Rev. 7 - February 28th, 2023

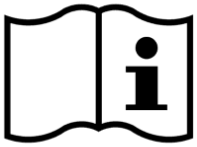
R7780

Unattended Data Acquisition Module for Unattended Monitoring Systems

CAEN
Tools for Discovery

User Manual
UM7585

Purpose of this Manual



This document contains the full hardware description of the R7780 device.

Change Document Record

Date	Revision	Changes
Jun. 08th, 2020	00	Initial Release
Oct. 07th, 2020	01	Updated Chap. **8**
Dec. 01st, 2020	02	Added Sec. **5.3**.
Dec. 18th, 2020	03	Updated Sec. **5.3**.
Jul. 22nd, 2021	04	Removed "Preliminary". Updated Chap. **1** and Chap. **2**.
Jul. 07th, 2022	05	Updated Chap. **8**
Oct. 18nd, 2022	06	Added icon to Sec. **Purpose of this Manual**, changed CAEN contacts in Sec. **Reference Documents**, updated HVPS OUTPUT specifications in Chap.**2**
Feb. 28th, 2023	07	Modified **Tab. 2.1**, Chap. **5** and Chap. **6**. Changed **Fig. 8.18**

Symbols, Abbreviated Terms, and Notation

CPU	Central Processing Unit
HV	High Voltage
ICR	Incoming Counting Rate
LV	Low Voltage
PDA	Personal Digital Assistent
SD	Solid State

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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

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 (while this is true for the boards marked ”MADE IN ITALY”, we cannot guarantee for third-party manufactures).

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1 Introduction

The R7780 module manages the acquisition and analysis over up to 8 neutron detectors that can work in unattended mode. Mechanics are compliant to 19" racks, and it can be operated also as stand-alone.

This is a Neutron Coincidence Analyzer and Multiplicity module combining the functions of a Shift Register and a Pulse Train Recorder. The eight single-ended TTL inputs (LEMO) feature independent counting capability. Moreover, adjustable input thresholds give the possibility to compensate TTL signal voltage drops in case of long-distance use.

The internal 100MHz sampling clock fits for high count-rate applications and the on-board intelligence synergy of a FPGA and a Single Board Computer (an ARM CPU running Linux) makes it possible to provide time-stamped lists and the overall neutron counting information (coincidence timing, multiplicity distributions of coincident events, etc.) required for the analysis in Nuclear Safeguards and nuclear material process monitoring.

After the start-up sequence based on a programmable configuration file, the device can collect data without external control on a local non-volatile memory. Two SD cards, externally accessible for insertion/extraction, store all measurement results and log information in two identical copies for redundancy reasons. The presence of a OTG USB port allows the automatic data retrieval by a USB stick.

The device can also operate in attended mode controlled by an external host computer using the USB port as virtual point-to-point serial connection (reserved for INCC software protocol[1]).

The R7780 is equipped with a video output (HDMI) to connect an external display for monitoring the state of the device and acquisition information.

High power outputs are available as well: one high-voltage channel for the detector biasing and two different low-voltage channels (+5V and +12V) to power the front-end electronics such as preamplifiers and discriminators.

Complete device control, including firmware upgrade, is possible by Web Interface.

Device	Description
R7780	CAEN Shift Register Multiplicity and Time Recorder

Tab. 1.1: Device table

[1] *INCC Software Users Manual*

2 Technical Specifications

PHYSICAL	**Form Factor** 1U width, 265mm depth compatible with 19” rack		**Weight** 2400 g
CONNECTORS	**Inputs** - 8 signal inputs - Single-ended TTL (Z_{in} = 50 Ω) - LEMO 00 female socket - Internal fast comparator with a software-programmable TTL threshold (from 0.1 V to 4.3 V with a resolution of 0.01 V) common to each group of 4 channels to compensate for cable length signal attenuation	**HV** High voltage output SHV plug **+5V, +12V** Low voltage outputs BNC jack receptacle **SD1, SD2** Memory slots for SD cards **EXT** OTG USB-2.0 port for USB stick Type-A socket	**HDMI** Video monitoring output Type-A HDMI socket **USB** USB-2.0 port Type-B socket **ETHERNET** GbE port RJ45 shielded jack **Power In** 9-36V DC rack power input
MINIMUM PULSE WIDTH	10 ns		
PULSE PAIR RESOLUTION	Pulse width + 10 ns		
HVPS OUTPUT	Single channel for the detector power supply: - Output Bias Voltage (V_{set}) = 0 to +2000 V - V_{set} Resolution = 1 V - V_{mon} Resolution = 1 V - V_{out}/V_{set} (V_{out} > 200 V) Accuracy = 1.5% - V_{out}/V_{mon} (V_{out} > 200 V) Accuracy = 1.5% - Ramp-Up/Ramp-Down = 1 to 500 V/s in steps of 1 V - Maximum Output Bias Current (I_{set}) = 500 µA - I_{mon} Resolution = 1 µA - I_{max_out}/I_{set} (V_{out} > 500V) Accuracy = 3% - I_{out}/I_{mon} (V_{out} > 500V) Accuracy = 3%		
LOW VOLTAGE OUTPUTS	Two channels for the preamplifier power supply: - +5 V @ 1 A - +12 V @ 1 A		
ON-BOARD CPU	**SBC** ARM Cortex-A9 quad-core @ 1 GHz running Linux®		**FPGA** Cyclone V GX
OPERATING MODES	- UNATTENDED: After the start-up sequence, all data are logged on-board without external intervention - ATTENDED: The device works under full control of an external PC (INCC software compliance) transmitting raw data for further analysis; time-stamped lists are saved to binary files compatible with PTR-32 format - LIST: Like the attended mode, but raw data are saved on the SD cards to PTR-32 files under the user external control		

DATA LOGGING ON SD CARD	- Local storage on non-volatile memory of log files and analysis results (Coincidence and Multiplicity data) in unattended mode, while log files and raw data (time-stamped pulses) in list mode - Two removable 32GB SD cards replicate same folder structure and contains same data for redundancy reasons to prevent from non-volatile memory device failures - LED indicators inform on the SD card state - Attaching a USB stick to the OTG USB port activates the fully automatic copy of all data from non-volatile memory; a LED indicator shows the state of the process
PROGRAMMABLE PARAMETERS	- Gate width from 10 ns to 1.3 ms in steps of 10 ns - Pre-delay from 0 to 100 µs in steps of 10 ns - Long delay (the delay between the Reals+Accidentals gate and the Accidentals gate) from 0 to 5 ms in steps of 1 µs - Measurement time between 0.1 s and 43600 s (12 h) - Reals+Accidentals and Accidentals on 64-bit counters - Number of multiplicity bins for Accidentals and Reals+Accidentals up to 512 (32 bits per each bin)
SYSTEM PERFORMANCES	- Internal clock = 100 MHz - Timestamp resolution = 10 ns - Pulse pair resolution = pulse width + 10 ns - Maximum rate in coincidence/multiplicity mode = 7 Mcps (measured at constant rate) - Maximum rate in counting mode = 16.6 Mcps (measured at constant rate)
COMMUNICATION INTERFACES	**Ethernet** - 1 Gbit Ethernet - 1000Base-T - Configuration, operation, and data taking in attended mode **USB** - USB-2.0 version - Virtual COM port reserved for local communication through the INCC software protocol with a Windows-based computer - Configuration, operation and data taking in attended mode
SOFTWARE	- Windows® and Linux® support - Compatibility with INCC software - Web Interface (Board information retrieval and configuration, files management, data readout, firmware upgrade)
ENVIRONMENTAL	**Environment**: Indoor use **Operating Temperature**: –10°C to +55°C **Storage Temperature**: –10°C to +85°C **Operating Humidity**: up to 93% RH non condensing **Storage Humidity**: up to 93% RH non condensing **Altitude**: < 2000m **Pollution Degree**: 2 **Overvoltage Category**: II **EMC Environment**: Commercial and light industrial **IP Degree**: IPX0 Enclosure, not for wet location
REGULATORY COMPLIANCE	**EMC** CE 2014/30/EU Electromagnetic compatibility Directive **Safety** CE 2014/35/EU Low Voltage Directive
POWER REQUIREMENTS	Integrated primary power supply unit 9-36V DC: - 1 A @ 28 V - 1.17 A @ 24 V - 2.4 A @ 12 V - 3.22 A @ 9 V Measured in full load conditions (12V and 5V preamplifier outputs on 1A, HVPS output on 2kV@500µA, SBC on, fan on, USB stick in, 2 SD cards in, Ethernet link active)

Tab. 2.1: Specification table

3 Safety Notices

The following HAZARD SYMBOLS may be reported on the unit:

CAUTION: indicates the need to consult the “Precautions for Handling, Storage and Installation” document provided with the product.
A potential risk exists if the operating instructions are not followed.

HIGH VOLTAGE: indicates the presence of electric shock hazards. Enclosures marked with these symbols should only be opened by CAEN authorized personnel.
To avoid risk of injury from electric shock, do not open this enclosure.

To 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: Do Not Operate Without Covers.

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

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!

CAUTION: Do Not Operate with Suspected Failures.

IF YOU SUSPECT THIS PRODUCT TO BE DAMAGED, HAVE IT INSPECTED BY QUALIFIED SERVICE PERSONNEL!

CAEN provides the specific document “Precautions for Handling, Storage and Installation”, available in the documentation tab of the product web page, that is mandatory to read before operating with CAEN equipment.

4 Packaging and Panels

4.1 Packaging

The R7780 board is housed in a 19” rack package: H = 1.25U, D = 265mm.

