Rev. 0 - September 24th, 2024

R7771B

Neutron Pulse Train Recording Device

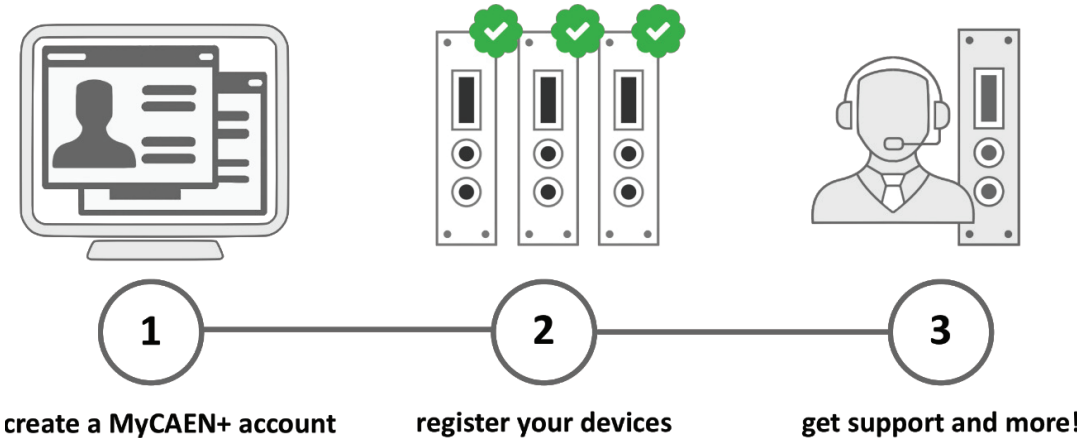
CAEN
Tools for Discovery

User Manual
UM11599

Register your device

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

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



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

Purpose of this Manual

This document contains the full hardware description of the new R7771B Neutron Pulse Train Recorder device.

Note: If you are in possess of an old R7771B or R7771 modules, please refer to the R7771 User Manual **[RD1]**.

Change Document Record

Date	Revision	Changes
September 24th, 2024	00	Initial Release

Symbols, Abbreviated Terms and Notation

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

Reference Documents

[RD1] UM7292 – R7771 Neutron Pulse Train Recorder User Manual

[RD2] UM7284 – R7771 Control Software User Manual

All CAEN documents can be downloaded at:
`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

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 new R7771B module replaces the obsolete R7771 and previous R7771B versions. This is a device boxed in a mechanics compliant to 19" racks and designed for performing neutron pulse trains recording independendtly on 32 channels. The device works in attended mode, where time-stamped lists of input TTL pulses coming from a neutron detector are provided to an external computer to be recorded for further analisys.

The front panel HV output channel can provide the bias for the detector power supply, while a LV output channel (+5V on BNC connector) is also available to supply power for the preamplifier. On the rear panel, another LV output (+12V and -12V on 3-pin connector) has been added to interface with CAEN A1421x preamplifier family. The internal CPU manages the board settings, the acquisition for attended operations, and the data transfer of the pulse train from each of the board channels to an external host PC for further analysis. The computational resources and data throughput allow the acquisition of a high total continuous input rate (up to $3x10^6$ cps).

The R7771B device can be controlled by a point-to-point direct connection through the USB-2.0 interface and by a remote network connection through the Ethernet 10/100T port. The acquisition, configuration, and data saving can be then controlled through the CAEN R7771 Control Software, which is available to the users **[RD2]**.

Device	Description
R7771B	32 Channel Neutron Pulse Train Recorder (LVPS ±12V @ 500 mA)

Tab. 1.1: R7771B device table

2 Technical Specifications

PHYSICAL	**Form Factor** 1.25U wide Compatible with 19” rack **Weight** 2650 g
CONNECTORS	**Inputs** • 32 signal inputs • BNC jack receptacle • Single-ended TTL (Z_{in} = 50 Ω) • Minimum pulse width detected = 10 ns **HV** High voltage output SHV jack receptacle **LV** Low voltage outputs • BNC jack receptacle • 3-pole male TINY xlr receptacle **USB** USB-2.0 port Type-B socket **ETHERNET** 10/100 Mbps port RJ45 shielded jack **Power In** AC power input
MIN. PULSE WIDTH	10 ns
PULSE PAIR RESOL.	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 • Ramp-Up/Ramp-Down = 1 to 500 V/s in steps of 1 V • Maximum Output Bias Current (I_{set}) = 1 mA
LVPS OUTPUTS	Preamplifier power supply channels: • +5 V @ 1.5 A (on BNC front connector) • +12 V @ 500 mA and -12V @ 500 mA (on 3-pole rear connector)
ON-BOARD CPU	**SBC** • 1 ARM Cortex-A8 @ 1GHz • SDRAM Memory 512MB DDR3L @ 800MHz • Linux® on board **FPGA** Cyclone V GX
OPERATING MODES	ATTENDED: The device works under full control of an external PC transmitting raw data for further analysis; time-stamped lists are saved to binary files compatible with PTR-32 format
PULSE TRAIN RECORDER	• Internal clock = 100 MHz • Timestamp resolution = 10 ns • Pulse pair resolution = pulse width + 10 ns
BUTTONS AND INDICATORS	• Power LED (green) • HV ON LED (red) • Reset button
COMMUNICATION INTERFACES	**Ethernet** • 10/100 Mbps Ethernet • Configuration, operation, and data taking in attended mode **USB** • USB-2.0 version • Configuration, operation, and data taking in attended mode
FIRMWARE	Firmware can be upgraded via Web interface
SOFTWARE TOOLS	• Windows® and Linux® support • CAEN R7771 Control Software
POWER REQUIREMENTS	• Voltage = 100 - 240 V ∼ • Frequency = 50/60 Hz • Current = 0.5 A RMS (max.) • FUSE = 2x T1A 6.3x32 250VAC

Tab. 2.1: Specification table

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 product manual
	Caution, risk of electrical shock
	Protective conductor terminal
	Earth (Ground) Terminal
	Alternating Current
	Three-Phase Alternating Current

The following symbol may be reported in the present manual:

	General warning statement

The symbol could be accompanied by the following terms:

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

CAUTION: 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: 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 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

THIS DEVICE SHOULD BE INSTALLED AND USED BY 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

See Chap. **6** for the Technical Support contacts.

