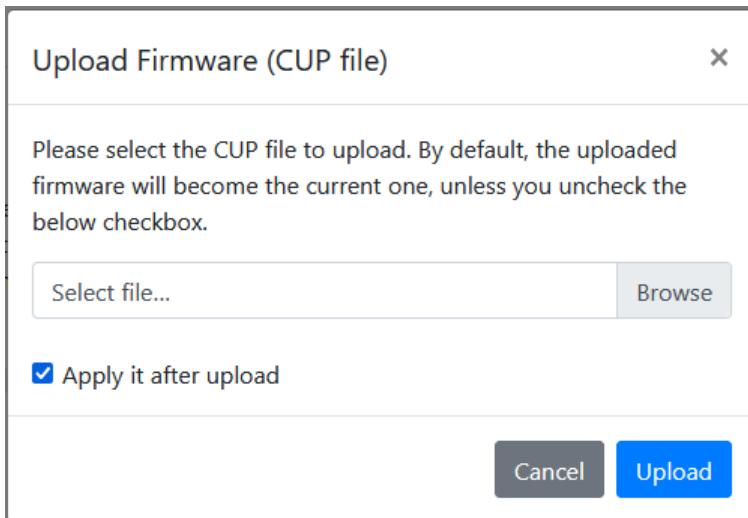
Fig. 10.18: Firmware upgrade window

- A reboot may be requested to make the upgrade effective: power cycle the Digitizer or use the "Reboot device" option for a remote reboot (see Sec. **10.4.1**). After reboot, the CUP version set as "default" will be the current (see Sec **10.8**).

📝   **Note:** The CUP upgrade function is also supported by the CAEN Toolbox software utility **[RD5]**.

10.12   Clock Settings

This is the section where the clock settings of the Digitizer are managed:

Reference clock	**Internal**: The Digitizer is set to work upon the internal oscillator as the reference clock (default).
	External: The Digitizer is set to work upon an external clock reference; the front panel CLK-IN LED is on. By applying the proper clock signal to the front panel CLK-IN connector, the PLL-LOCK LED lights on to indicate that the PLL of the Digitizer is locked.
	In case of a PLL failure, or if no signal is sent to CLK-IN, the PLL-LOCK LED is off and the FAIL LED is on (the failure should be signaled also by the error flags in the Dashboard page, Sec. **10.5**).
	The External setting is typically used in the daisy chain propagation of the clock (by CLK-IN / CLK-OUT) for multi-board synchronization.
Output clock	**Enable**: The reference clock signal is sent to the front panel CLK-OUT connector. Enabling the output clock, the CLK-OUT LED of the Digitizer is on.
	Disable: No clock signal is sent out to CLK-OUT.
	The output clock enable is typically used in the daisy chain propagation of the clock (by CLK-IN / CLK-OUT) for multi-board synchronization.
Clock out delay	The clock reference signal is sent to CLK-OUT with a programmable delay: select the desired delay value and then press Apply to confirm.
	This setting is generally used for compensating the phase skew of the clocks when synchronizing a multi-board system.
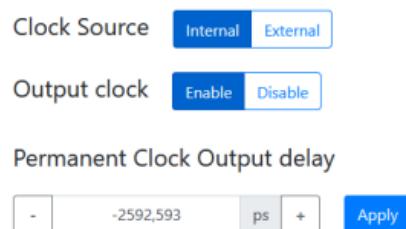
Fig. 10.19: Clock Settings page

10.12.1   PLL Settings

When the Clock Source is set to External, in this subsection it is possible to synchronize the Digitizer to a programmed reference clock frequency provided on CLK-IN connector.

Users can select the frequency from a set of stored configurations and add new ones by uploading special PLL programming files provided by CAEN on request (Chap. **16**).

The PLL configuration file has the following features:

- It is a text file

- It configures the PLL only for one specific frequency value provided on CLK-IN (reported in the filename)

- The default frequency of 62.5 MHz is always provided on CLK-OUT (typically to Daisy chain the clock in multi-board synchronization)

- The same file can be used indifferently on Desktop and VME boards, also on Digitizer 2.0 modules of different series.

Fig. 10.20: PLL Settings Menu

To know more about a stored PLL configuration file:

- *Click on More to see the file details (file version, input and output programmed clocks, clock signal accuracy, file date, checksum and notes)*

To apply a stored PLL configuration:

- *Press the Apply button close to the wanted PLL programming file in the list -> Reboot the digitizer*

To download a stored PLL configuration file on the host computer:

- *Press the ⬇ button*

To store a new PLL configuration:

- *Press the Upgrade New PLL button -> Browse your PC pointing to the new programming text file -> Press the Upload button*
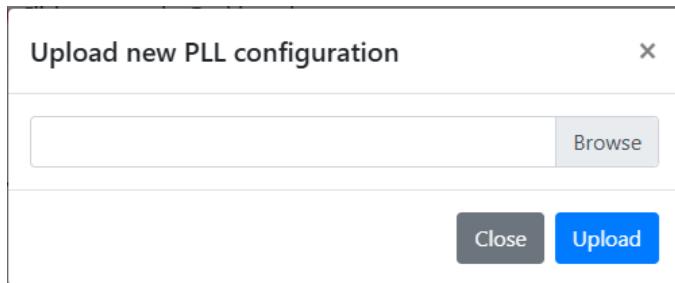

Fig. 10.21: PLL Upload Dialog

Once the desired PLL configuration has been applied, check that the Clock Source is set to External (Sec. 10.12). The green LED close to the CLK-IN connector must be on. The PLL-LOCK green LED must be on as soon as the proper external clock is fed into CLK-IN.

Note: Users who need new PLL configurations can open a ticket to contact CAEN Support (see Chap. **16**). CAEN will evaluate the feasibility of the configuration and possibly provide the relevant programming txt file.

Note: The PLL configuration files factory stored in the digitizer memory cannot be removed. Users can anyway delete those files that have been uploaded afterwards.

10.13 License

This page manages the runtime license needed by the pay firmware, basically the DPP firmware (provided by CAEN) and the SCI-Compiler firmware (made from users for the Open FPGA).

Fig. 10.22: License page

Once loaded on the digitizer, if not licensed, the firmware runs in Trial mode, that is 30 minutes per power cycle with all the functions working.

To users who purchased a runtime license, the Apply function allows writing the received PUC (Product Unlock Code) on the digitizer memory to remove the time limitation and activate the license.

The stored PUC, if present, is always displayed in the relevant textbox for backup.

Note: After Apply and Remove functions, the device reboot is always required to make the operation effective

10.13.1 PUC Activation

- Type the received 24-digit PUC in the text box according to kind of Runtime license;

- Press the Apply key;

- Wait for a few seconds until a message informs you that the process is completed;

- Reboot the Digitizer. The PUC should be displayed in the related textbox.

- Set a compliant CUP as current (Sec. **10.11**) and the License parameter in the Dashboard must show the "Licensed" value (Sec. **10.5.1**)

11 On-board Zynq® UltraScale+™ MPSoC

The Digitizer is equipped with a Zynq UltraScale+ MPSoC module including an ARM-based processor running Debian 11 GNU/Linux OS. The User can access via SSH protocol the SoC module via both the USB and the Ethernet protocol and develop his/her own software on the OS installed, as if almost were a PC with a Linux OS installed.

Note: ARM-based processors have much lower computational power than normal PCs. Running softwares requiring high computational capability on the embedded SoC could drastically reduce the overall performance of the entire x2740-2745 module.

11.1 How to Access the Embedded OS

It is possible to access the Linux OS installed on the SoC by performing the USB or Ethernet connection using the SSH protocol:

- Open the terminal.

- Digit *ssh admin@caendgtz-usb-{PID}* in case of USB connection or *ssh admin@{ip address}* in case of Ethernet connection.

- Insert the Password when required (*admin*)

- Once the connection is established, the window opened is similar to the one in the figure above. The User can visualize information regarding the OS installed on the ARM processor.


```
PS C:\Users_____> ssh caendgtz-usb-12741 -ladmin
admin@caendgtz-usb-12741's password:
Linux CAENDGTZ-VM 4.19.0-xilinx-v2019.2 #1 SMP Wed Nov 10 11:53:30 UTC 2021 aarch64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Tue Jan 31 10:56:44 2023 from 2001:db8:1::1
admin@CAENDGTZ-VM:~$
```

11.2 Library Installation

Once the SSH connection with the Debian GNU/Linux OS installed on the SoC available on the Digitizer is established the User can install the libraries required to work with the digitizer: the Dig2 and the FELib library available on our site **[RD4]**.