Device	Weight
R7780	2400 g

Tab. 4.1: Device weight table

4.2 Panels

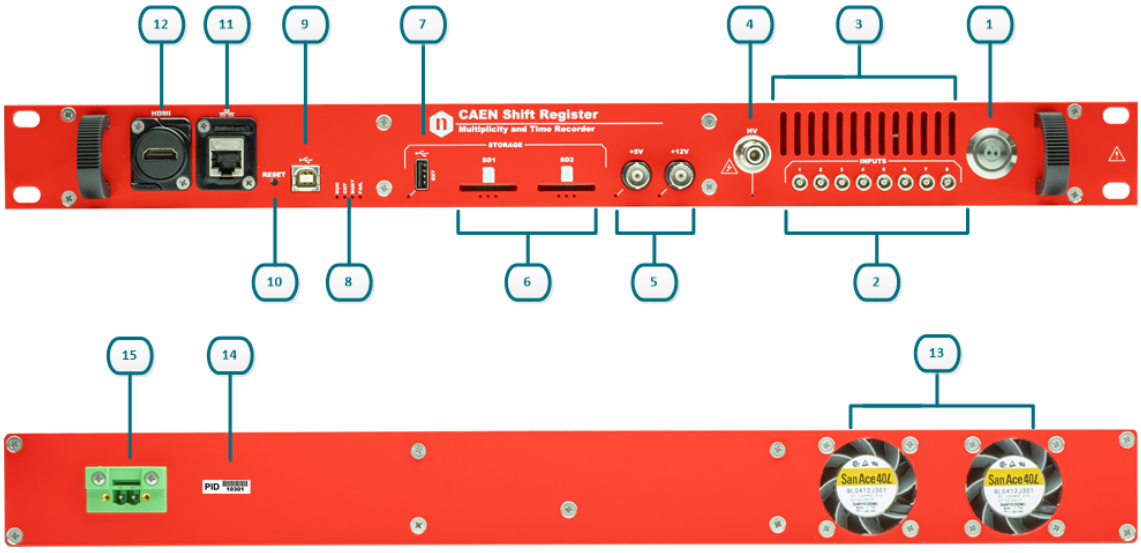

Fig. 4.1: Front Panel (top) and Back Panel (bottom) view

1. Power On/Off button.
2. LEMO input channels 1, 2, ... , 8.
3. Ventilation grill.
4. High Voltage Power Supply output (+2000V, 500µA) with status LED yellow (lights on if the output is on).
5. Low Voltage Power Supply outputs (+5V and +12V, 1A) with status LEDs green (lights on if the output is on).
6. Slots for SD card.
7. OTG USB port.
8. Diagnostic LED indicators.
9. USB communication port (USB-2.0).
10. Reset button.
11. Ethernet communication port (10/100).
12. Video monitoring output (HDMI).
13. Cooling fans.
14. PID label (unique Product Identifier).
15. DC Power input (9-36V).

5 Hardware Installation

5.1 Delivered Kit

The R7780 device is inspected by CAEN before the shipment and it is guaranteed to leave the factory free of mechanical or electrical defects. When receiving the unit, the user is strictly recommended to inspect for any damage which may have occurred during transportation. Particularly, inspect for exterior damages like broken knobs or connectors, and check that the panels are not scratched or cracked. All packing material should be held on until the inspection has been completed. If a damage is detected, the user must file a claim with the carrier immediately and notify CAEN.

Before installing the unit, make sure to read thoroughly the safety rules and installation requirements (see Chap. **3**), then place the package content onto your bench. The content should consist in the parts listed in **Tab. 5.1**.

Description	Item
R7780 module	
HDMI cable Type HDMI (19-pin) Male to HDMI (19-pin) Male	
ETHERNET cable Type RJ45 (8P8C) Plug to RJ45 (8P8C) Plug L=2MT	
User Manual	
Two 32GB SD cards	

Tab. 5.1: Part list table

5.2 Power-On / Power-Off

Once installed in a 19” rack and fixed by the front panel rack-mount brackets using standard screws, attach the device to the rack power supply through the back panel power DC input.

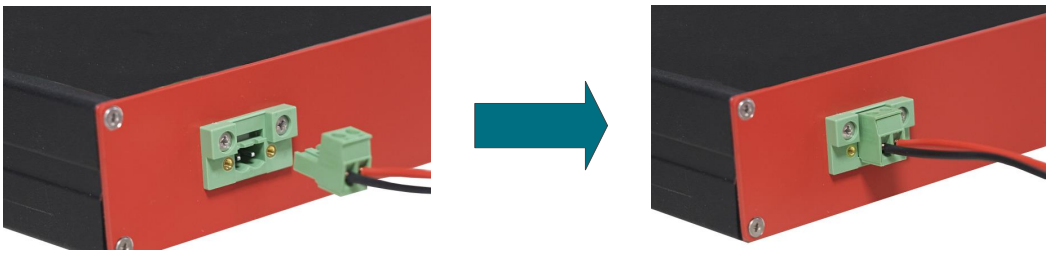

Fig. 5.1: Power supply connection

WARNING: check the polarity on the rack plug (**Fig. 5.2**).

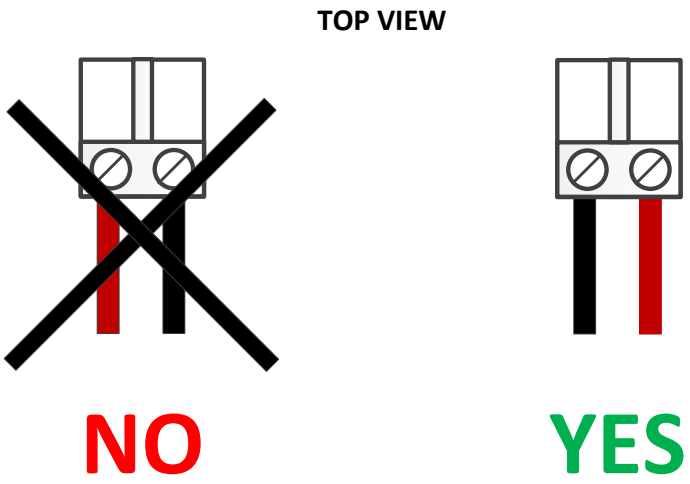

Fig. 5.2: Power plug safety indications

Press the front panel round button; the blue lighting on the switch indicates that the power is on.

Fig. 5.3: Power-On status

To power off the device, press again the round button; no lighting on the switch indicates that the power is off. Plug off the power cable for a safe operation.

Fig. 5.4: Power-Off status

5.3 HVPS Out

As described at Chap. **4**, the SHV connector on the R7780 front panel provides a 2000V/500µA output for the detector biasing (detailed HVPS out specifications in **Tab. 2.1**).

The SHV connector is protected by a safety cap (**Fig. 5.5**). Remove the fixing screw by a Phillips screwdriver and pull out the cap to access the connector (**Fig. 5.6**).

Fig. 5.5: SHV safety cap

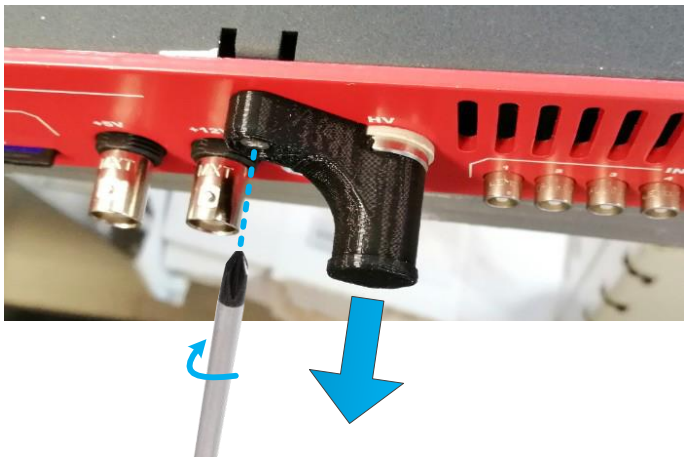

Fig. 5.6: SHV safety cap removal

ALWAYS CONNECT THE HVPS OUT TO A HIGH-IMPEDANCE LOAD BY A SHV CONNECTOR!

CAUTION: Because the unit is capable of sourcing hazardous live high voltages, it needs proper handling.

THE UNIT SHOULD BE USED ONLY BY QUALIFIED PERSONNEL WHO RECOGNIZE THE DANGERS OF HIGH VOLTAGES!

CAUTION: High-voltage cables can store charge if they are disconnected from the supply while the high voltage is on. The charge on the cable can cause injury or damage even after the cable is disconnected from the unit.

MAKE SURE THAT THE SOURCE IS TURNED OFF AND THAT HIGH VOLTAGE IS COMPLETELY DISCHARGED BEFORE REMOVING THE SHV CABLE!

5.4 Hardware Detection

5.4.1 Ethernet Connection

It is possible to connect to the R7780 Ethernet interface through a server, or through a point-to-point connection with a PC. In the latter case, the connection can be done using a crossed cable, a switch, or a computer with a Gigabit Ethernet port.

The default IP address of the R7780 device is: **10.0.0.10**. The user can change the IP by the Web Interface (see Chap. **8**).

Windows®
Once connected the Ethernet cable between the device and the PC, the network must be configured upon the following instructions (Windows 10 OS).