3 Packaging and Panels

3.1 Packaging and Compliancy

The R7771B device is housed in a 19” rack package: H = 1.25U, D = 265mm.

Device	Weight
R7771B	2650 g

Tab. 3.1: R7771B device weight table

3.2 Panels

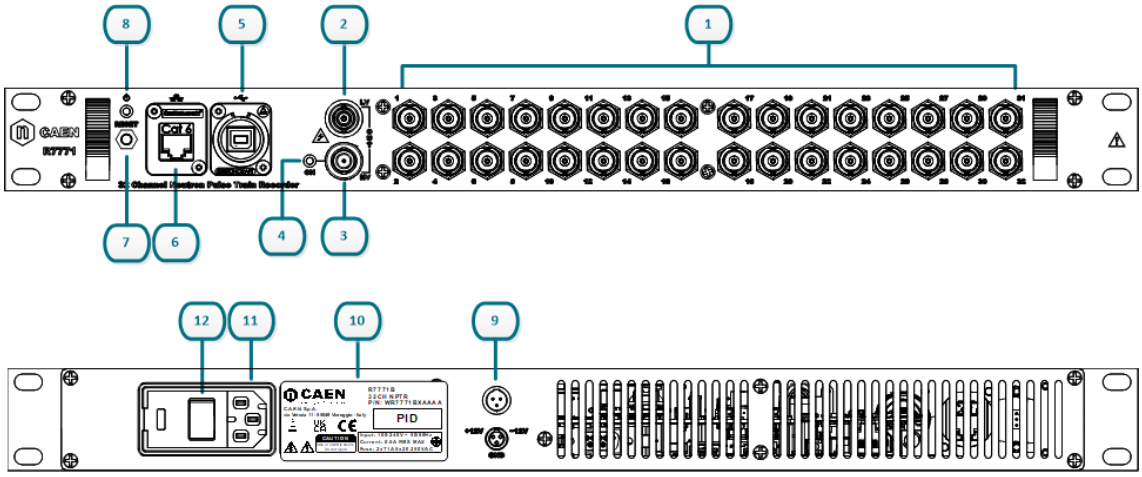

Fig. 3.1: Front (top) and Rear (bottom) front panels of the R7771B device

1. TTL input channel: 1, 2,..., 32.
2. Low-Voltage +5V output for preamplifiers power supply: LV OUT.
3. High Voltage power supply output for the detector: HV OUT.
4. High Voltage power supply LED indicator: ON (the red LED lights on if the HV channel is active).
5. USB-2.0 port.
6. 10/100T ETHERNET port.
7. Reset button: RESET.
8. Power LED indicator (the green LED lights on when the device is powered).
9. 3-pin ±12V Low-Voltage power supply output for A1421x preamp family.
10. Identifying label.
11. AC power input.
12. AC ON/OFF switch (the red neon indicator is on when the AC input is active).

4 Hardware Installation

4.1 Delivered Kit

The R7771B 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. **2**), then place the package content onto your bench. The content should consist in the parts listed in **Tab. 4.1**.

Description	Item
R7771B device	
Power cable	
USB cable A-B type, L=2MT, HI-SPEED	
ETHERNET cable, L=2MT	
User Manual	

Tab. 4.1: R7771B part list

4.2 Power-On / Power-Off

Once installed in a 19” rack and fixed by the front panel rack-mount brackets using standard screws, plug the provided power cable into the AC Input and then to the mains AC.

Switch on the rear red switch to power on; the red indicator will light on.

Fig. 4.1: Power-On status

To power off the device, switch again the rear red switch; the red indicator will light off. Plug off the power cable for a safe operation.

Fig. 4.2: Power-Off status

4.3 Rear ±12V Preamp Output

The rear 3-pin male connector (ref.: RT3MP REAN) for the low-voltage ±12V power supply is compliant with CAEN A1421x preamplifier and discriminator family for 3He tubes. The interfacing cable is included in the preamp delivery kit.

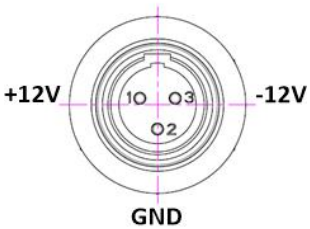

Fig. 4.3: Rear LV connector pinout

4.4 Hardware Detection

When connecting to the R7771B device via USB or Ethernet interface, the device will be recognized also as an external storage unit (see **Fig. 4.4**) including saved files and *webserver.html* file (see Chap. **5**).