- Download the binary files for aarch64 distribution.

- Copy the *tar.gz* files on the Debian GNU/Linux OS installed on the SoC with the terminal command:
  scp {file path}/{file name}.tar.gz admin@{digitizer path}:/home/admin
  Note that this command must be launched from the host PC, not from the SoC.

- Connect via ssh to the SoC as showed in Sec. **11.1**.

- Untar the packages with the following command: *sudo tar -zxvf {file name} -C / --no-overwrite-dir*

- Reboot the device.

- Once the installation of both libraries is completed, the User can check the content of the */usr/local/lib* folder.

Now the User is able to develop his own DAQ and run it on the SoC.

11.3 Run the FELib Demo

For example, the User can run the FELib Demo scope as example of a basic DAQ of the digitizer. The following steps require the digitizer to be online (for example the digitizer can be connected in DHCP to the Network), USB and Ethernet Point-to-Point aren't supported.

- Copy the *caen-felib-demo-scope* folder, for example, in the Debian GNU/Linux OS installed on the SoC.

- Connect via ssh and open the terminal inside the *caen-felib-demo-scope* folder.

- Update the system and download the *build-essential* package from the apt repository by digiting on the terminal:
  sudo apt update
  sudo apt install build-essential

- Now digit *make* on the terminal to compile the demo.

- Launch the demo.

12 First Acquisition with WaveDump2

This chapter suggests how to perform a simple waveform acquisition using the Digitizer and CAEN WaveDump2 readout software **[RD3]**.

The described example is based on a Windows 10 PC and a USB connection.

12.1 Setup

It is possible to input the analog signals into the Digitizer using one of the adapters provided by CAEN (accessories not included in the device delivery kit): A372M and A372F.

The A372F adapts all the 64 channels from the 40-pin 2mm header connectors of 2740 to 34-pin 2.54mm header ones, not applying any electrical modification to the original single-ended or differential analog channels of the Digitizer.

The A372M adapts all the 64 channels from the 40-pin 2mm header connectors of the 2740 to 64 MCX coaxial ones. This adapter must be used only with single-ended versions of the Digitizer (2740B).

Details, pinout, and assembly information can be found in the adapters' datasheet **[RD2]**.
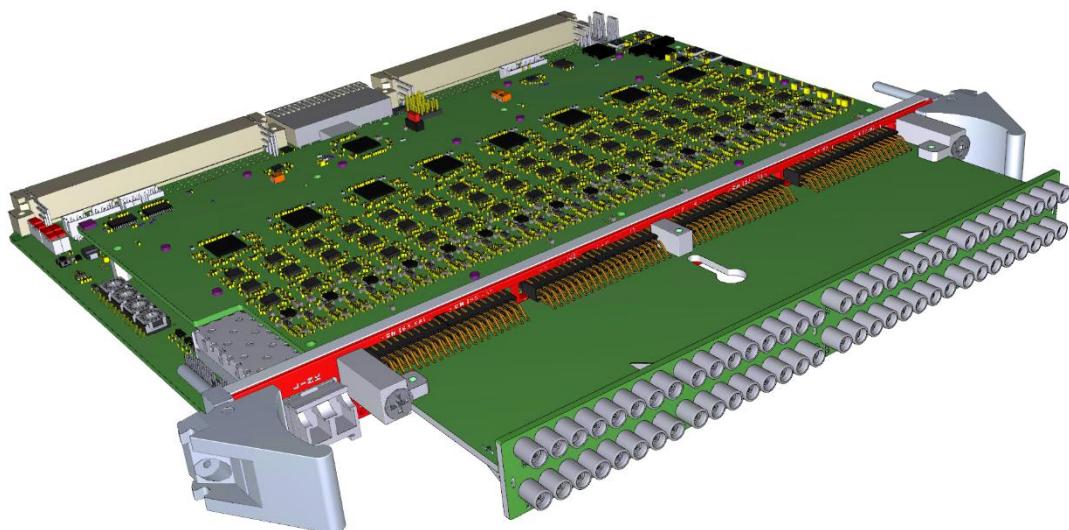

Fig. 12.1: The 2740 Digitizer matched with the A372M adapter.

In this document, a Gaussian signal of fixed amplitude, fixed-rate and negative polarity is generated as input pulse and fed into CH0 of the 2740 Digitizer.
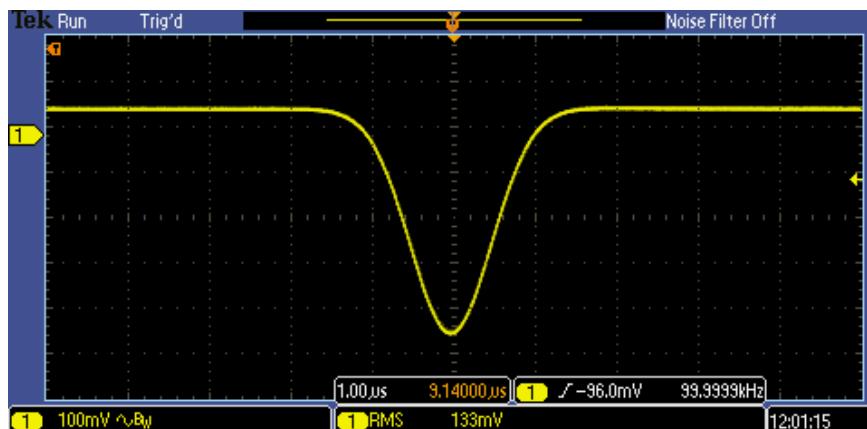

Fig. 12.2: Typical input Gaussian signal

12.2 Connection and Configuration

1. Download the WaveDump2 packet from the digitizer page on the CAEN website.

2. Unpack, then double-click on the installer file.

3. Complete the installation wizard.

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

   C:\Program Files\CAEN\WaveDump2

5. Run Wavedump2 optionally by:

   - the executable file in the *bin* subfolder;

   - the desktop shortcut;

   - the Start menu.

6. Click on the Connect icon in the top menu bar.
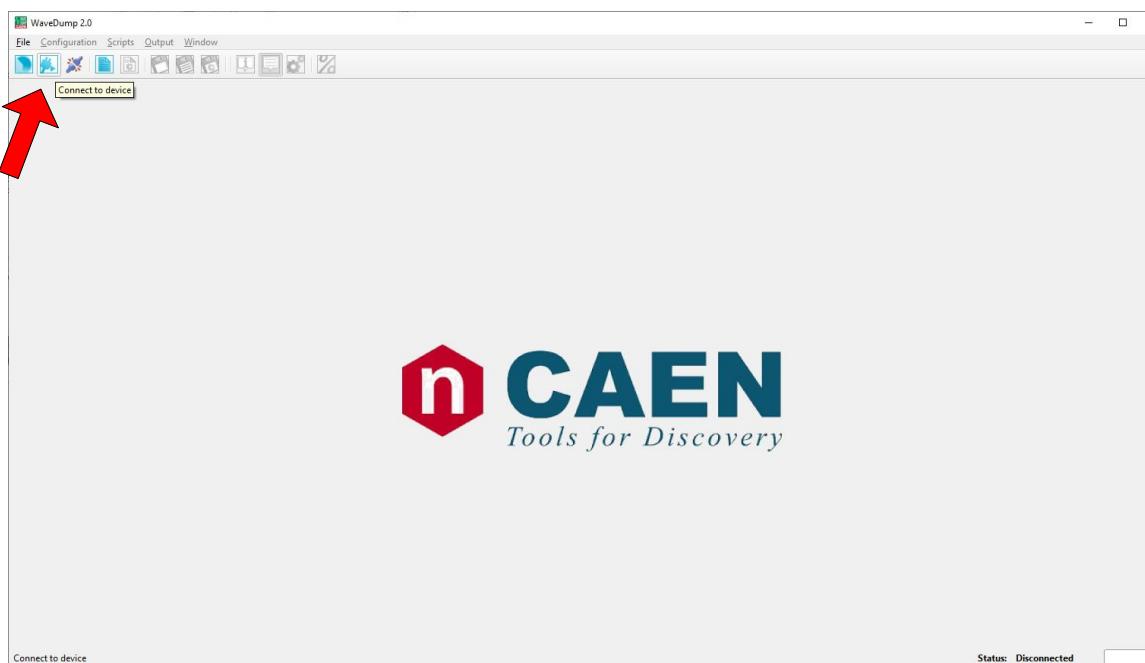
Fig. 12.3: WaveDump2 mainframe