1. Open the path:
   Control Panel - Network and Internet - Network and Sharing Center

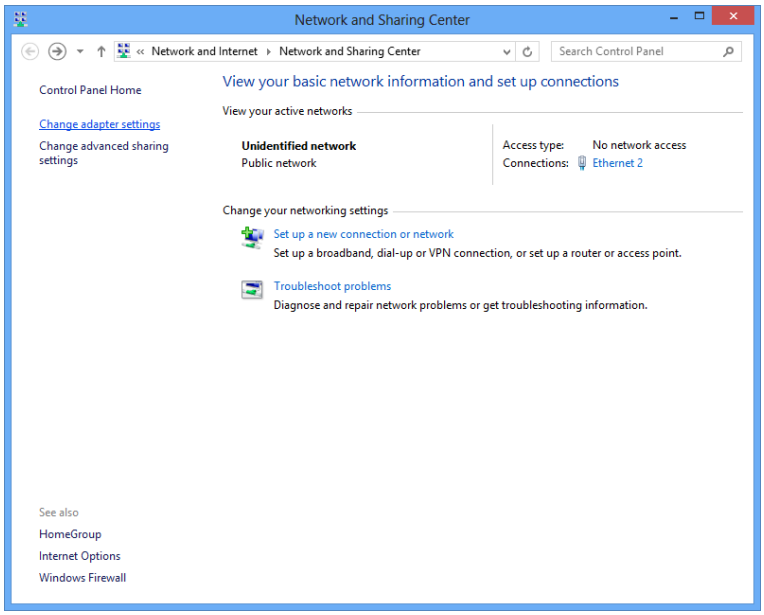

Fig. 5.7: Windows ”Network and Sharing Center”

2. Click on ”Change adapter settings”.

3. Right-click on the Ethernet icon and select ”Properties” (**Fig. 5.8**).

4. Click on ”Internet Protocol Version (TPC/IPv4)” and select ”Properties” (**Fig. 5.9**).

5. Configure the ”Internet Protocol Version (TPC/IPv4) Properties” as in **Fig. 5.10**.

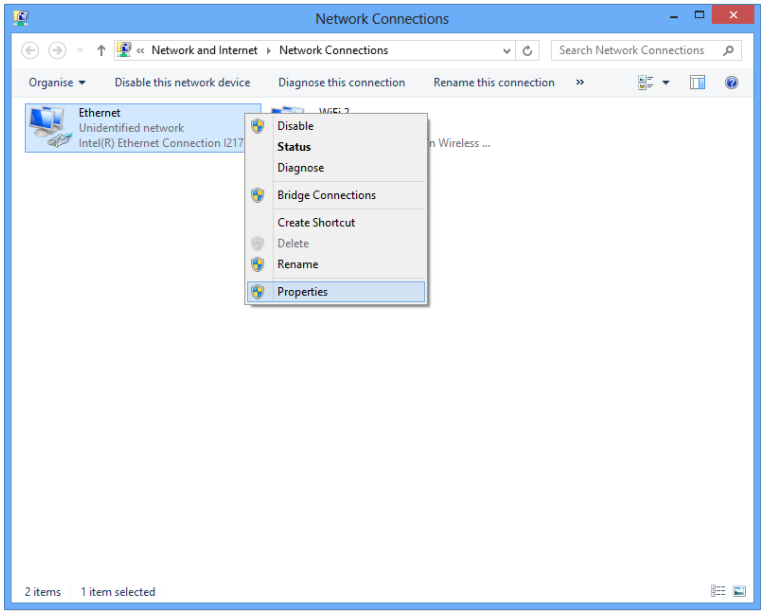

Fig. 5.8: Network Connections window

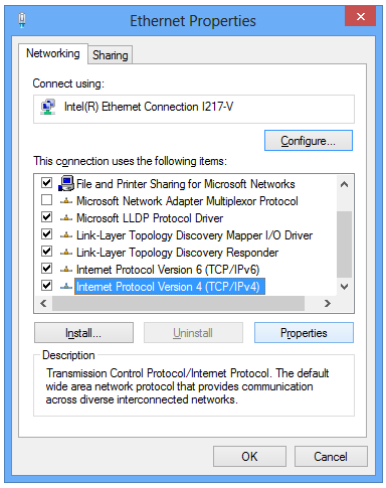

Fig. 5.9: Windows ”Ethernet Properties”

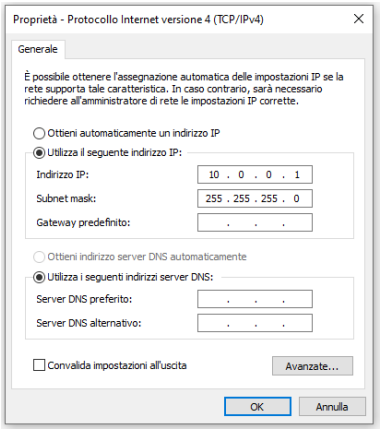

Fig. 5.10: Windows ”Internet Protocol Version (TPC/IPv4) Properties”

Linux®
Similar procedure is foreseen on Linux OS, as following described (Ubuntu Linux 18.04).

1. Click on top-right network icon, then open the path (**Fig. 5.11**):
   Wired Connection - Wired Settings

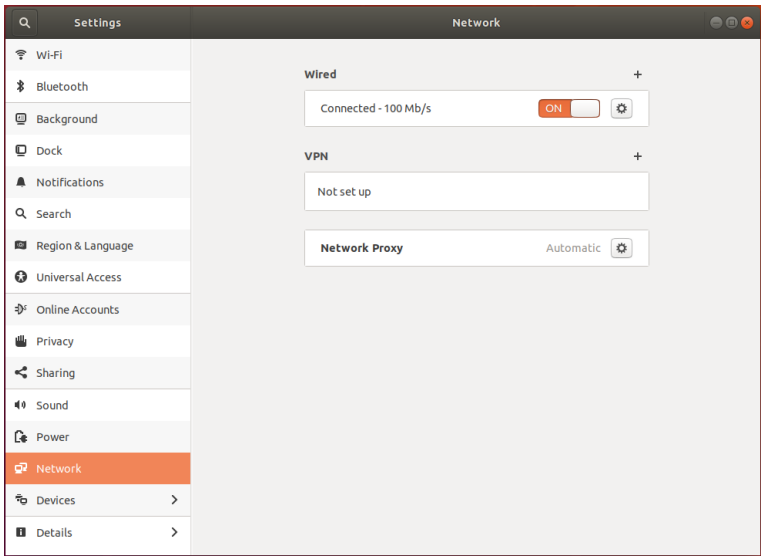

Fig. 5.11: Linux ”Wired Settings”

2. Click on the settings icon, select the IPv4 tab, configure and save as in **Fig. 5.12**.

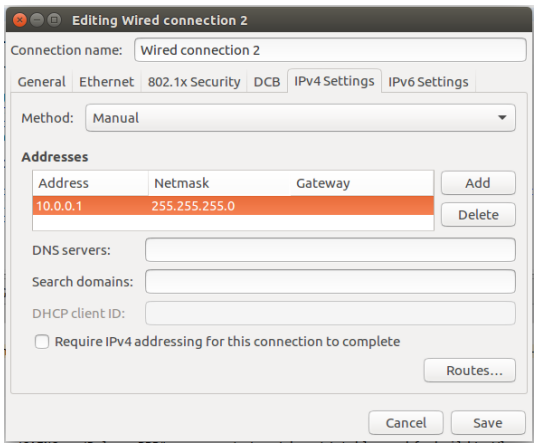

Fig. 5.12: Linux ”IPv4 settings”

5.5 Reset

The Reset button on the front panel allows to reset the R7780 device.

1. By pressing the button for less than 3 seconds before release, a basic reset takes place: all the active power supply channels are switched off (the HV according to the ramp-down settings configured by the user in the Web Interface, see Chap. **8**); the FPGA and the embedded CPU are reset.
2. If the button is pressed for more than 15 seconds before release, a complete factory reset is performed: HV and LV are switched off while the FPGA and CPU are reset to their factory configuration.

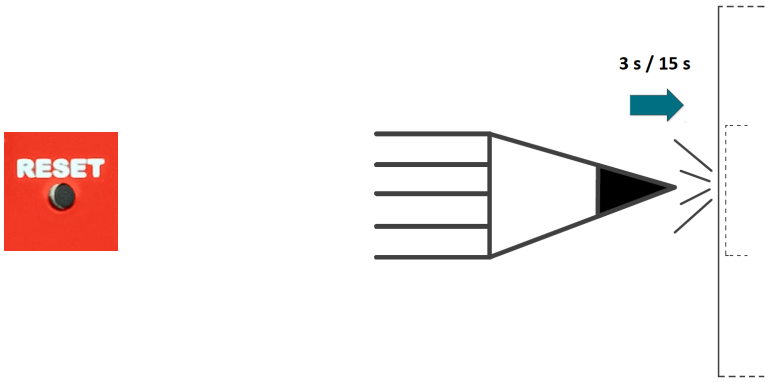

Fig. 5.13: Board Reset

5.6 Diagnostic LED Indicators

Name	Color	Function
RUN	GREEN	Lights on when the acquisition is running
CNT	GREEN	Lights on if the board is counting
BUSY	RED	Blinks if the board goes busy (i.e. the FIFO of the FPGA is full)
FAIL	RED	Lights on in case of a generic fail

Tab. 5.2: Diagnostic LEDs description

6 Logging Tools

6.1 SD Cards

The R7780 features two front panel slots for external SD memory cards that the user can remove and plug in a PC or compliant PDA having so data avaiable for further analysis. A set of three LED indicators under each slot is intended to guide the user through a correct and safe card usage.

Two 32GB SD cards are included in the R7780 kit (see **Tab. 5.1**), but higher capacity SD cards can be used to extend the data logging time. Formatting the cards using the FAT32 file system ensures the compatibility with all kinds of operating system and devices.

6.1.1 SD Card Indicators

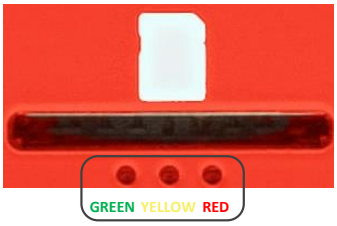

Fig. 6.1: SD card indicator lights

LEDs Status		Description
All LEDs off	○ ○ ○	**No SD card is present in the slot**
Green LED on	● ○ ○	**The SD card is present and unmounted**
Yellow LED on	● ● ○	**The SD card is present and mounted in the system**
Red LED on	● ● ●	**Write process to the SD card is in progress**
All LEDs blinking	✳ ✳ ✳	**FAIL: no SD card is present or no more space available on the SD card**

Tab. 6.1: SD LED status table

6.1.2 SD Card Insertion

Insert the SD card into the slot with the contacts side downwards as shown in **Fig. 6.2**. Completely push in the card until you hear a click' sound, then release.