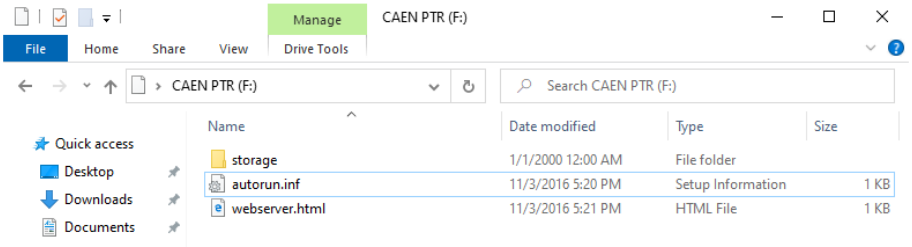

Fig. 4.4: R7771B internal storage unit

4.4.1 USB Connection

By Windows® and Linux® OS, the USB interface of the R7771B device is recognized both as a USB virtual COM port (in Device Manager/Ports (COM & LPT)) and as a virtual Ethernet (in Device Manager/Network adapters).
The number of the assigned serial port can be used for the software connection in case a serial communication needs to be established **[RD2]**. This option is allowed for retro-compatibility with existing devices.

Windows®
Once powered the R7771B device and connected the USB cable to the host PC, the operating system automatically detects the new hardware and loads the relevant driver. **Fig. 4.5** shows how the new peripheral is recognized in the Device Manager.

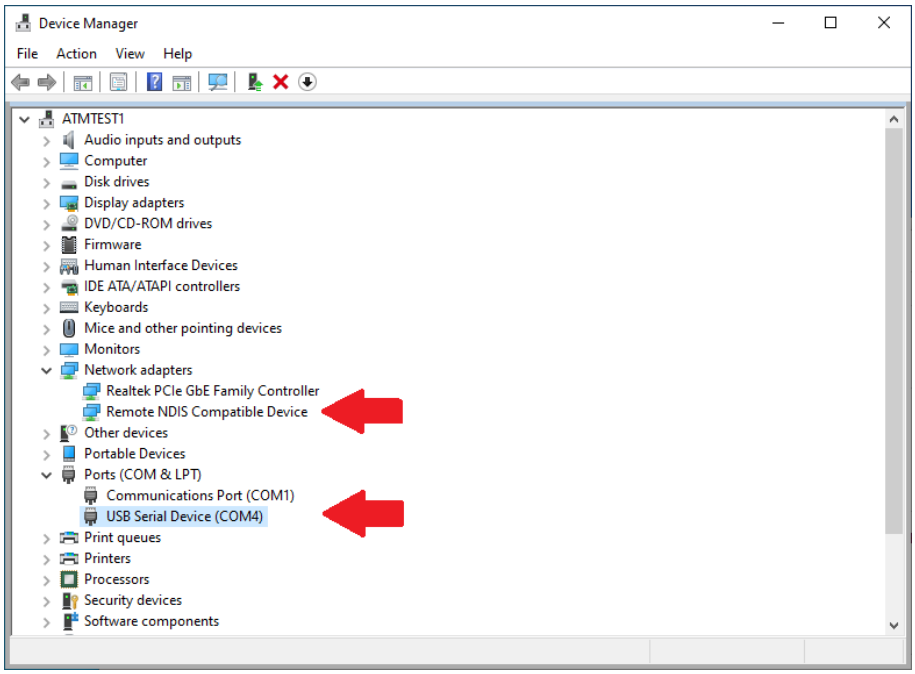

Fig. 4.5: R7771B detection by Windows OS in case of USB connection

Linux®

The R7771B connected through USB link is recognized as USB communication device in /dev/ttyACM0. By the ”dmesg” command, it is possible to check if the device has been correctly detected:

```
[78.814056] usb 1-2: new high-speed USB device number 3 using xhci_hcd
[79.159632] usb 1-2: New USB device found, idVendor=21e1, idProduct=0017
[79.159638] usb 1-2: New USB device strings: Mfr=3, Product=4, SerialNumber=5
[79.159643] usb 1-2: Product: ShiftRegister
[79.159647] usb 1-2: Manufacturer: CAEN_SpA
[79.159652] usb 1-2: SerialNumber: 1739BBBG0428
[79.332612] cfg80211: Loading compiled-in X.509 certificates for regulatory database
[79.340023] cfg80211: Loaded X.509 cert 'sforshee: 00b28ddf47aef9cea7'
[79.340108] cdc_acm 1-2:1.2: ttyACM0: USB ACM device
```

4.4.2 Ethernet Connection

It is possible to connect to the R7771B 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 R7771B device is: **172.16.0.2**.

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

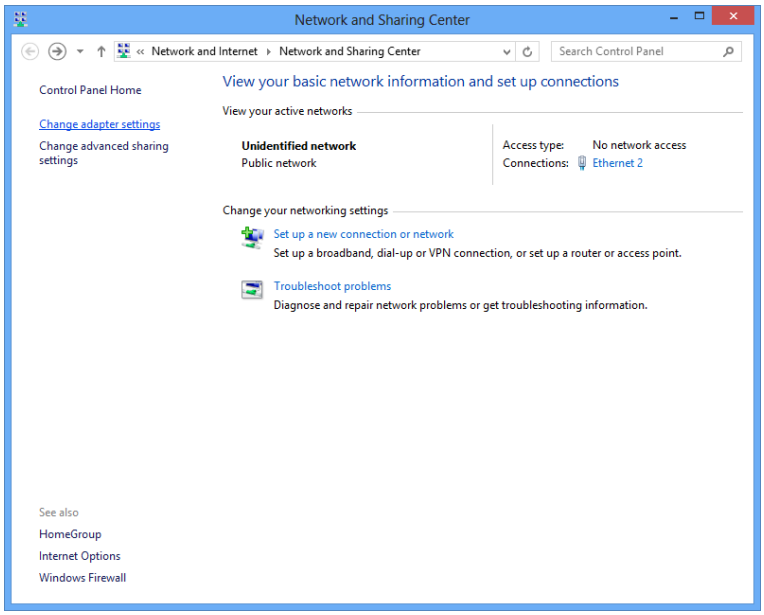

Fig. 4.6: Windows ”Network and Sharing Center”

2. Click on ”Change adapter settings”.
3. Right-click on the Ethernet icon and select ”Properties” (**Fig. 4.7**).
4. Click on ”Internet Protocol Version (TPC/IPv4)” and select ”Properties” (**Fig. 4.8**).
5. Configure the ”Internet Protocol Version (TPC/IPv4) Properties” as in **Fig. 4.9**.