7. Select the USB connection type option and digit the PID number of the target device, then click on the Connect button. In the Logs panel, at the bottom of the main window, the software reports connection success. The User can optionally define a device name (Name) that will be used by the software to identify the active device.
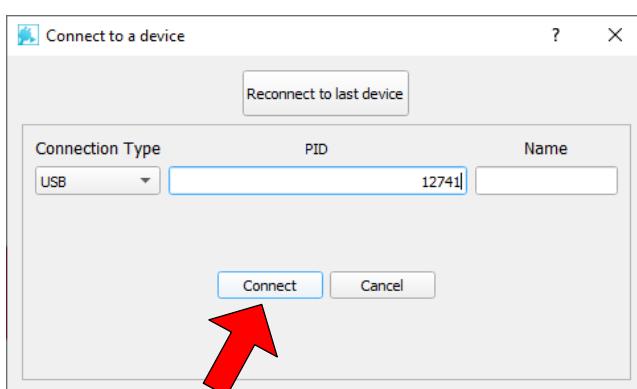

**Fig. 12.4**: Connection panel
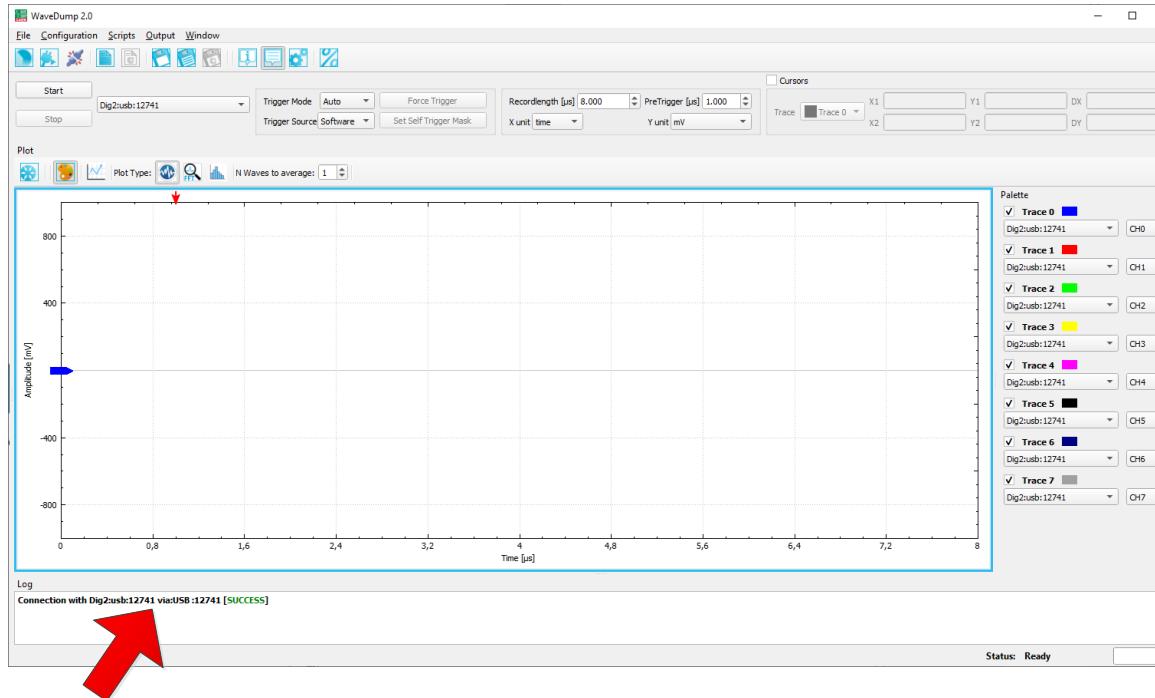
Fig. 12.5: Logs panel

8.   In the Plot toolbar, click on the Palette icon to show the Graph settings panel.

9.   Enable only Trace 0 and select CH0 as the associated channel.
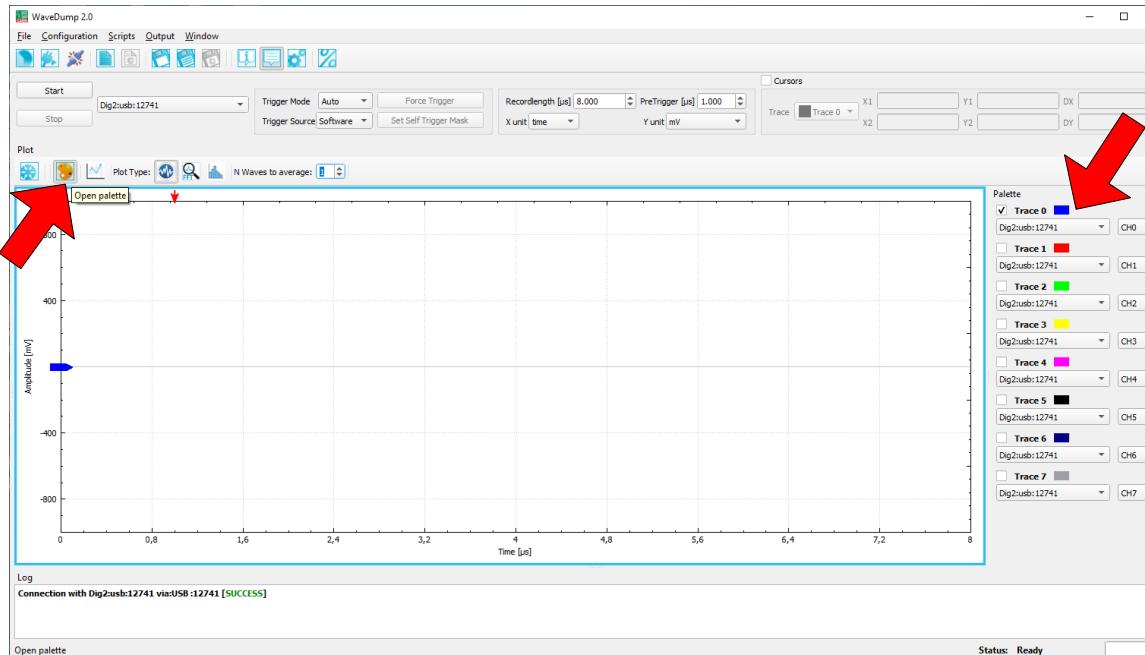

Fig. 12.6: Graph settings

10. In the Control panel, set Trigger Mode Auto and Trigger Source Software for the connected active device (if not entered by the User, the software assigns a default device name: *Dig2:usb:12741* in the example). Auto 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 fixed timeout, a software trigger is sent. Software Trigger source setting makes a trigger to be sent by the software to force event acquisition.
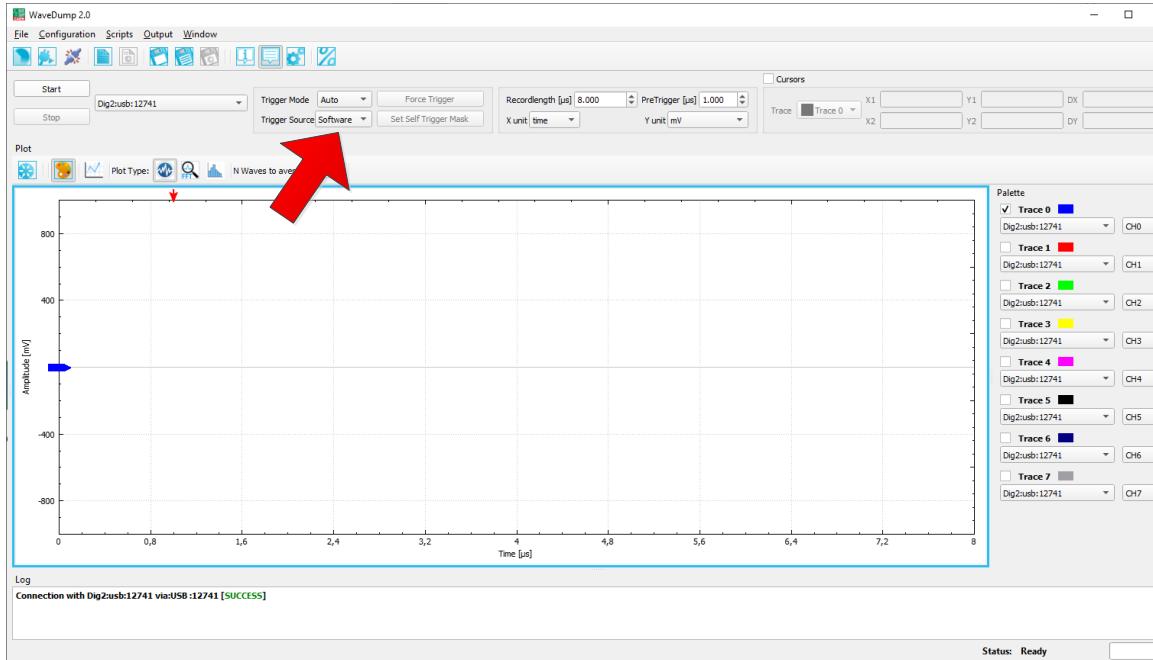
Fig. 12.7: Trigger settings