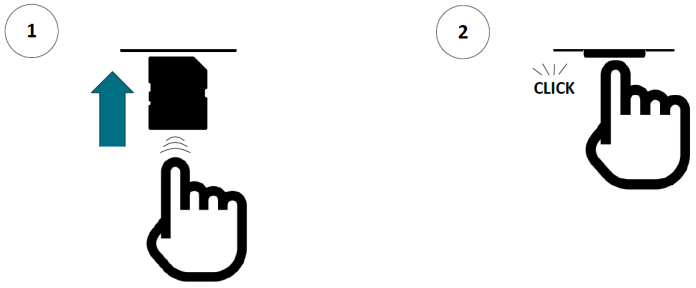

Fig. 6.2: SD card insertion

6.1.3 SD Card Extraction

When the device is switched on, if the SD cards are present in the slots, the system continuously writes to the active log files the relevant information about its status and about the measurement progress. Furthermore, if data acquisition is active in UNATTENDED mode, also data files are continuously updated with the new analysis results. Being careful to follow specific steps, it is always possible to remove the SD cards to copy the files or to replace them. The safe extraction procedure is follwing described.

BE AWARE THAT A NOT SAFE REMOVAL OF THE SD CARDS WILL CAUSE THE CORRUPTION OF THE LOG AND DATA FILES IN USE BY THE DEVICE SYSTEM!

1. Unmount the SD cards: click the "Unmount SD cards" button in the Web Interface page (see Chap. **8**). If a measurement is running in UNATTENDED mode, data acquisition will automatically be stopped. All the log and data files will be closed and the SD cards will be unmounted by the system. The red and yellow SD cards LEDs will go off as soon as the SD cards are ready to be removed, only the green LEDs will be on (see **Tab. 6.1**).
2. Remove the SD cards: to extract the SD card, push and release as in **Fig. 6.3**; the card will be ejected and available for removal. The device will wait until at least one SD card has been re-inserted.

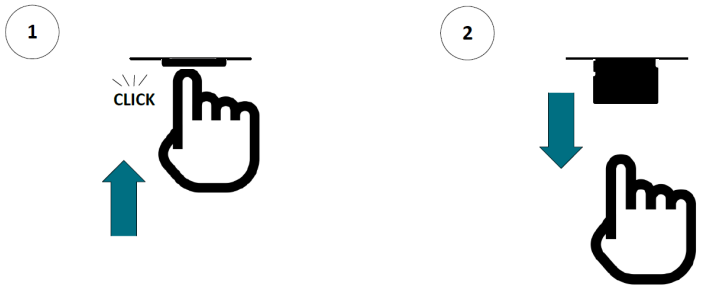

Fig. 6.3: SD card extraction

3. Re-insert one or both the SD cards (see **Fig. 6.2**) and press the ”Restart with SD cards” button in the Web Interface page when ready. The device will restart logging to new log files.
   If the device was operating in UNATTENDED mode and data acquisition had been stopped, a new data acquisition will be restarted automatically and new data files will be created.

NOTE: the device checks for the presence of the SD cards every time a new data acquisition starts, and if only one card is mounted, that will be the only one used for writing. For this reason, if the ”Restart with SD cards” button is clicked and only one SD card is in its slot, the device will use only this SD card. If the second one is inserted at a later time, it will be used only after data acquisition is restarted.

NOTE: if data acquisition was running when a SD unmount request is received, the device is programmed in such a way that it will restart acquiring data automatically after a given time interval. The auto-restart timer starts as soon as one SD card has been re-inserted in the slot. The length of this time interval can be defined by the user from the dedicated section in the Web Interface. This automatic restart can be useful in case the user forgets to press the ”Restart with SD cards” button after re-inserting the SD cards.

6.2 Files and Formats

6.2.1 Unattended Mode

When the R7780 works in UNATTENDED mode, the results of the analysis are saved to ASCII data files with DATAZ extension (.dataz) that are stored under the removable SD cards in two identical copies. In addition, also log files and configuration files (ASCII) are stored. Both the SD cards contain two copies of the data and log files for redundancy reasons.

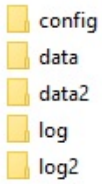

Fig. 6.4: SD card folder structure

DATAZ Files
The data files are stored in two copies inside each of the two SD cards, inside two dedicated folders. The name of the folders for storing the data files can be configured by the user (the default folder names are ”data” and ”data2”). Inside the data folders, a monthly subfolder is created if this option is enabled.
The DATAZ file starts with a header section identified by the ”$HEADER” tag, containing the complete configuration of the device. The header is followed by the ”$DATA” section. Whenever an acquisition cycle ends, a new line is appended to the ”$DATA” section containing the analysis results in CSV format. Each reported line in the data file has a CRC32 checksum appended. The last comma before the checksum is not part of the CRC32 calculation. When data acquisition ends, the file is closed and a final tag ”$END” is added.

The format of the analysis results is different depending on the device CountingMode setting:

- CountingMode = Counting → the device counts the total number of pulses detected by every input channel. The results contain: the cycle number, the datetime, the single cycle time, the sum of the counts recorded by all the input channels, the counts recorded by every input channel and the CRC32 checksum.

Example:

$DATA
Nr,DateTime,MeasurementTime,Total,Total1,Total2,Total3,Total4,Total5,Total6,Total7,Total8,CRC32
1,2020-08-27,18:02:48,100.0,6452023,3663005,415472,397179,397483,397326,397612,353052,430894,3B0D2C36
2,2020-08-27,18:04:28,100.0,6452264,3663003,415422,397489,397435,397354,397614,353060,430887,53804234
3,2020-08-27,18:06:08,100.0,6452050,3663004,415477,397198,397448,397322,397646,353066,430889,626F56EE
$END

- CountingMode = Coincidence → the pulses collected by the enabled channels are processed by the coincidence counter and the results contain in addition: the total number of counts processed by the coincidence counter, the Reals (R), the Reals and Accidentals (R&A), the Accidentals (A).

Example:

$DATA
Nr,DateTime,MeasurementTime,Total,Total1,Total2,Total3,Total4,Total5,Total6,Total7,Total8,Totals,R,R$A,A,CRC32
1,2020-08-27,18:08:08,100.0,6452078,3663002,415480,397195,397480,397329,397653,353052,430887,6451817,0,23679359,28474514,6AE70AA7
2,2020-08-27,18:09:48,100.0,6452331,3663004,415454,397467,397425,397346,397689,353054,430892,6452085,0,236686381,28476451,4E9A9DD
3,2020-08-27,18:11:28,100.0,6452101,3663005,415464,397231,397455,397344,397658,353056,430888,6451837,0,23674327,28462725,793FE23
$END

- CountingMode = Multiplicity → the multiplicity distributions are also calculated and the results contain in addition: the total number of bins N, the contents of the N bins of the R&A distribution, the contents of the N bins of the A distribution.

Example:

$DATA
Nr,DateTime,MeasurementTime,Total,Total1,Total2,Total3,Total4,Total5,Total6,Total7,Total8,Totals,R,R$A,A,
MultiplicityBins,Mult0,Mult1,Mult2,Mult3,Mult4,Mult5,Mult6,Mult7,Mult8,Mult9,MultAcc0,MultAcc1,MultAcc2,
MultAcc4,MultAcc5,MultAcc6,MultAcc7,MultAcc8,MultAcc9,CRC32
1,2020-08-27,
18:13:16,100.0,6451970,3663005,415480,397193,397378,397354,397612,353059,430889,6451710,0,23684136,
28456404,10,12359,837130,1210290,1341846,1146231,800134,503536,291399,156891,80257,12709,340028,
925562,986590,1386492,1078719,738033,452147,260427,137275,91710EF
2,2020-08-27,
18:14:56,100.0,6452283,3663003,415454,397483,397418,397321,397658,353060,430886,6452041,0,236681017,
28463815,10,12434,837673,1211699,1338562,1147819,802522,501208,291673,156913,80063,13081,338626,
923440,986385,1387300,1080666,738801,453582,260375,137222,7BC58F09
3,2020-08-27,
18:16:36,100.0,6452199,3663004,415465,397194,397556,397350,397690,353053,430887,6451935,0,23674942,
28472971,10,12350,839699,1212235,1341000,1142751,801352,502768,290453,156903,80403,13428,
337843,922830,986590,1385535,1079938,741815,453500,260076,137238,ECFF192F
$END

6.2.2 Attended Mode

When operating in attended mode, no data is saved on the SD cards, but the R7780 provides time stamp lists to the host PC in the PTR-32 (INCC compatible).

6.2.3 List Mode

When operating in list mode, the R7780 saves the timestamp list on one of the SD cards in PTR-32 binary format. Raw data are stored in the dedicated ”lists” folder of SD card1.

6.3 OTG USB Port

The R7780 is equipped with a front panel OTG USB port (USB 2.0) with a status red LED. Plugging a common USB stick into this port, the entire content of the plugged SD cards is automatically copied to the external drive. The LED is off if no stick is in or if the copy process is completed, while stays on during the data transfer.

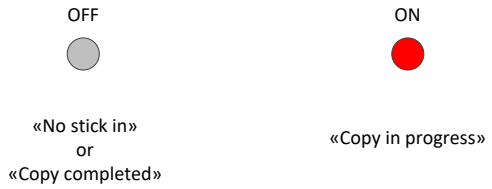

Fig. 6.5: OTG Port LED status

7 Video Monitor Output

By directly connecting the video output of the R7780 to a display, it is possible to automatically monitor the device status information.