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. 4.10**):
   Wired Connection - Wired Settings
2. Click on the settings icon, select the IPv4 tab, configure and apply as in **Fig. 4.11**.

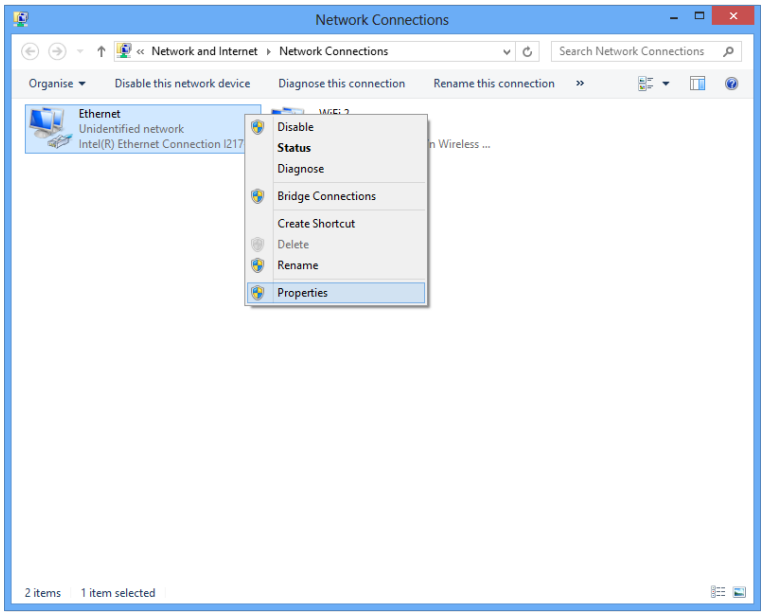

Fig. 4.7: Network Connections window

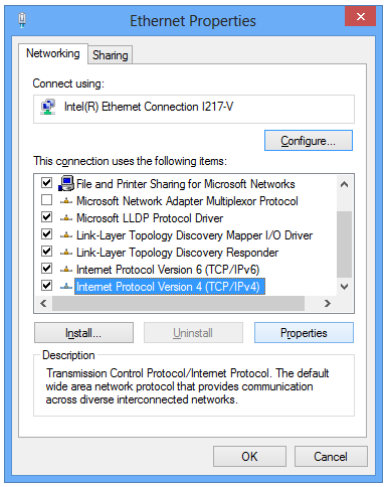

Fig. 4.8: Windows ”Ethernet Properties”

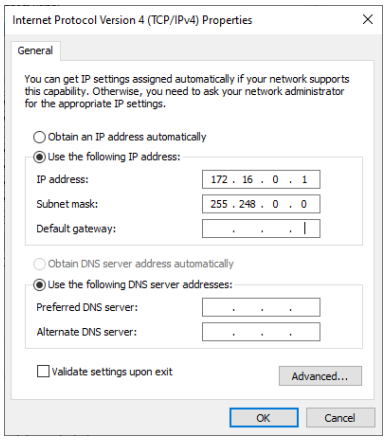

Fig. 4.9: Windows ”Internet Protocol Version (TPC/IPv4) Properties”

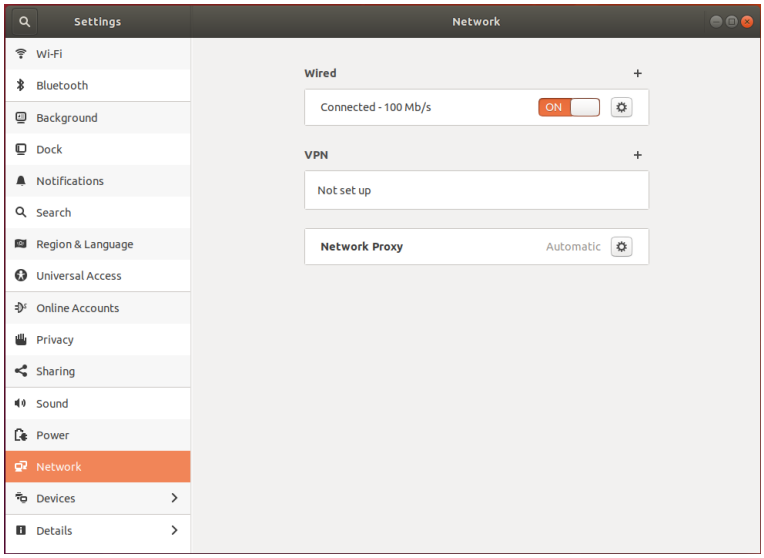

Fig. 4.10: Linux ”Wired Settings”