11. Start the acquisition by pressing the related button in the Control panel; current events for the active trace are plotted upon the Auto trigger mode. On the device, the front panel RUN LED must be on while the TRG LED lights on each time a trigger arrives.
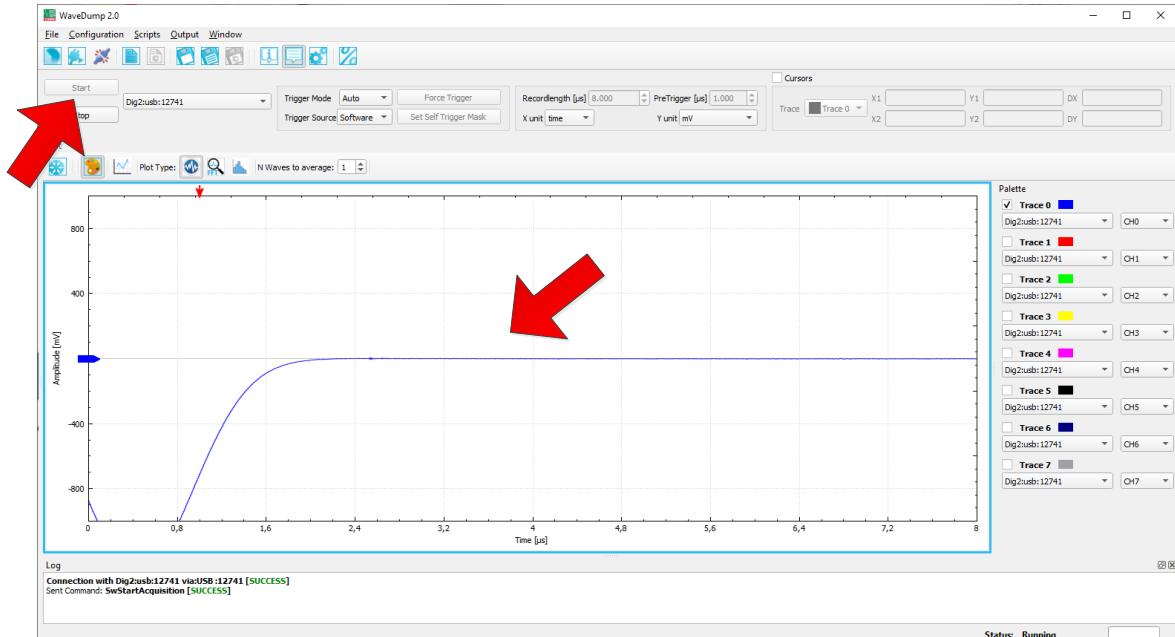

Fig. 12.8: Start Acquisition

12. Click on the Graph Tools icon to show the Oscilloscope Tools panel. In the Amplitude settings, the default DC Offset value is 50% of the device input dynamic range, which means the baseline position of the active trace is around the ADC midscale.
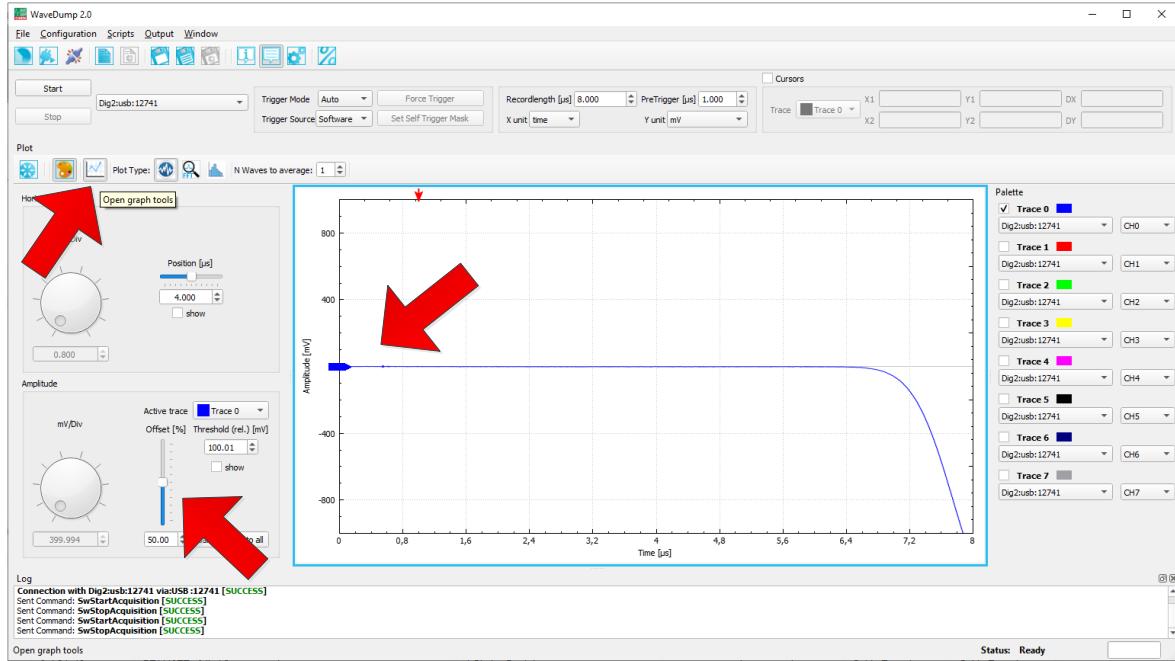

Fig. 12.9: Oscilloscope Tools panel

13. To get events upon the channel self-trigger mode, stop the acquisition by the related button in the Control panel (the RUN LED on the device front panel must be off) and inspect the plotted signal (Trace 0) to estimate the trigger threshold value to set for CH0. The trigger threshold must be placed out of the baseline noise band (the value must be set as positive or negative according to the input pulse polarity).
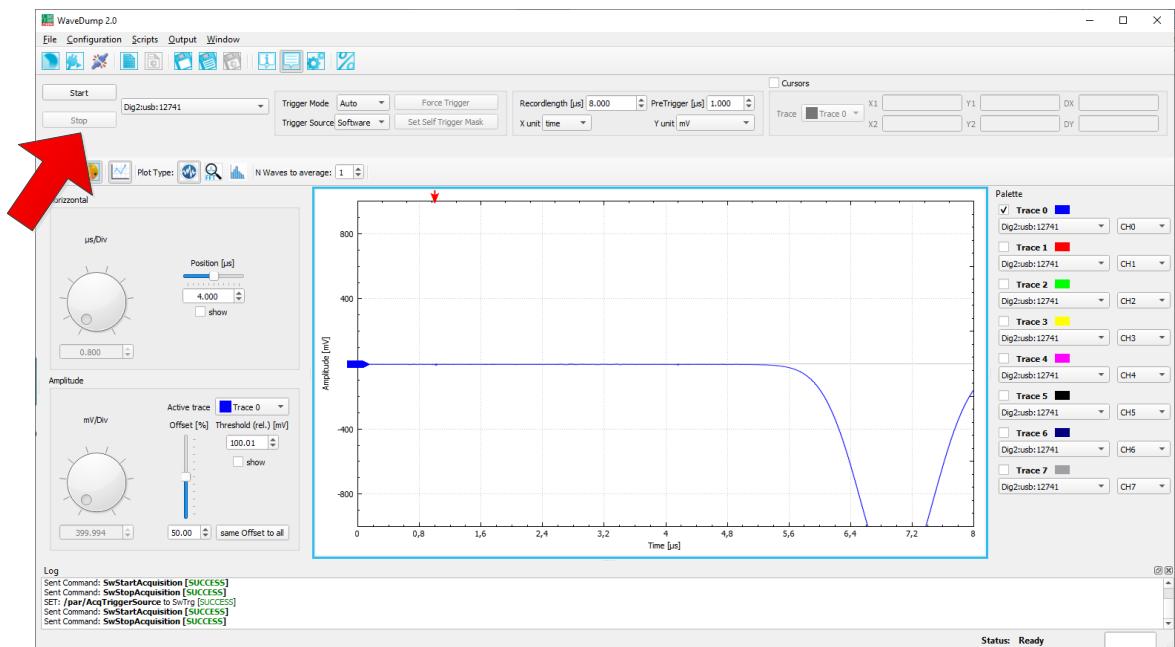