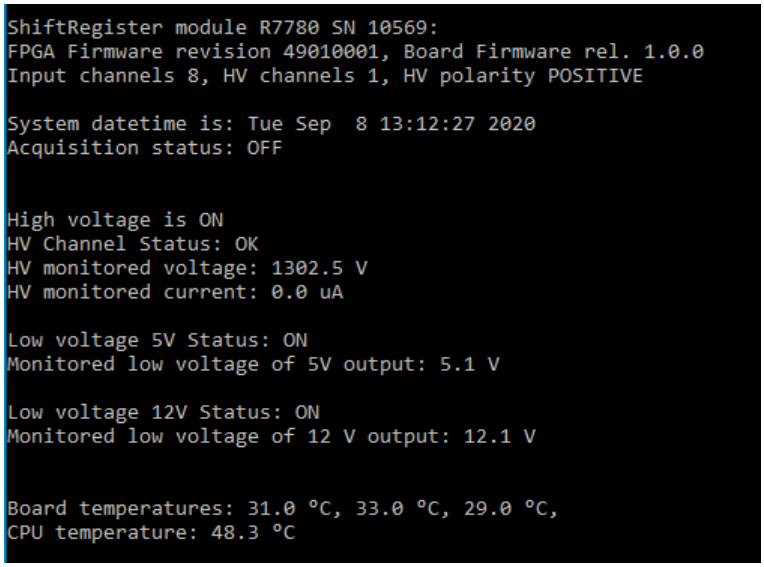

Fig. 7.1: Status information from the video output

8 Web Interface

The R7780 is provided with a web interface for checking its state of health, downloading data, updating the device configuration and firmware. The web interface is available by simply pointing the web browser at the device IP address (see Sec. **5.4.1**).

8.1 Dashboard Page

The home page of the Web Interface is the “Dashboard” page , which shows some general info about the device and its general status such as the device serial number, the number of input channels and HV channels, and the current versions of the FPGA firmware and the embedded software.

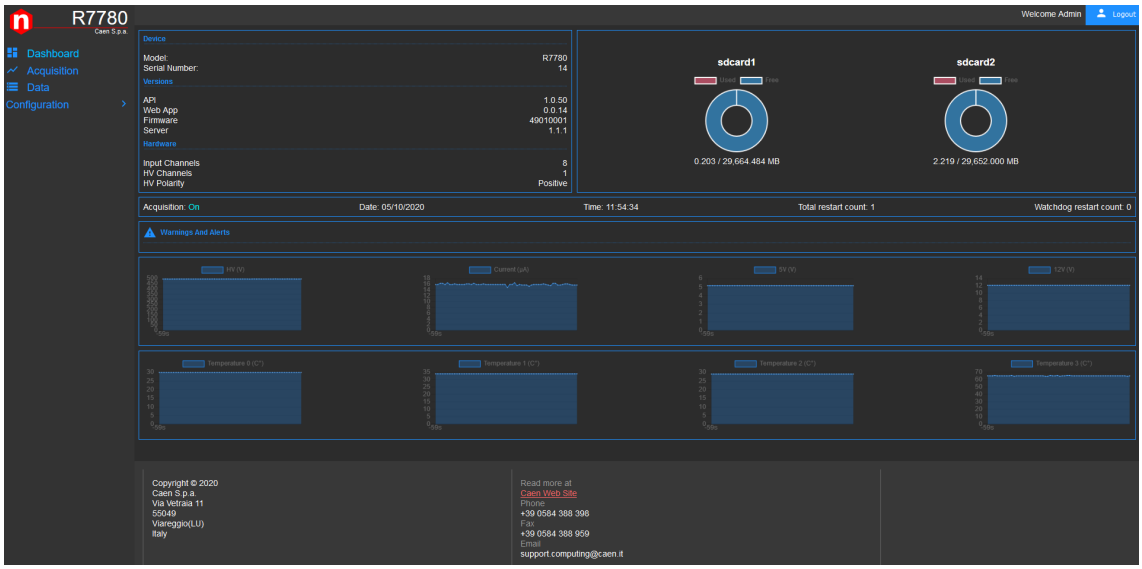

Fig. 8.1: Home page of the R7780 Web Interface.

The SD cards status is also shown on top right in the Dashboard. It is so possible to check whether the memory cards are mounted and the available space.

The ”Warning and Alerts” section (center) reports any kind of warning or error detected by the device: if data acquisition is not running, if the device is running in factory mode, if a power supply failure occurred, and more (see for example **Fig 8.2**).

Fig. 8.2: Some warnings shown on the Dashboard.

In the lower part of the Dashboard, a set of graphs shows the trend of the monitored levels of the power supply outputs (high-voltage and low-voltages), and the board internal temperatures.

This kind of basic status view is shown without requiring to login (guest access), but other information are protected by simple predefined user names (user, admin) and passwords. It is possible to enter the login credentials from the dedicated section on the top right of the home page (**Fig. 8.3**)

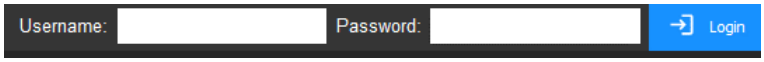

Fig. 8.3: Login section

An ”user” has all the rights assigned to a guest, plus the right to see all the collected data (past and present) and configuration, and to restart the device. Only an ”admin” user is allowed to modify the configuration and to update the firmware, after logging in.

8.2 Acquisition Page

The Acquisition page provides a real-time data display showing the measurement results and, from this page, it is possible to start and stop data acquisition (when the device is working in unattended mode [1]), and to switch on/off the low and high voltage power supplies. It is also possible to write a remark that will be saved to the log files on the SD cards.

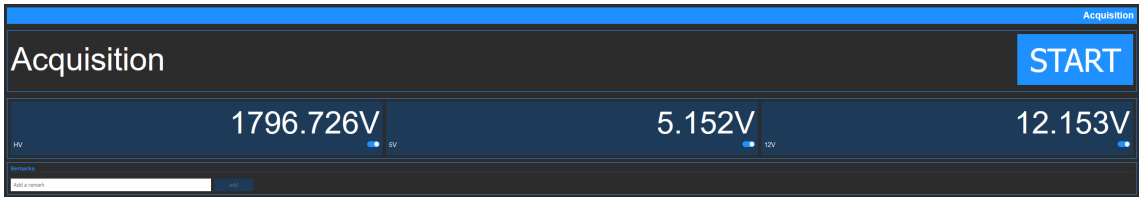

Fig. 8.4: Top section of the Acquisition page of the R7780 Web Interface.

The plots showing the measurement results are active when data acquisition is ongoing and starting from the moment when the Acquisition page is opened: from then on, the plots are updated every time a new acquisition cycle is completed. If data acquisition is stopped the plots are freezed and by switching to another web page they are deleted. Four kinds of plots are available depending on the device counting mode:

- *Count Rate Plot*: this graph shows the counting rate of every input channel measured in the acquisition cycles and it is available for the Counting, Coincidence and Multiplicity counting modes. It is possible to add/remove one or more channels from the plot by clicking on the channel symbol in the legend. The maximum number of data points that can be simultaneously included in the plots is 50.
- *Coincidences plot*: this graph shows the Reals and the Accidentals coincidences measured in the acquisition cycles and is available only in Coincidence and Multiplicity counting mode. By positioning the mouse over the column bar of the plot, the exact value of the column height is highlighted. The maximum number of data points that can be simultaneously included in the plots is 50.
- and *Multiplicity distributions plot*: this graph shows the A (in red) and R+A (in cyan) multiplcity distributions measured in the last acquisition cycle and is available only when the counting mode is set to Multiplicity. The plot is updated every time a new cycle ends.
- and *HVPlateau plot*: this graph shows the count rate of the input channels measured in the acquisition cycles as a function of the High Voltage value, and is available only when the counting mode is set to HVPlateau. The plot is updated every time a new cycle ends.

[1] When the Counting mode is set to HVPlateau, the STOP acquisition button allows to abort the whole plateau measurementand to restart.

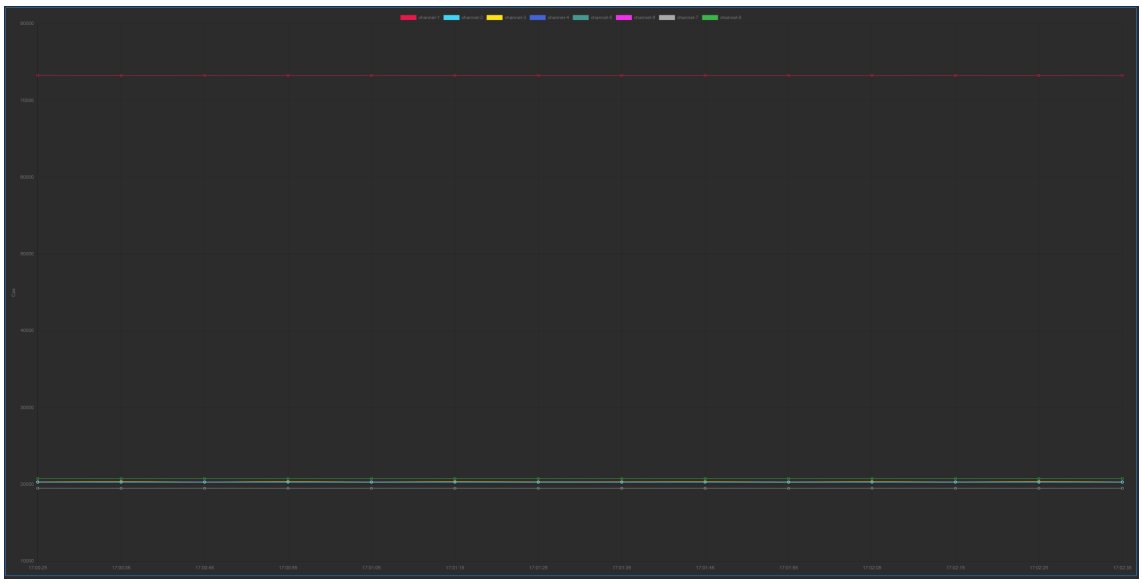

Fig. 8.5: Example of Count Rate Plot shown in the Acquisition page. The acquisition cycle time is 10 seconds and the plot shows data collected from 17:00:25 up to 17:02:35. Channel 1 count rate is about 72 kCps while it is about 20 kCps for the other input channels.