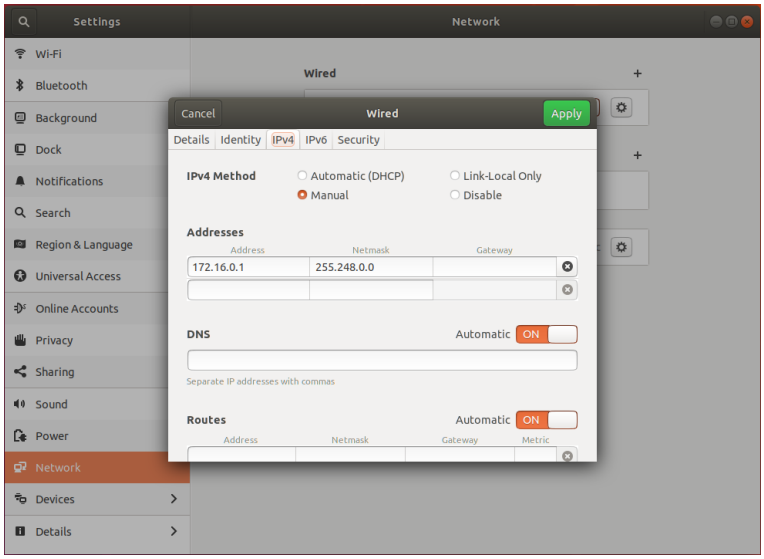

Fig. 4.11: Linux ”IPv4 settings”

4.5 Reset

To reset the R7771B device, the Reset button on the front panel must be pressed for 3 seconds before to release, as shown in **Fig. 4.12**.
The CPU and the FPGA will be reset in a few seconds. In case the HV was active before the reset, it is turned off according to the ramp-down settings configured by the user in the software **[RD2]**.

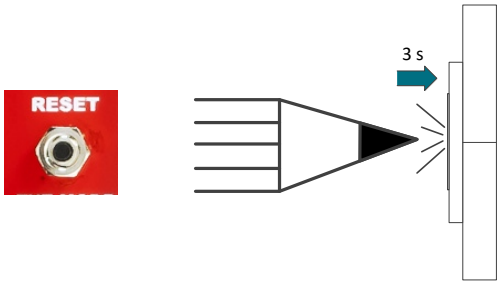

Fig. 4.12: Board Reset

5 Web Interface

When connected through the Ethernet or USB link (see Chap. **4**), it is possible to access the R7771B Web Interface to make a series of operations here described.

In case of Ethernet connection, open the web browser and type the IP Address of the R7771B device as web address. In the default case, the IP Address is **172.16.0.2**.

In case of USB connection, open the R7771B storage units and click on the *webserver.html* webpage; alternatively, type **http://R7771_XX** in the web browser, while **XX** is the R7771B device serial number.

Finally, insert **Username = admin**, and **Password = admin** to login into the web interface.

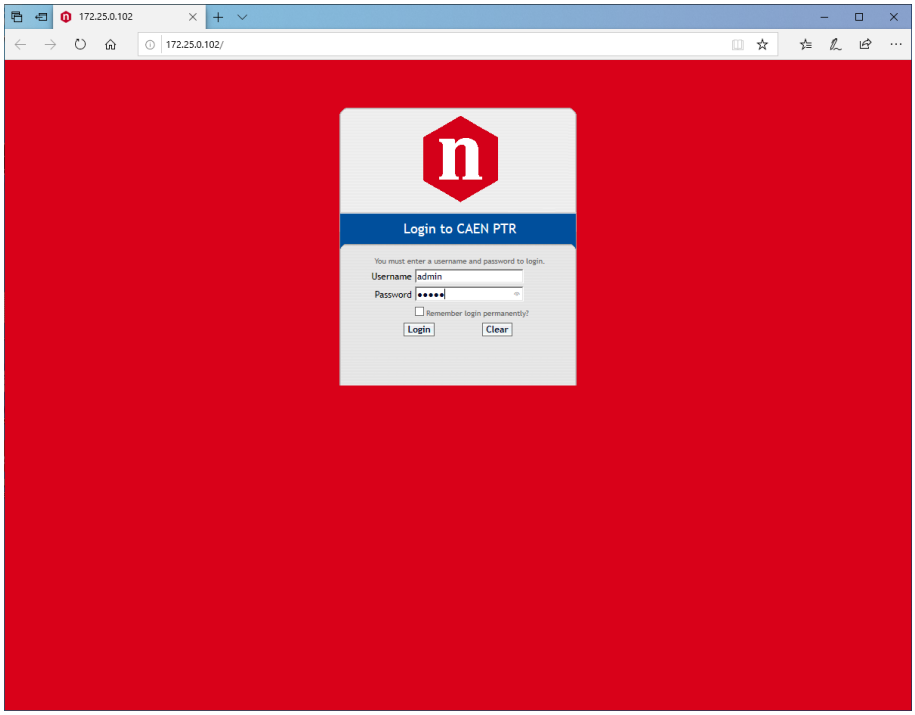

Fig. 5.1: Login page

From the main page of the R7771B web interface (**Fig. 5.2**), it is possible to select three items in the menu:

- File Manager;
- Network Settings;
- Firmware Upgrade.

Click on the **Sidebar** label to get the information about the R7771B device and the memory.

From the sidebar menu (**Fig. 5.3**), it is possible to get the R7771B **Model Type**, its **Serial Number** and **Firmware Version**. **Date** and **Time** are also reported, as well as the information related to the internal **CPU load averages** and the **Real Memory** corresponding to the RAM.