Fig. 12.10: Stop Acquisition

14. In the Control panel, select Trigger Mode Normal and Trigger Source Self. Click on the Self Trigger Mask to open the Trigger Mask dialog.
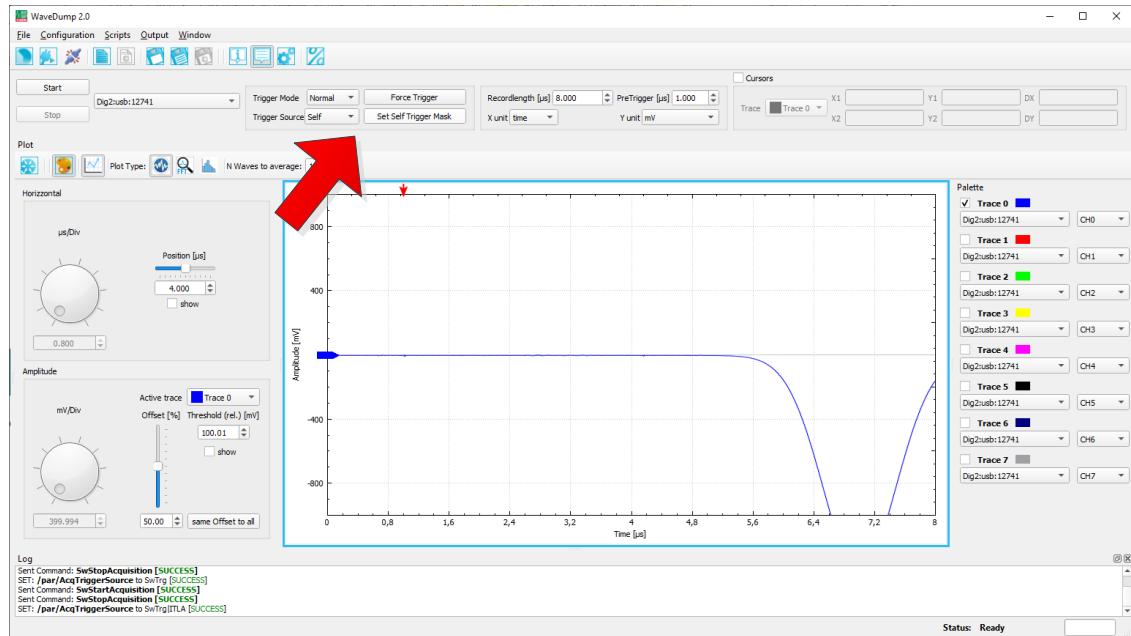

Fig. 12.11: Self-Trigger settings

15. The Trigger Mask dialog allows selecting the channel that must participate in the global trigger. Click on 0 to select CH0 and press OK to confirm.
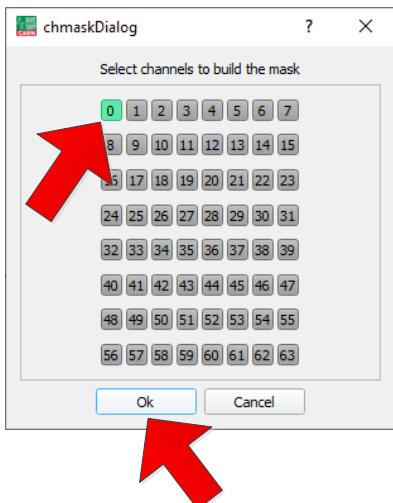

Fig. 12.12: Trigger Mask dialog

16. In the Oscilloscope Tools, digit the trigger threshold signed integer value for the active trace (Trace 0) in the Threshold textbox of the Amplitude settings. Check the Show checkbox to make the trigger threshold level visible on the plot (yellow trace). The threshold value is related to the baseline level.
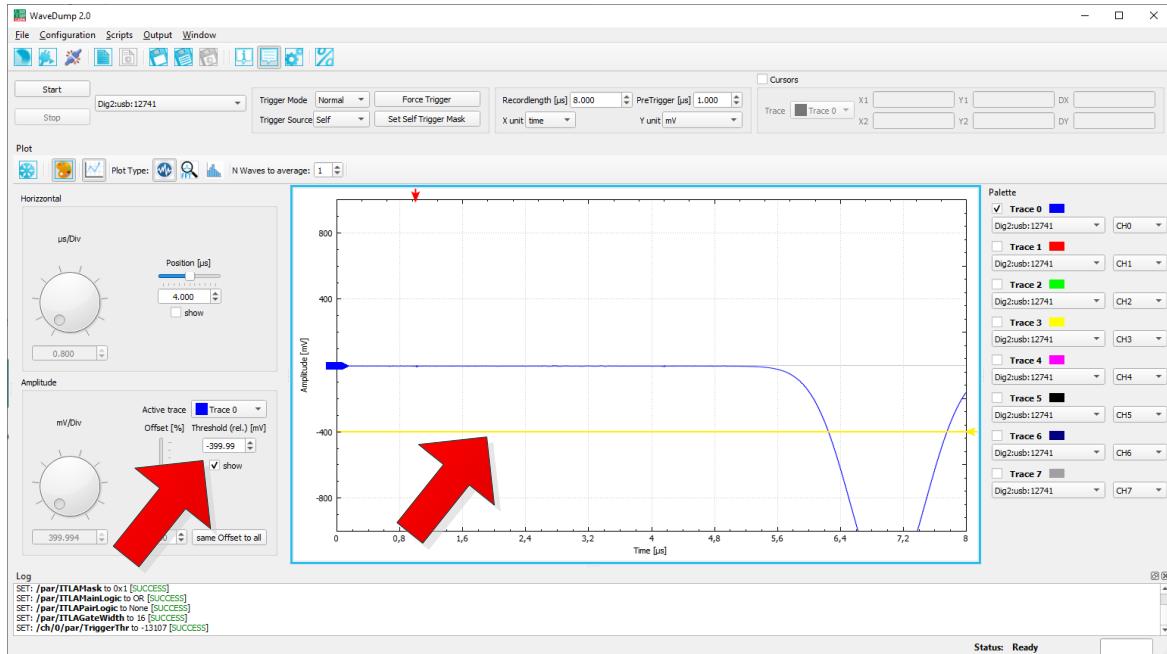

Fig. 12.13: Trigger Threshold

17. Start the acquisition: the device is now getting events upon CH0 self-triggering.
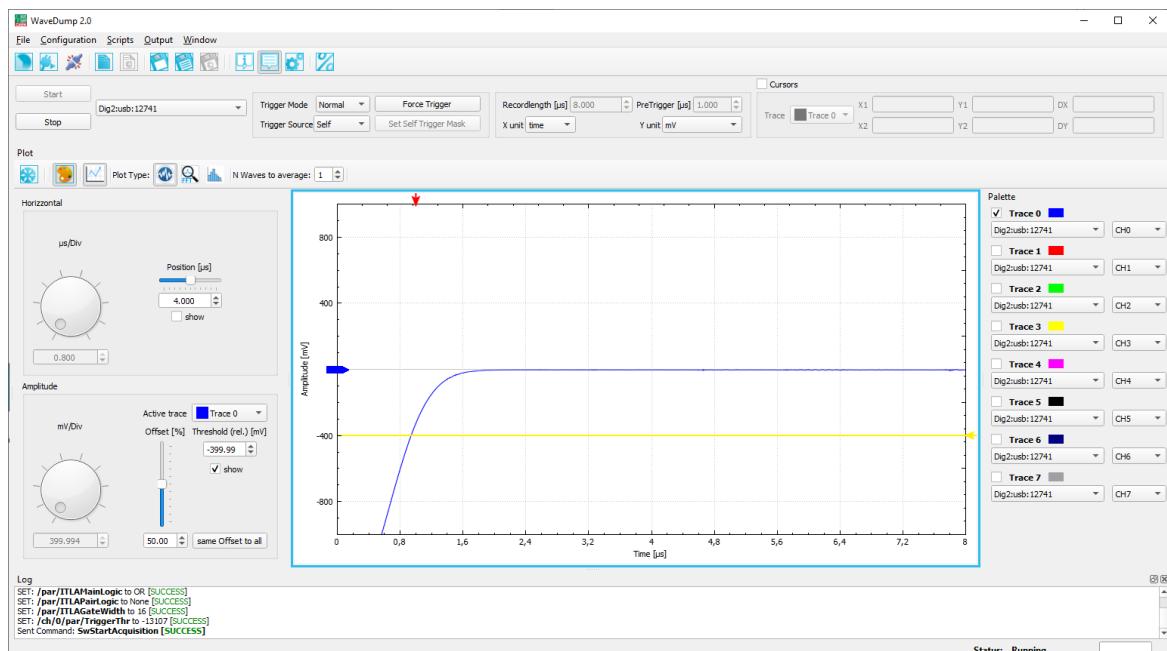

