Rev. 1 - April 18th, 2024

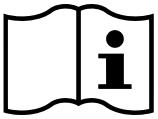
N6780

Dual Digital Multi Channel Analyzer (HV & Preamplifier Power Supply) Desktop

CAEN
Tools for Discovery

User Manual
UM3190

Purpose of this Manual



This User Manual contains the full description of the N6780, Dual Digital MCA.

Change Document Record

Date	Revision	Changes
April 29th, 2015	00	Initial release
April 18th, 2024	01	Revised cover and sales network pages. Updated HV ripple values in § **2.** Updated § **12**

Symbols, abbreviated terms and notation

ADC	Analog to Digital Converter
CSP	Charge Sensitive Preamplifier
DPP	Digital Pulse Processing
DPP-CI	DPP for Charge Integration
DPP-PHA	DPP for Pulse Height Analysis
DPP-PSD	DPP for Pulse Shape Discrimination
MCA	Multi-Channel Analyzer
PMT	Photo Multiplier Tube

Reference Documents

[RD1] GD2512 – CAENUpgrader QuickStart Guide

[RD2] DPP-PHA Registers Description

[RD3] UM2088 – Digital Pulse Height Analyzer User Manual

[RD4] GD2783 – First Installation Guide to Desktop Digitizers & MCA

[RD5] GD2812 – DeskBoot QuickStart Guide

[RD6] GD2827 - How to make coincidences with CAEN digitizers

[RD7] UM1935 – CAENDigitizer Library User & Reference Manual

[RD8] UM1934 - CAENComm User & Reference Manual

[RD9] UM3185 - CAENDPP Library User & Reference Manual

[RD10]GD2080 - Introduction to Digitizers

[RD11]UM3182 - DPP-PHA and MC^{2}Analyzer User Manual

All CAEN documents can be downloaded at:

https://www.caen.it/support-services/documentation-area/ (login required)

Manufacturer Contacts

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

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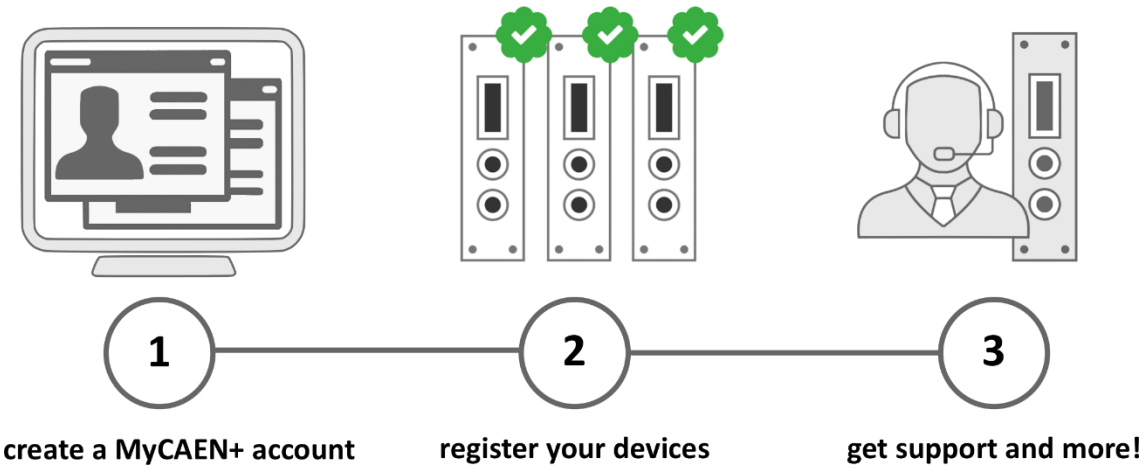
MyCAEN+ dashboard is designed to offer you a direct access to all our after sales services. Registration is totally free, to create an account go to https://www.caen.it/become-mycaenplus-user and fill the registration form with your data.



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Safety Notices

CAUTION: this product needs proper cooling.

USE ONLY CRATES WITH FORCED COOLING AIR FLOW SINCE OVERHEAT MAY DAMAGE THE MODULE!