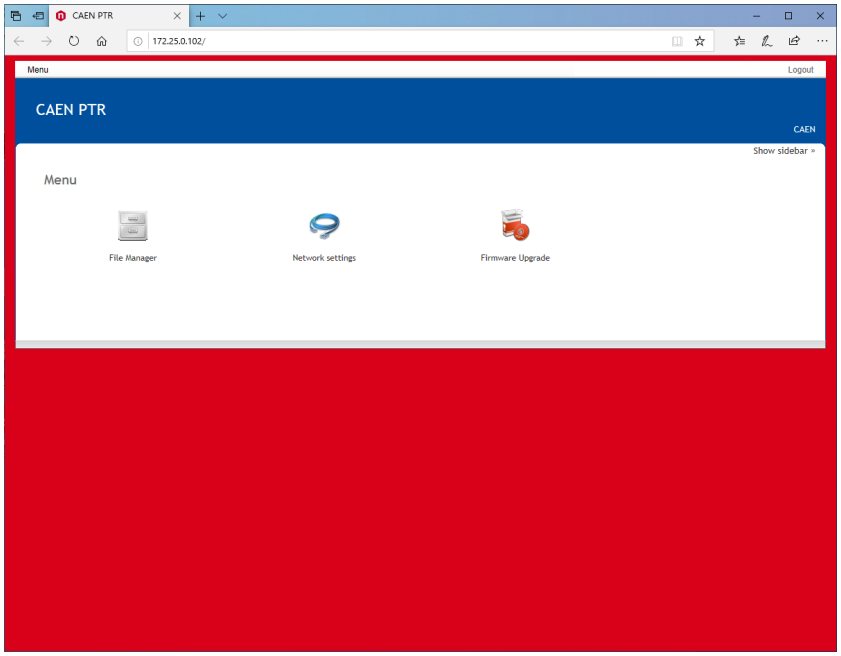

Fig. 5.2: Main page

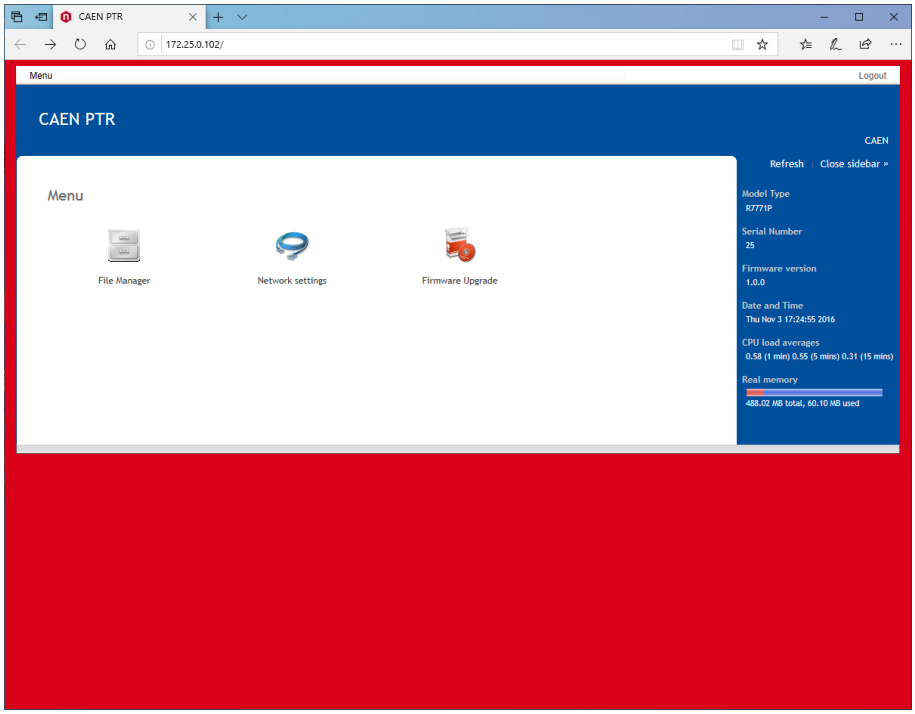

Fig. 5.3: Sidebar menu

5.1 File Manager

In the File Browser menu, it is possible to get the list of files saved into the R7771B device. Selecting the desired run, it is possible to download it on the local PC and/or to perform some operation (order, cut, copy, paste the files, creating and deleting directories, changing the right, etc.) through the button in the operation ribbon.

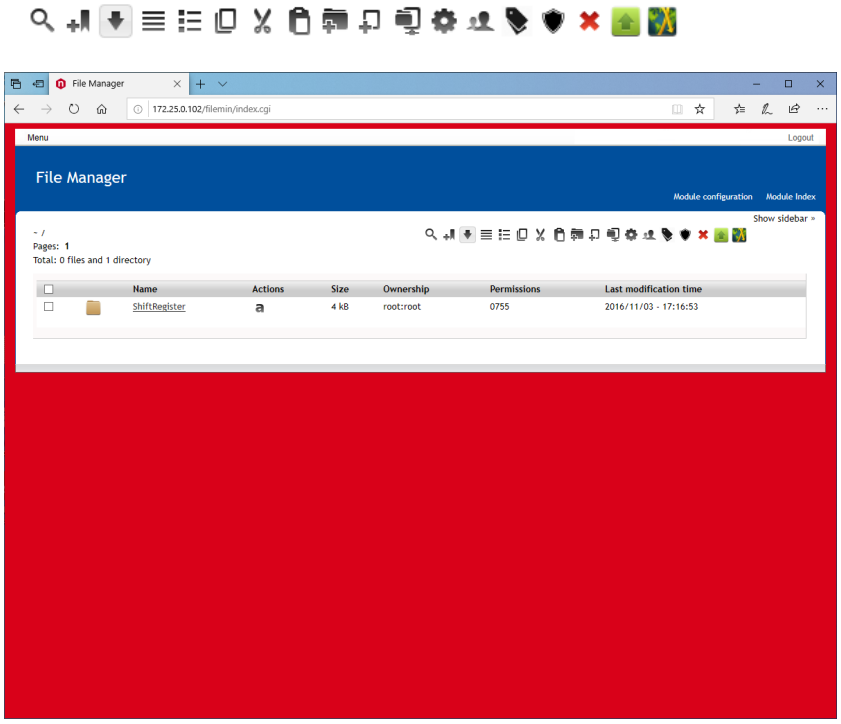

Fig. 5.4: File Manager page

In the File Manager, each row is associated to a specific run and contains a set of information directly visible and related to the single file:

- **Name:** the name fo the data file;
- **Actions:** the available actions on the data file;
- **Size:** the size in bytes of the data file;
- **Ownership:** the file owner;
- **Permissions:** file read/write permission;
- **Last modification time:** time of the last modification of the file.