Fig. 12.14: Acquisition in Normal mode

18. At this point, it could be useful to tune some additional settings: stop the acquisition, select Configuration in the top main menu, and then click on the Setup Configuration option.
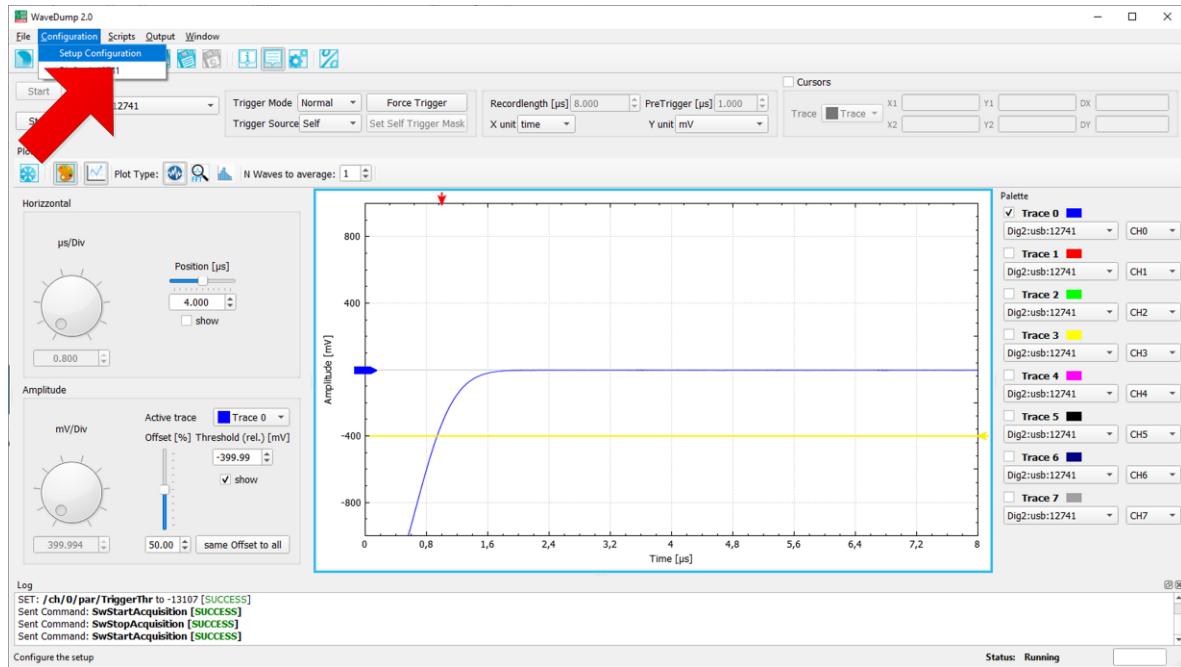

Fig. 12.15: Setup Configuration

19. In the System Settings panel, apply a higher value of pre-trigger in the Main Settings area, click the CH0 button, and set Trigger Polarity on FALL in the Channel Settings area (typically, use FALL with negative pulses and RISE with positive ones).
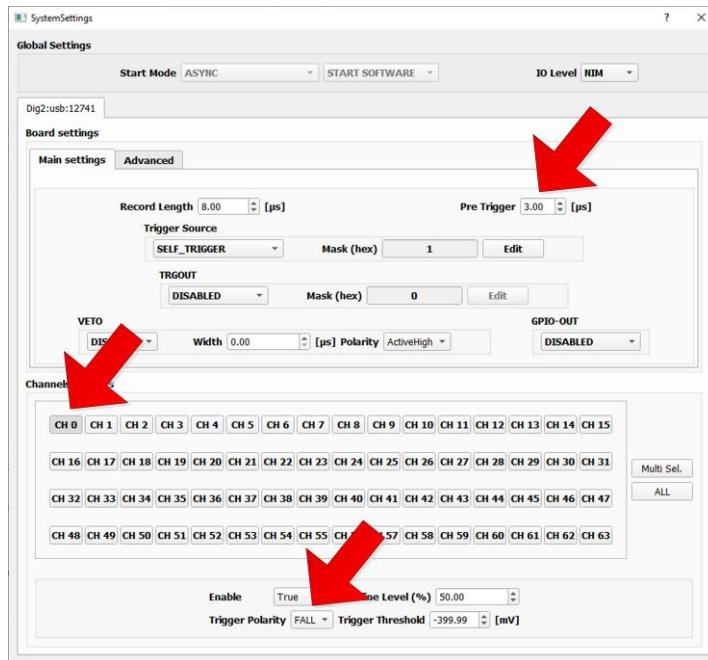

Fig. 12.16: System Settings

20. Turn back to the mainframe and start the acquisition. The thin red arrow on top of the graph indicates the current pre-trigger value.
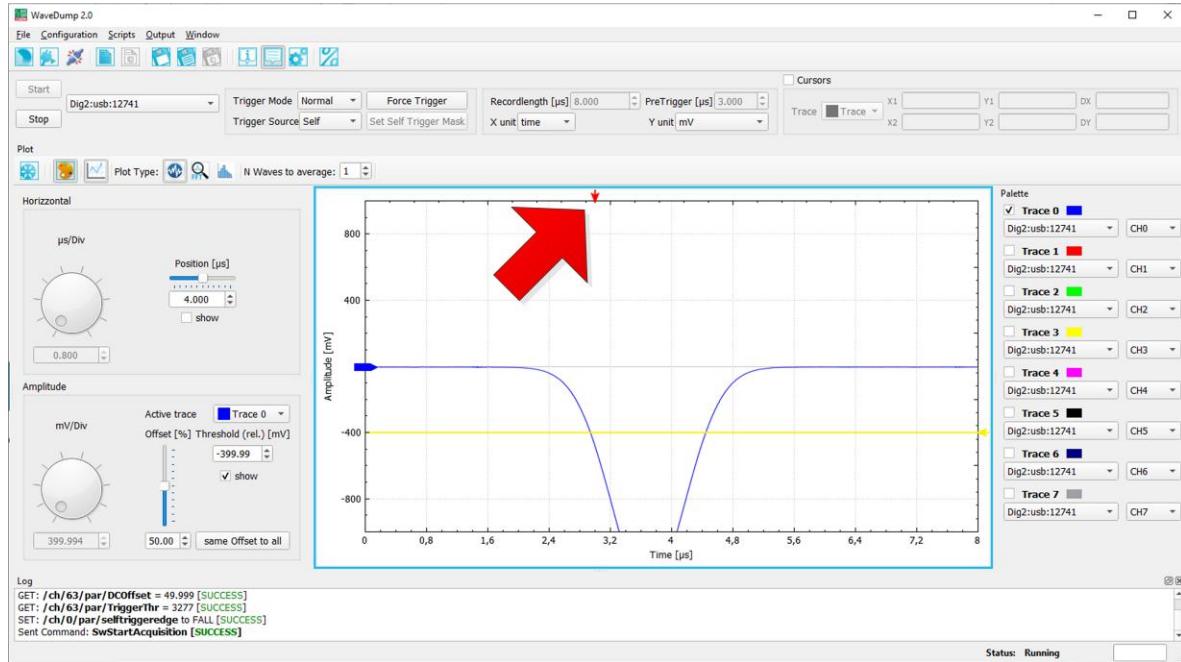