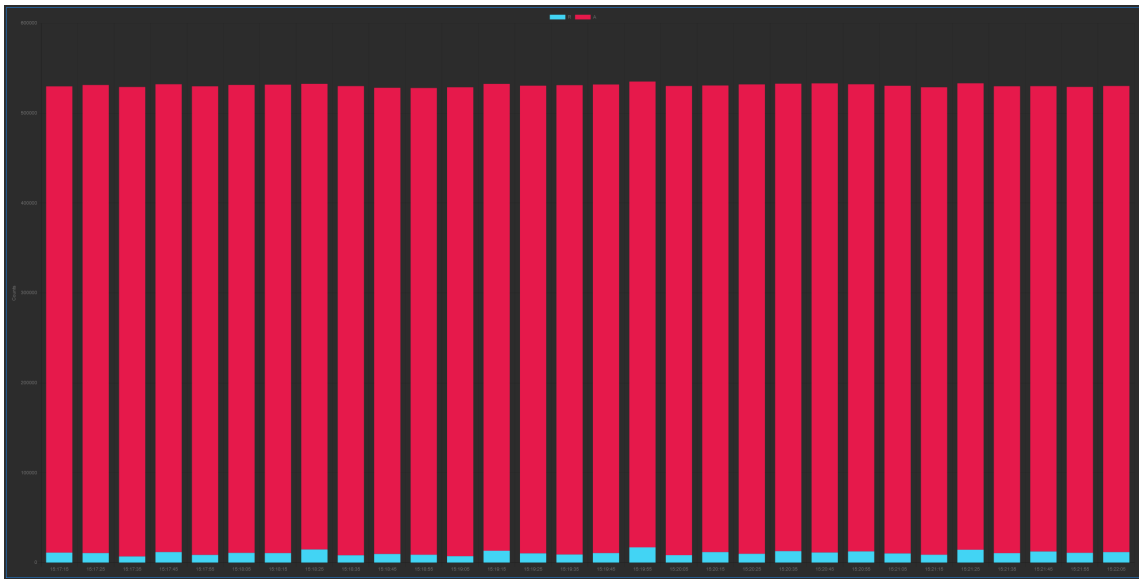

Fig. 8.6: Example of Coincidences Plot shown in the Acquisition page. The acquisition cycle time is 10 seconds and the plot shows data collected from 15:17:15 up to 15:22:05.

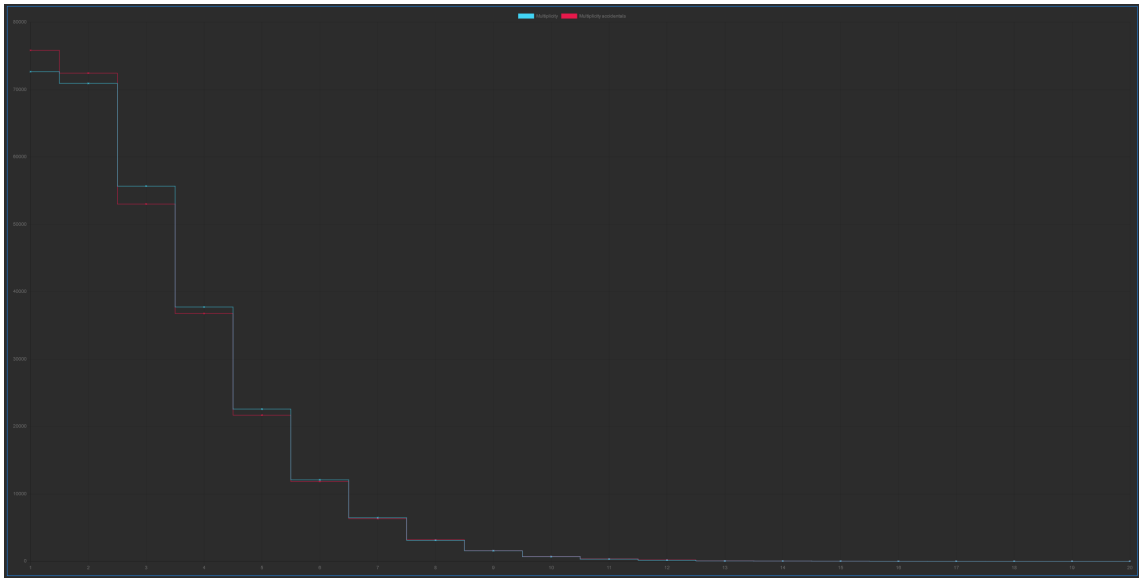

Fig. 8.7: Example of Multiplicity Plot shown in the Acquisition page. The acquisition cycle time is 10 seconds and the number of multiplicity bins is set to 20.

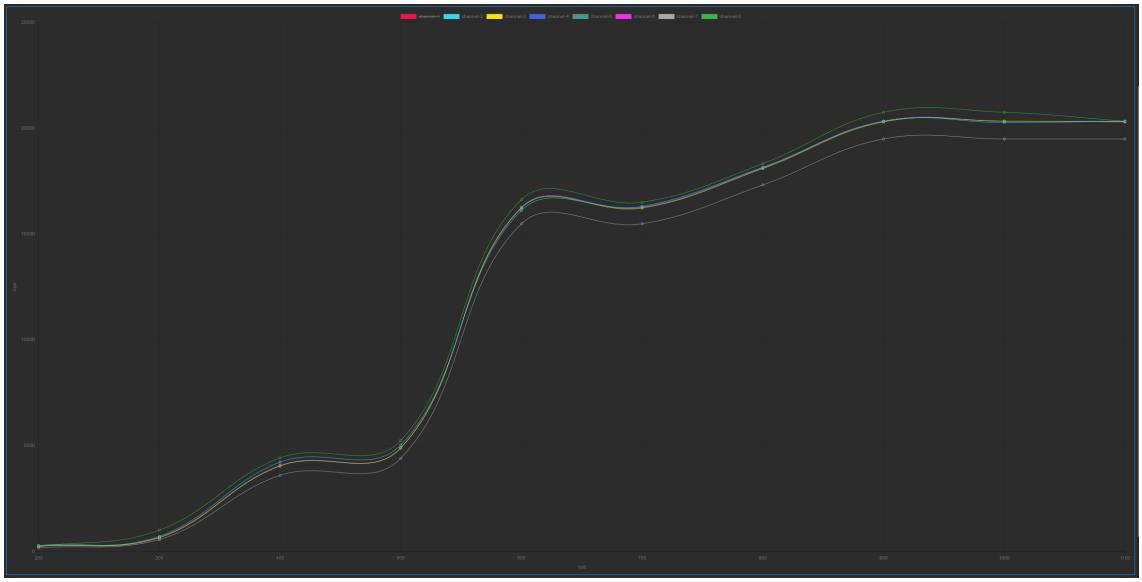

Fig. 8.8: Example of HVPlateau Plot shown in the Acquisition page. The HV value was varied from 200 V to 1100 V.

8.3 Data Page

The Data page contains a view of the SD cards directory list and files (**Fig. 8.3**). From this page, it is possible to browse the SD cards contents and to download or delete one or more files. This page contains also a table showing the results of the last 5 measurements: total counts, single channels counts, R, ReA, A.

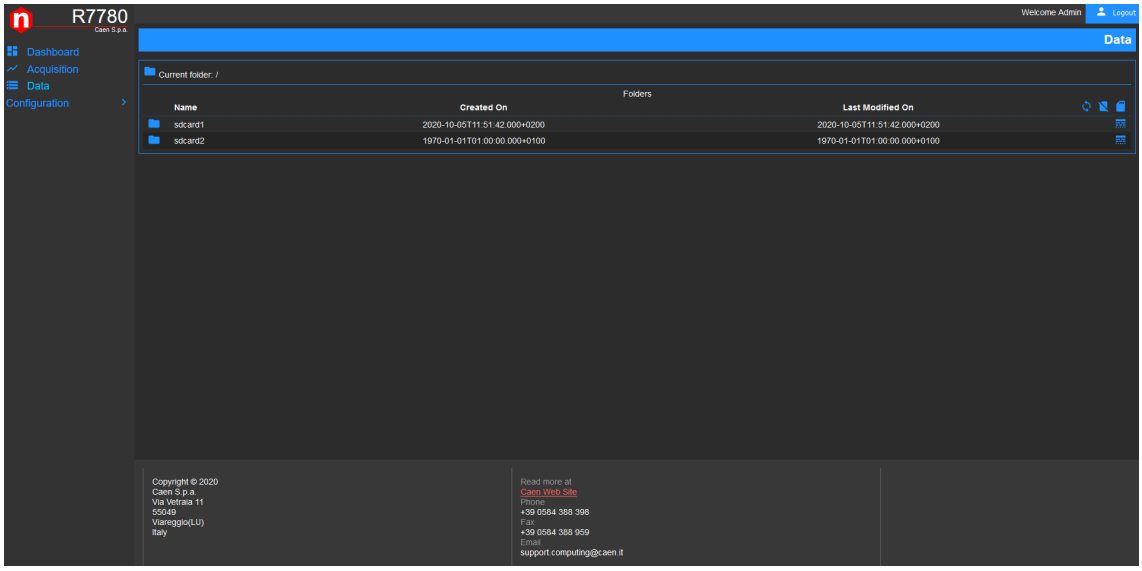

Fig. 8.9: Data page of the R7780 Web Interface.

Click on the blue folder icon of a valid SD card in the list to access the internal directories (**Fig. 8.10**).