The run folder contains the log and config subfolders storing the log of the run and the last saved configuration before a new run is started (**Fig. 5.5**). A new log file is generated at any power-on of the device and the date of creation is inside the filename.

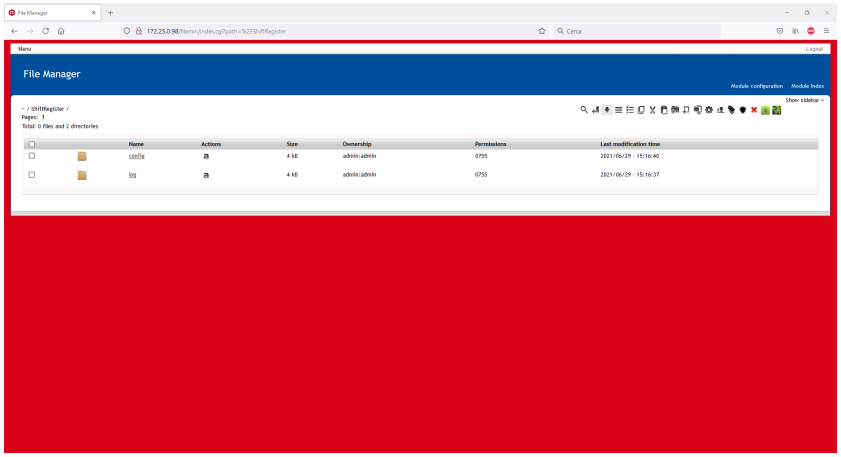

Fig. 5.5: Run folder content

Clicking on the **Module Configuration** button, a configuration window opens (**Fig. 5.6**). From this page, it is possible to configure the appearance of the File Manager section.

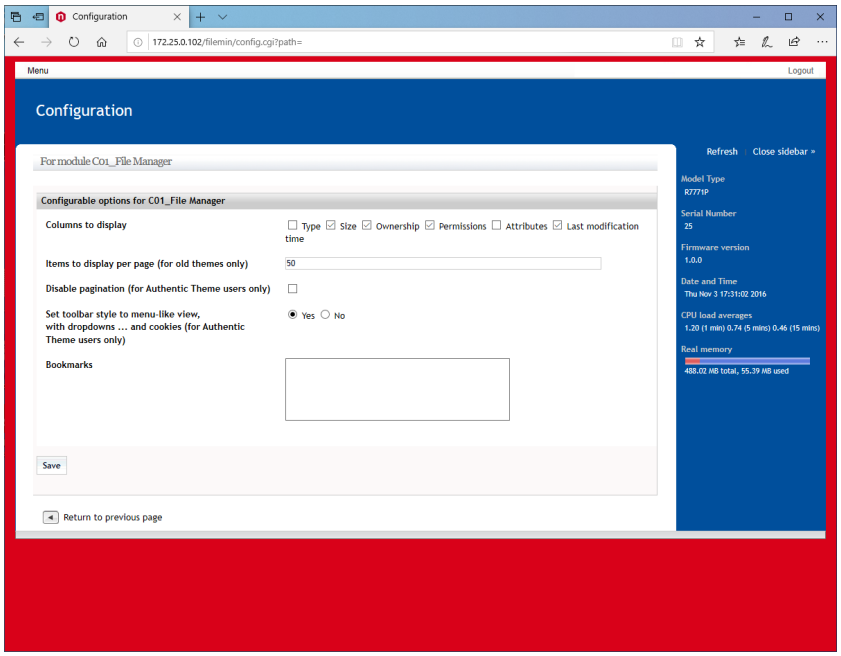

Fig. 5.6: Configuration page

5.2 Network Settings

In the Network Settings menu it is possible to get and modify the current IPv4 Address of the R7771B device to configure the LAN settings and Gateway, if required. If the IP Address is modified from the website interface, the network has to be configured again with the new settings.