Fig. 12.17: Pre-trigger setting

21. In the Amplitude settings of the Oscilloscope Tools, apply a higher Offset in the percentage of the input range.
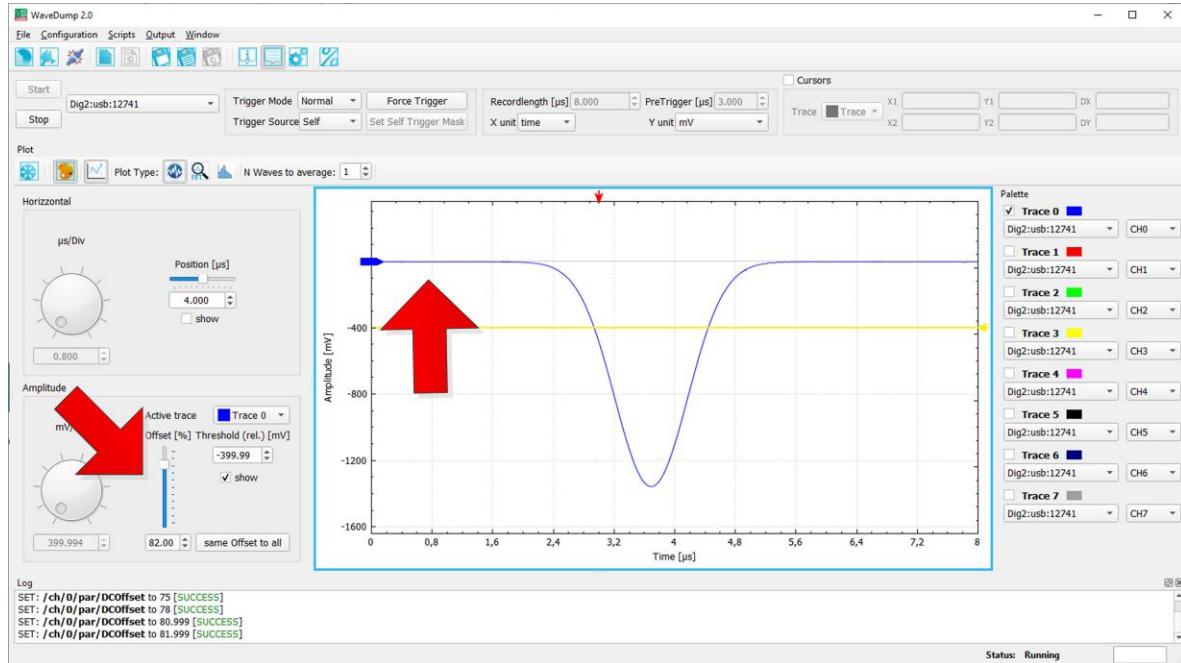

Fig. 12.18: DC Offset setting

22. By clicking on the Statistics icon in the top menu bar, a set of information related to the current acquisition is displayed and updated runtime.
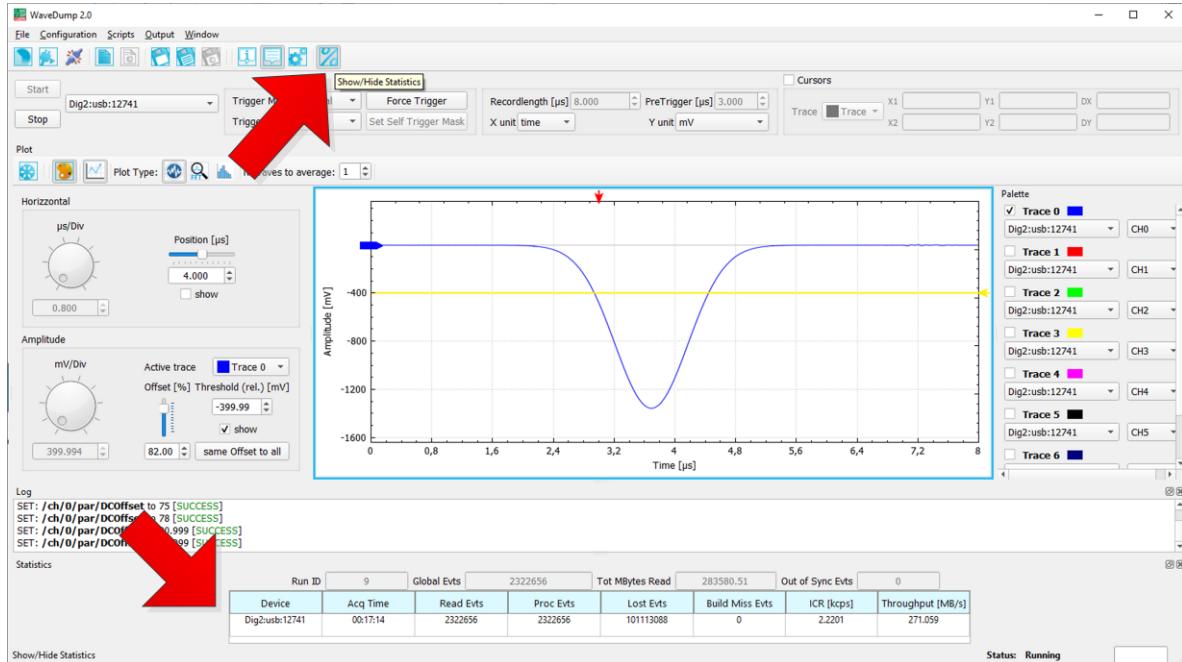

Fig. 12.19: Statistics

23. If you want to record data, stop the acquisition and click Output on the top main menu, then select Configure.
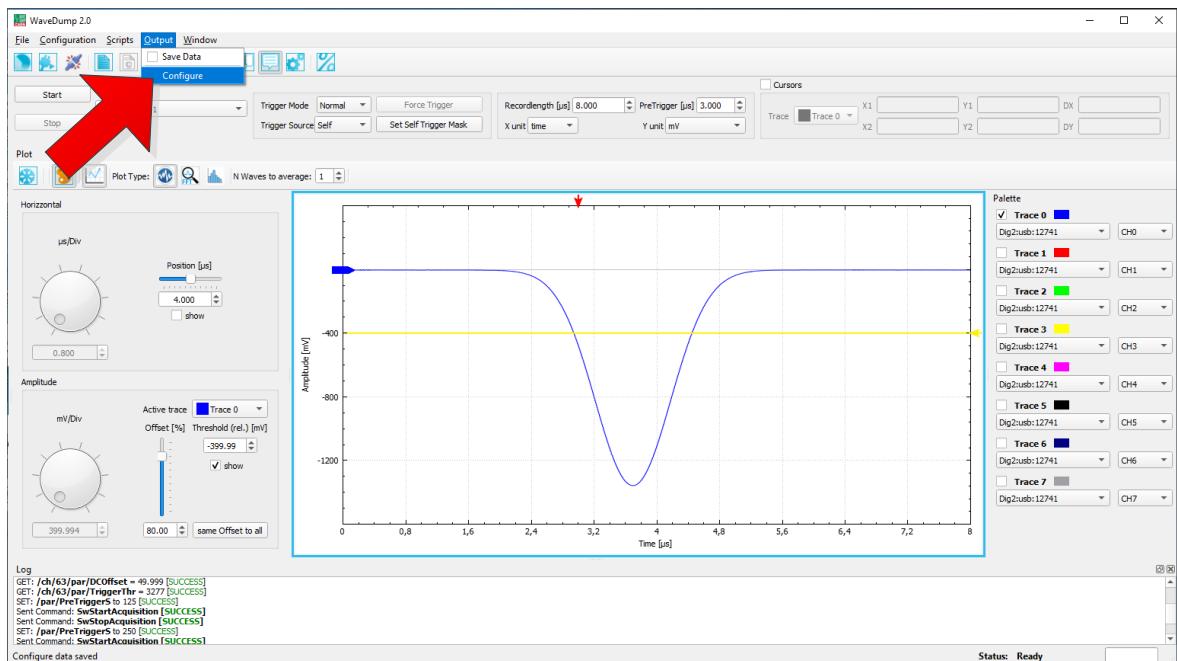