CAUTION: this product needs proper handling.

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

1 Introduction

The **N6780** is a 16k-channel MCA housed in a 2-unit wide NIM system integrating pulse processing and HV capabilities for Gamma and X-ray spectrometry. It is composed of a 724 series digitizer (2 channels, 14 bit, 100 MS/s), a detector's HV power supply block (2 channels, up to ±5 kV @300 µA of bias voltage), two connectors for the power supply of preamplifiers (low voltages: ±12 V, ±24 V). The board is equipped with a **DPP-PHA Firmware**, that is a Digital Pulse Processing algorithm making the N6780 a spectroscopy acquisition system providing energy (i.e. pulse height) and timing information as well as portions of the waveform for debugging, monitoring and pulse shape analysis. It is ideally suited for high energy resolution detectors, such as **HPGe**, connected to the output of a Charge Sensitive Preamplifier (CSP), but it can also properly work with PMT-based detectors like **NaI**. The N6780 operates as a traditional spectroscopy acquisition chain made of Shaping Amplifier plus Peak Sensing ADC, thus representing a digital replacement of that modules. It is possible to apply the digital algorithm used in the N6780 also to signals that are not coming from CSP (for instance the output of a PMT), but for this type of detector CAEN recommends solutions based on its faster digitizers (such as the 720 or 751 series) running specific algorithms for the digital Charge Integration (DPP-CI) or Pulse Shape Discrimination (DPP-PSD).

The module has been designed to operate as a scalable multi-channel acquisition system. Thanks to two analog input channels of simultaneous acquisition, it is able to manage coincidences and anticoincidences between a pair of detectors, allowing the user, for example, to easily take advantage of background rejection or anti-Compton techniques. The module is designed with synchronization capabilities, so that multi-board systems can easily be built by the customer (contact CAEN for further information).

The N6780 houses USB 2.0 and Optical Link interfaces. USB 2.0 allows data transfers up to 30 MB/s. The Optical Link supports transfer rate of 80 MB/s and offers Daisy-chain capability. Therefore, it is possible to connect up to 8/32 MCA modules to a single Optical Link Controller (Mod. A2818/A3818).

The following list summarizes what can be done by the N6780 and the MC^2 Analyzer supported software (see § **9**):

- receive the signals coming from a charge sensitive preamplifier (CSP) and adapt to the dynamic range (by the programmable DC offset and Gain);
- detect input pulses and generate a local trigger on them;
- calculate the time of arrival of the trigger and the pulse height by means of digital shaping filters (trapezoidal filters);
- build an event made of a configurable combination of Trigger Time Stamp, Pulse Height (energy) and raw waveforms (i.e. series of ADC samples belonging to a programmable size acquisition window);
- detect pile-up conditions and manage the count loss (dead-time);
- implement coincidences and anticoincidences between channels within the board as well as across different boards (refer to **[RD6]**);
- save events (list) into a memory buffer and manage the readout through the Optical Link or USB.

Lists can be read by the software, which allows to:

- accumulate, plot and save the histograms (energy spectra over up to 16k channels), compensate for the dead-time and plot the spectra acquired from each channel;
- generate output files (lists, histograms or waveforms) in a binary or ASCII format.
- run the signal inspector that plots the waveforms of the input signals as well as of the internal filters in order to adjust the parameters of the acquisition;
- set manually or automatically parameter configurations.
- perform advanced mathematical analysis on both the ongoing histograms and collected spectra (e.g. peak search, background subtraction, peak fitting, energy calibration, ROI selection, dead time management, histogram rebin)
- set and monitor the HV power supply of up to two detectors.

Other features NOT managed by the MC^{2}A, but hardware provided are:

- The power-up of up to two preamplifiers (directly interfacing with the relevant connectors);
- Configuration of the inhibit logic for HV shut-down as input from the amplifier (hardware selectable).