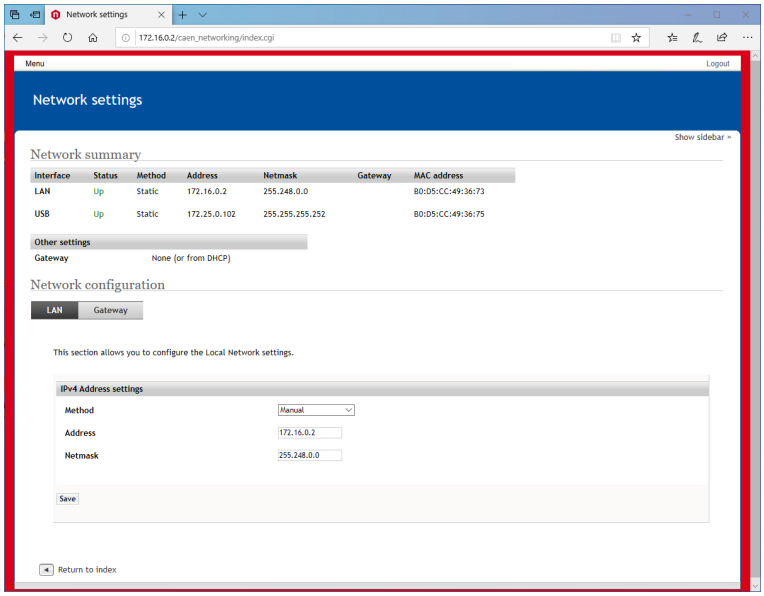

Fig. 5.7: LAN settings

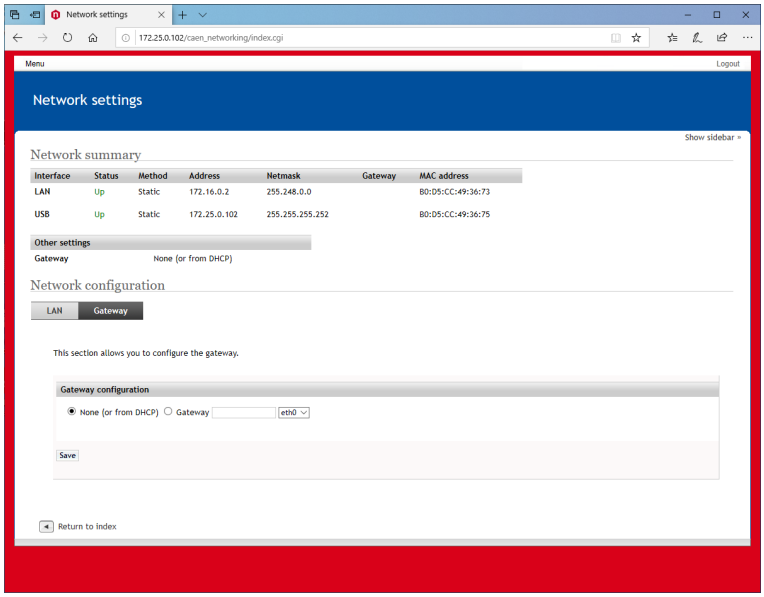

Fig. 5.8: Getaway settings

Note: In case of Ethernet configuration loss for whatever reason, it can be modified again only by accessing via mini-USB link, which is managed as virtual Ethernet with fixed configuration.

5.3 Firmware Upgrade

In the Firmware Upgrade menu it is possible to:

- retrieve the current firmware revision and to upload a new firmware revision on the R7771B device;
- clear the current device configuration.

Using the **Clear** button, the device is set back to its default configuration:

Operating Mode = Attended
Measurement Time = 0
Number of Runs = 1 (single infinite run mode with manual stop by the user)
Vset = 1650 V
Vramp = 10 V/s
Channel Aggregation mode = 0 (CH_ALL)
Rossi-Alpha Distribution Window = 1 ms; Step = 1 us
Bin Number for the multiplicity distributions = 512

To upgrade the device firmare, use the **Browse** button and point the programming file, then press **Upload** perform the upgrade.

Note: When the .cup file has been uploaded, the board needs to be restarted in order to start the update. The upgrade process takes about 5 minutes. Do not power off the board during this time and wait until the device is visible again in the PC as PTR device (the device window will open automatically when the update is finished)

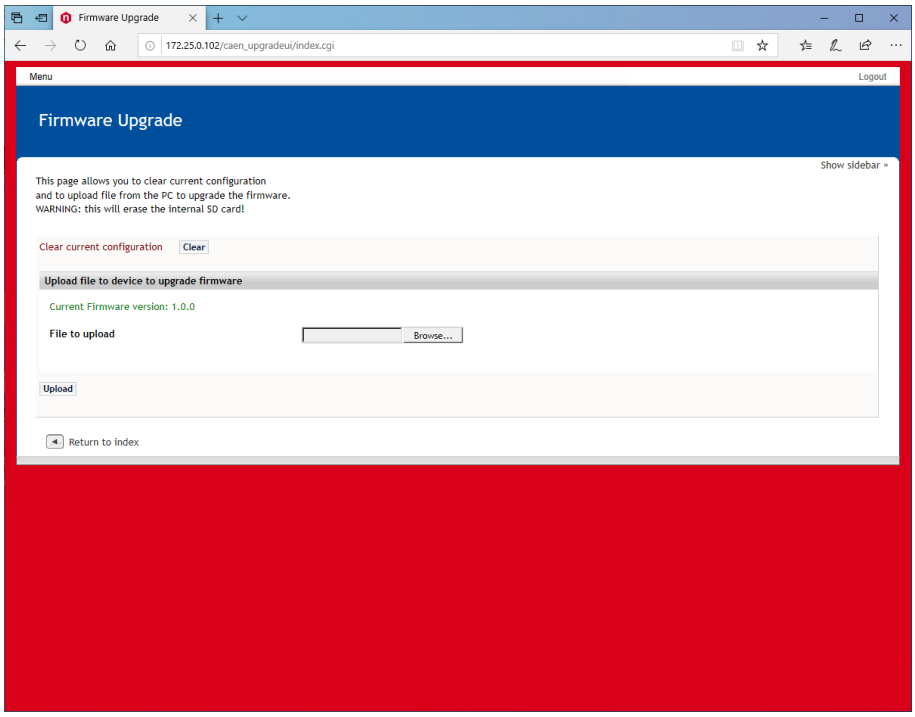

Fig. 5.9: Firmware Upgrade page

In order to work best with the R7771B device, it is recommended to keep the firmware always updated to the latest web available release!

6 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/safety-information-product-support

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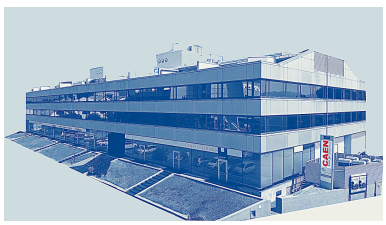

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