Fig. 12.20: Output Configuration

24. In the Output Settings panel, customize the output file configuration and press Ok to confirm. By default, the destination path is: *C:/Users/<USER>*
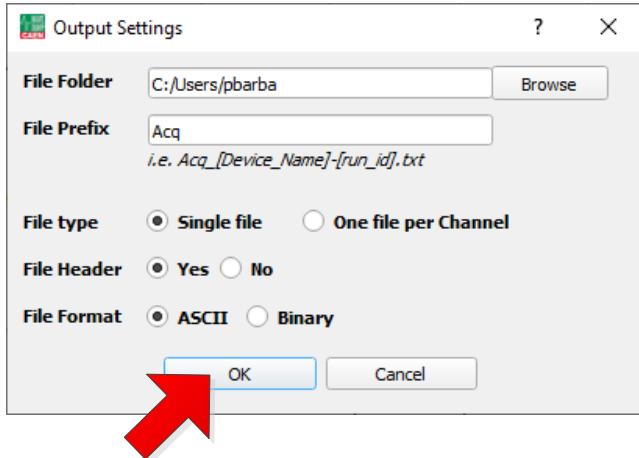

Fig. 12.21: Output Settings

25. Check Save to enable data saving. After the recording session (Start/Stop acquisition), the output files will be available at the configured path. For the output file formats, refer to **[RD3]**.
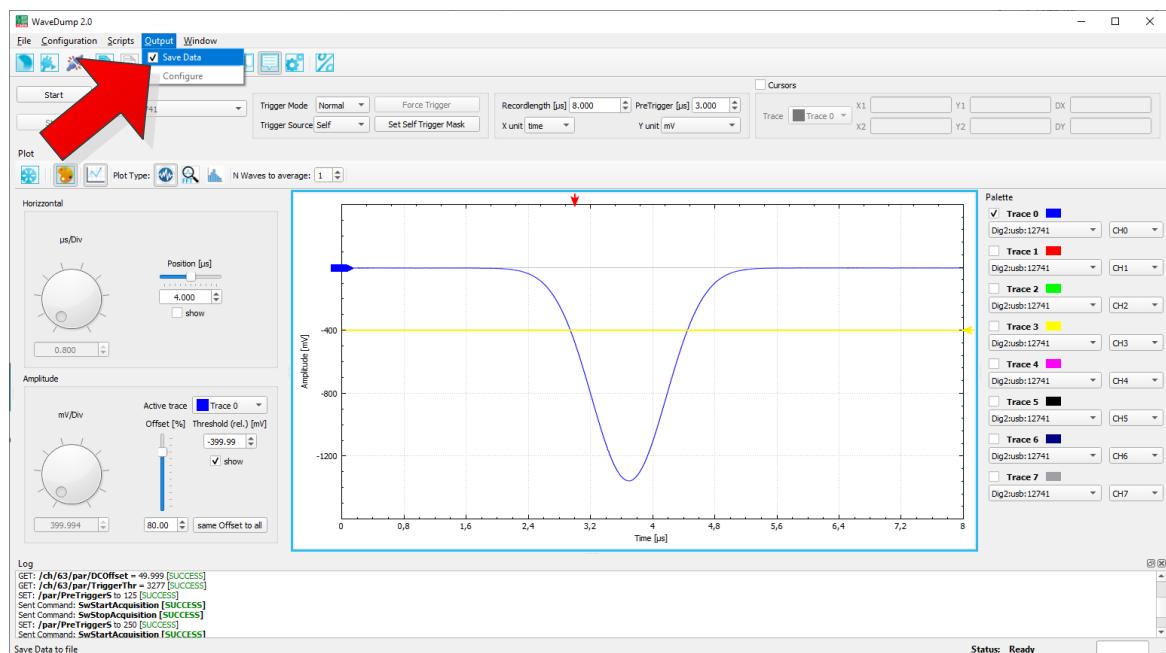

Fig. 12.22: Outputs Enable

26. Stop the acquisition, select File in the top main menu, then click on Exit to quit WaveDump2.


Fig. 12.23: Exit

CAEN **Electronic Instrumentation**
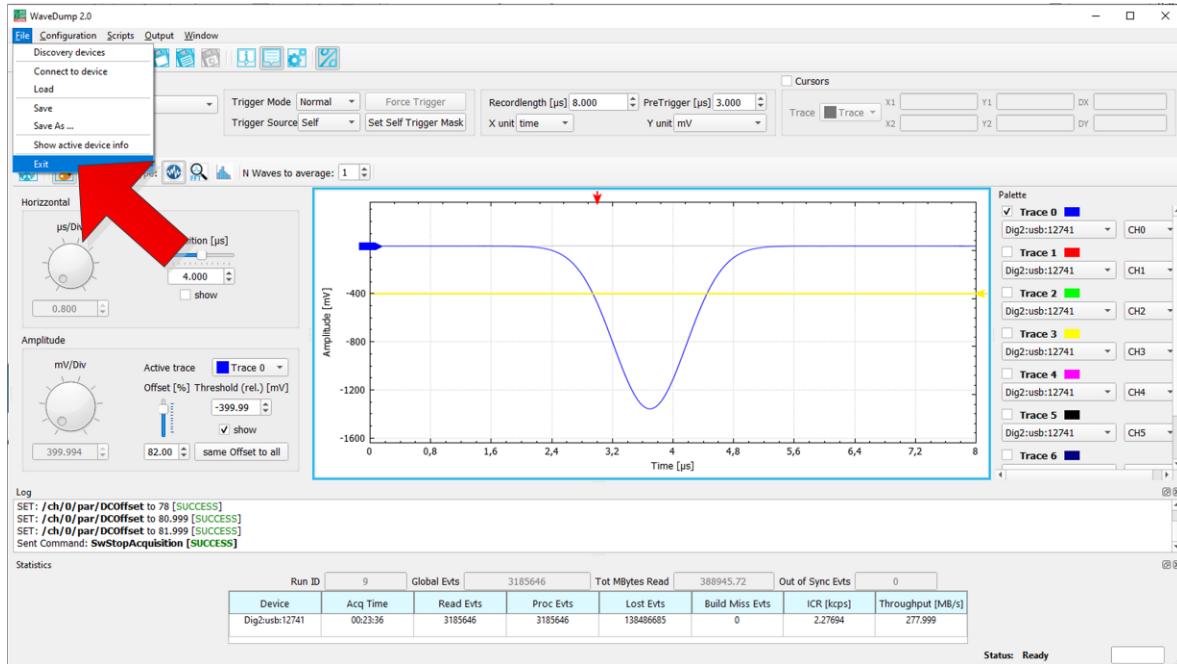
13 Instructions for Cleaning

The equipment may be cleaned with isopropyl alcohol or deionized water and air-dried. Clean the exterior of the product only.

Do not apply cleaner directly to the items or allow liquids to enter or spill on the product.

13.1 Cleaning the Touchscreen

To clean the touchscreen (if present), wipe the screen with a towelette designed for cleaning monitors or with a clean cloth moistened with water.

Do not use sprays or aerosols directly on the screen; the liquid may seep into the housing and damage a component. Never use solvents or flammable liquids on the screen.

13.2 Cleaning the air vents

It is recommended to occasionally clean the air vents (if present) on all vented sides of the board. Lint, dust, and other foreign matter can block the vents and limit the airflow. Be sure to unplug the board before cleaning the air vents and follow the general cleaning safety precautions.

13.3 General cleaning safety precautions

CAEN recommends cleaning the device using the following precautions:

1) Never use solvents or flammable solutions to clean the board.
2) Never immerse any parts in water or cleaning solutions; apply any liquids to a clean cloth and then use the cloth on the component.
3) Always unplug the board when cleaning with liquids or damp cloths.
4) Always unplug the board before cleaning the air vents.
5) Wear safety glasses equipped with side shields when cleaning the board

14 Device decommissioning

After its intended service, it is recommended to perform the following actions:
- Detach all the signal/input/output cable
- Wrap the device in its protective packaging
- Insert the device in its packaging (if present)

⚠️ **THE DEVICE SHALL BE STORED ONLY AT THE ENVIRONMENT CONDITION SPECIFIED IN THE MANUAL, OTHERWISE, IT WILL NOT BE GUARANTEED PERFORMANCE AND SAFETY**

15 Disposal

The disposal of the equipment must be managed in accordance with Directive 2012/19 / EU on waste electrical and electronic equipment (WEEE).

The crossed bin symbol indicates that the device shall not be disposed with regular residual waste.

16 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 use 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

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