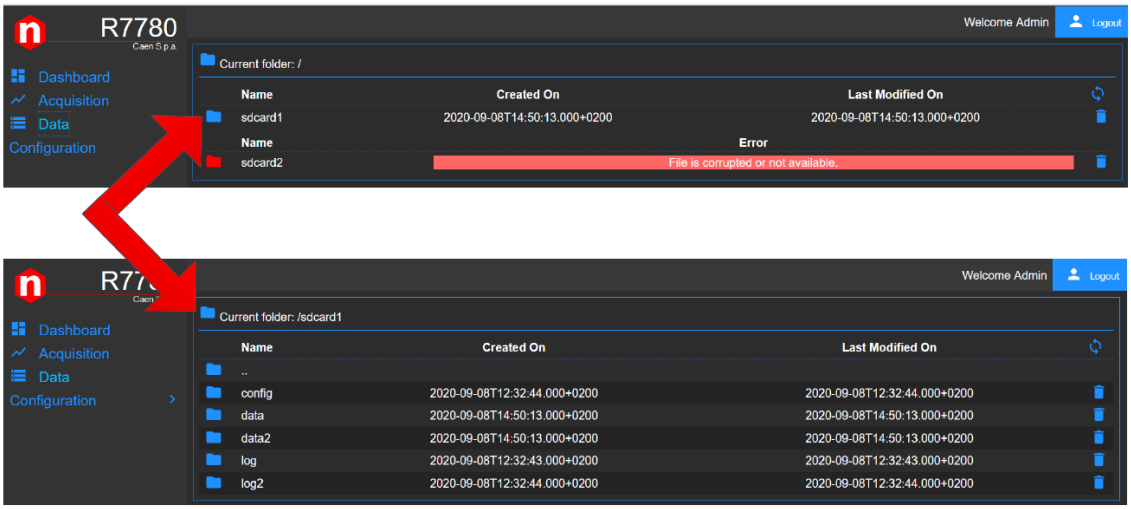

Fig. 8.10: Data page management phase 1

According to the desired kind of data, click on the relevant blue folder icon to access the directory content. In the same way, access the file subdirectories ordered by date and then click on a file for download (**Fig. 8.11**).

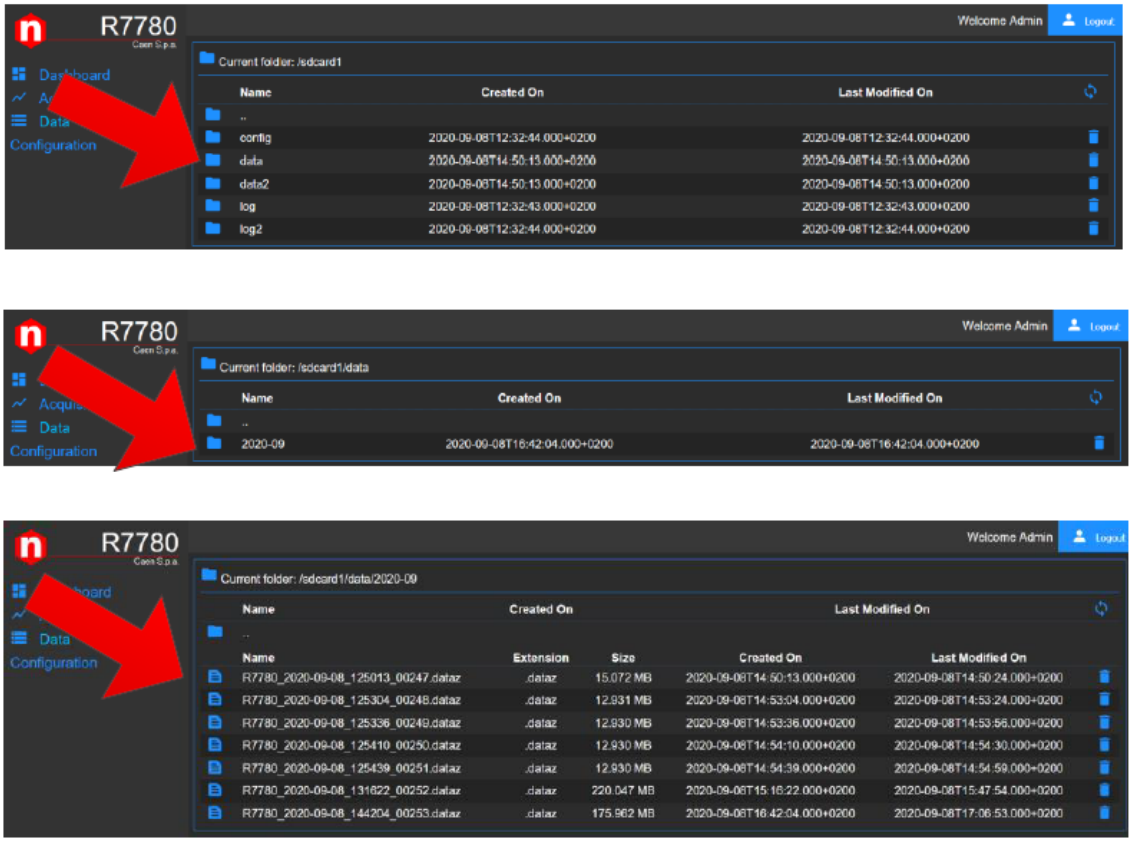

Fig. 8.11: Data page management phase 2

Four buttons are present on the right on top of the Data page (see Fig. 8.12):

1. Reload button: click this button to reload the page in order to see the updated contents of the file folders.
2. Unmount SD cards: click this button to unmount the SD cards. If an acquisition is in progress it will be automatically stopped, all files will be closed and the SD cards will be unmounted. It will be then possible to remove them (SD cards led will be in ”Green LED on” status, see Sec. 6).
3. Remount SD cards and Restart: click this button when SD cards are again in their slots and the system can be restared. SD cards will be remounted and logging will restart on new log files. Only if an acquisition was running when the unmount has been requested, a new data acquisition will start automatically.
4. Format SD cards: click this button to format the corresponding SD card. If an acquisition is in progress it will be automatically stopped, all files will be closed and the selected SD card will be formatted. All data that are present on this SD card will be lost. Only if an acquisition was running when the format has been requested, a new data acquisition will start automatically when the format procedure ends.

Fig. 8.12: The SD card buttons on the Data page. Starting from the left: Reload button, Unmount button, Remount and Restart button and Format button.

Note 1: The ”Unmount SD cards” button should be used whenever the SD cards must be removed. Improper removal may cause files damage or system malfunctioning.

Note 2: When a SD card is removed and reinserted, it is automatically remounted by the device so that, if the user forgets to click the ”Remount and Restart” button, data acquisition can be restarted automatically after the preset time. The Auto Restart time can be set from the Configuration → Acquisition page. See also section 6 for some more details.

The table shown in the Data page contains a summary of the last 5 measurement results and the table format depends on the device counting mode (see fig. 8.13).

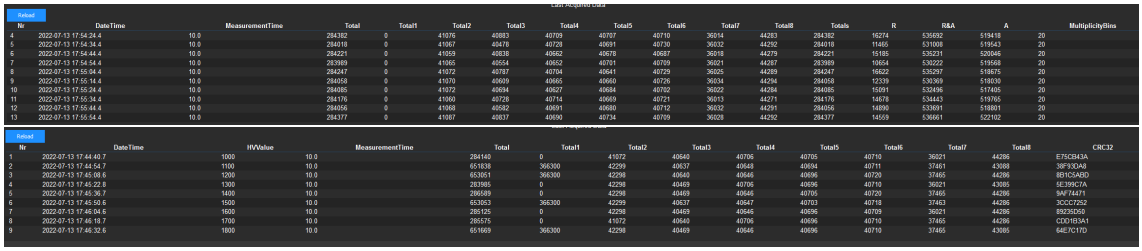

Fig. 8.13: Two examples of the Data table showing the results of the last 5 measurements in Multiplicity and HVPlateau counting mode.

8.4 Configuration Menu

The Configuration menu contains all the device settings divided into five main groups: Tools, Network, Acquisition, Date & Time and Users settings. In the Tools settings page (**Fig. 8.14**) there are two buttons, one to Reboot the device (both the FPGA and the internal CPU are restarted), and the other to Reset the device to factory settings (all the factory settings are restored). This last button can be used in case the device firmware becomes corrupted or in case of severe firmware failures, and allows to restore the original factory firmware.

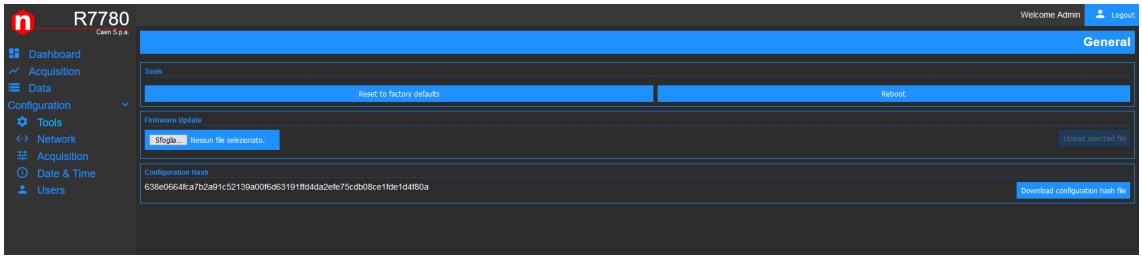

Fig. 8.14: Tools settings page

In this page, it is also possible to update the device firmware by uploading the ”.cup” file and then restarting the board. As shown in fig. 8.15, a warning message is shown when the file has been uploaded and device should be restarted. Click the Reboot button or use the Power button on the front panel of the board to reboot. In case a wrong file has been uploaded by mistake, it is possible to remove it by clicking the button ”cancel update” which appears after a file has been uploaded (see **Fig. 8.15**)

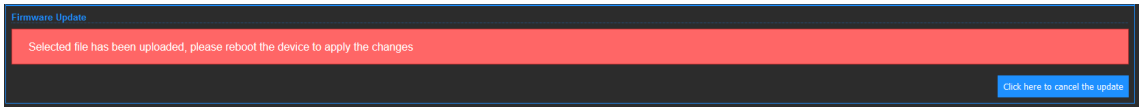

Fig. 8.15: Message shown on the Tools page after uploading a .cup file.

On restart, the device will detect the presence of the update file and it will be loaded. The LEDs on the front panel will be in the ”Update” status: the OTG USB port LED is on and the yellow SD cards LEDs are

on. When the update is complete, all the status LEDs will go off and after a few minutes the device will be ready to restart (the green and yellow SD cards LEDs will be on). In case of errors the device will startup in recovery mode (all the red status LEDs will be on). In recovery mode, it is only possible to restore the device to factory settings or to start a new update.

In the Tools page there is also a button that can be clicked to download a special binary configuration file from the device. This binary file is built from the current firmware and software relevant files that are running on the device. By hashing this file (SHA256 hash) it is possible to check the integrity of the current device system: the hash obtained from the configuration file can be verified aginst the one shown on this web page.

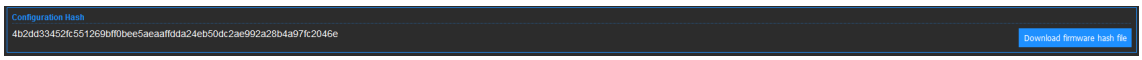

Fig. 8.16: The configuration hash shown in the Tools page.

8.5 Network Page

The Network page contains all the network related settings, which can be changed by the Edit button to configure the device IP address and the DNS (**Fig. 8.17**).
ATTENTION: pay attention when editing these settings because the connection with the device might be lost in case a wrong configuration is applied by mistake.

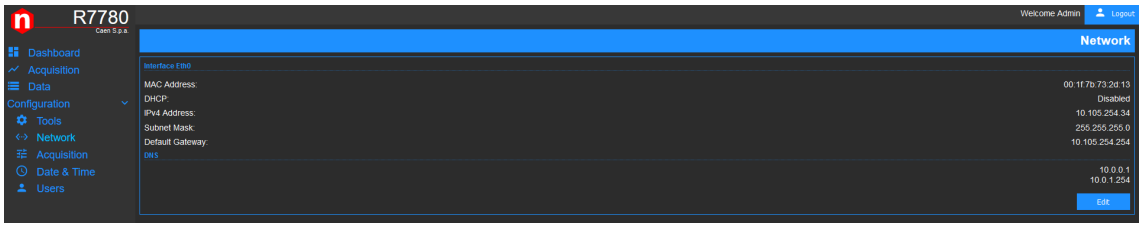

Fig. 8.17: Network settings page

8.6 Acquisition Page

The Acquisition page shows the current device settings related to data acquisition (**Fig. 8.18**). It is possible to edit them and to modify one or more values. The editing procedure does not allow to proceed in case a wrong value is entered or in case one or more fields are left empty. The configuration can not be modified if data acquisition is running.

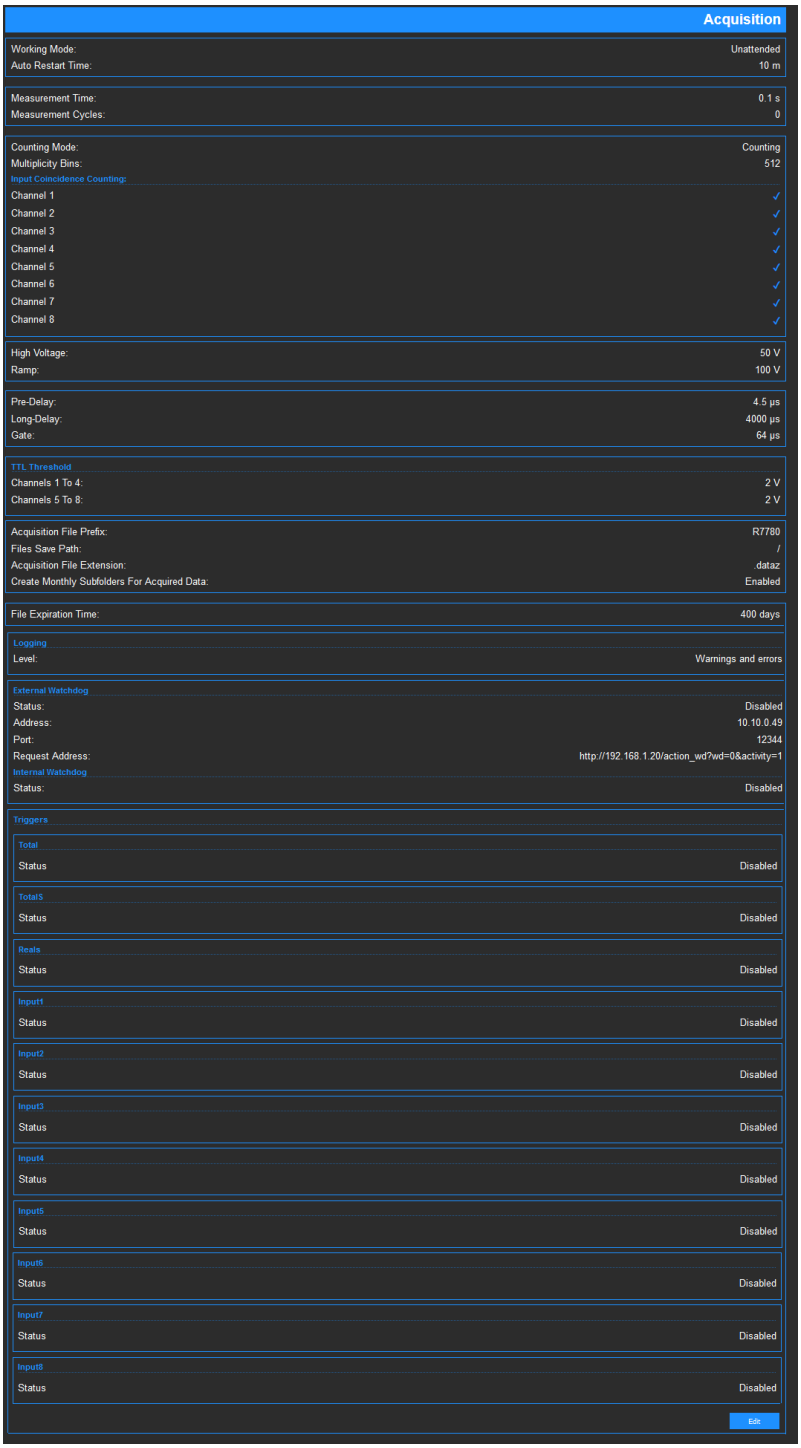

Fig. 8.18: Acquisition settings page

8.7 Date & Time Page

The Date & Time page shows the current device date-time. From this page, it is possible to manually set the system clock and to update the NTP. The NTP settings can also be managed.

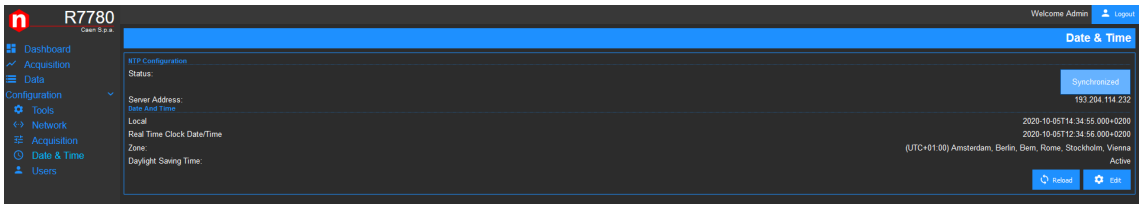

Fig. 8.19: Date & Time settings page

By clicking the Edit button, the datetime settings can be adjusted. If NTP is enabled, it is possible to set a new NTP server IP address.

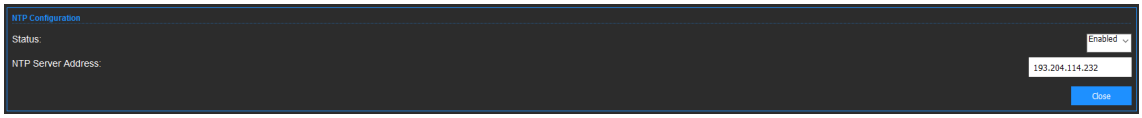

Fig. 8.20: Edit options when NTP is enabled.

If NTP is disabled, the datetime can be manually adjusted.

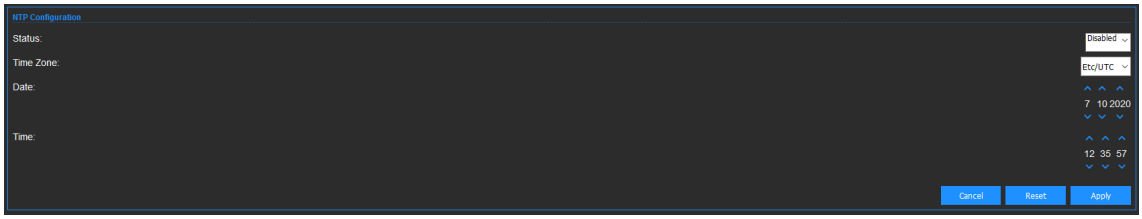

Fig. 8.21: Edit options when NTP is disabled.

8.8 Users Page

The Users page allows to configure the admin and user passwords. Only an admin user has the rights to modify the login credentials.

Fig. 8.22: Users page of the R7780 Web Interface.

By default the passwords are simply set to ”admin” and ”user” for admin and user respectively. If the passwords are changed, they will be valid starting from the next login.

9 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.

9.1 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.

9.2 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.

9.3 General Cleaning Safety Precautions

CAEN recommends cleaning the device using the following precautions:

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

10 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 CONDITIONS SPECIFIED IN THE MANUAL, OTHERWISE PERFORMANCES AND SAFETY WILL NOT BE GUARANTEED

11 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.

12 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

User Manual UM7585

R7780 - Unattended Data Acquisition Module for Unattended Monitoring Systems

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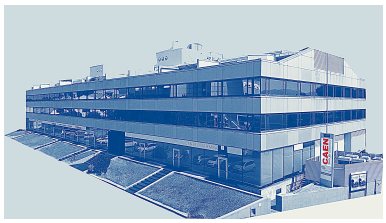

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