Table of related items:

Board Model	Description	Product Code
N6780P	2 Channels Digital MCA - Positive HV	WN6780XPAAAA
N6780N	2 Channels Digital MCA - Negative HV	WN6780XNAAAA
N6780M	2 Channels Digital MCA - Mixed HV	WN6780XMAAAA
Accessory	**Description**	**Product Code**
A1422A005F2	1 Ch. Charge Preamplifier, 5mV/MeVgain	WA1422A005F2
A1422B005F2	4 Ch. Charge Preamplifier, 5mV/MeVgain	WA1422B005F2
A1422C005F2	8 Ch. Charge Preamplifier, 5mV/MeVgain	WA1422C005F2
A1422A045F2	1 Ch. Charge Preamplifier, 45mV/MeVgain	WA1422A045F2
A1422B045F2	4 Ch. Charge Preamplifier, 45mV/MeVgain	WA1422B045F2
A1422C045F2	8 Ch. Charge Preamplifier, 45mV/MeVgain	WA1422C045F2
A1422A090F2	1 Ch. Charge Preamplifier, 90mV/MeVgain	WA1422A090F2
A1422B090F2	4 Ch. Charge Preamplifier, 90mV/MeVgain	WA1422B090F2
A1422C090F2	8 Ch. Charge Preamplifier, 90mV/MeVgain	WA1422C090F2
A1422A400F2	1 Ch. Charge Preamplifier, 400mV/MeVgain	WA1422A400F2
A1422B400F2	4 Ch. Charge Preamplifier, 400mV/MeVgain	WA1422B400F2
A1422A005F3	1 Ch. Charge Preamplifier, 5mV/MeVgain	WA1422A005F3
A1422B005F3	4 Ch. Charge Preamplifier, 5mV/MeVgain	WA1422B005F3
A1422C005F3	8 Ch. Charge Preamplifier, 5mV/MeVgain	WA1422C005F3
A1422A045F3	1 Ch. Charge Preamplifier, 45mV/MeVgain	WA1422A045F3
A1422B045F3	4 Ch. Charge Preamplifier, 45mV/MeVgain	WA1422B045F3
A1422C045F3	8 Ch. Charge Preamplifier, 45mV/MeVgain	WA1422C045F3
A1422A090F3	1 Ch. Charge Preamplifier, 90mV/MeVgain	WA1422A090F3
A1422B090F3	4 Ch. Charge Preamplifier, 90mV/MeVgain	WA1422B090F3
A1422C090F3	8 Ch. Charge Preamplifier, 90mV/MeVgain	WA1422C090F3
A1424	Scintillation Preamplifier	WA1424XAAAAA
A2818	PCI Optical Link	WA2818XAAAAA
A3818A	PCIe 1 Optical Link	WA3818AXAAAA
A3818B	PCIe 2 Optical Link	WA3818BXAAAA
A3818C	PCIe 4 Optical Link	WA3818CXAAAA
AI2730	Optical Fibre 30 m simplex	WAI2730XAAAA
AI2720	Optical Fibre 20 m simplex	WAI2720XAAAA
AI2705	Optical Fibre 5 m simplex	WAI2705XAAAA
AI2703	Optical Fibre 30 cm simplex	WAI2703XAAAA
AY2730	Optical Fibre 30 m duplex	WAY2730XAAAA
AY2720	Optical Fibre 20 m duplex	WAY2720XAAAA
AY2705	Optical Fibre 5 m duplex	WAY2705XAAAA

Tab. 1.1: Compliance table of supported CAEN boards, accessories and DPP firmware

2 Technical Specifications

MECHANICAL	**Dimensions** 2-unit wide NIM	**Weight** 1300 g
ENVIRONMENTAL	**Operational Conditions** 0 – 50°C Temperature Range - EMC compliant	
ANALOG INPUT	**Input Features** ▪ BNC connector ▪ Single ended, DC coupled ▪ Impedance: 1 kΩ ▪ Positive and negative signals accepted ▪ Programmable 4-step analog coarse gain corresponding to: 0.6Vpp/1.4Vpp/3.7Vpp/9.5Vpp ranges ▪ Bandwidth: DC to 40 MHz ▪ Programmable DC offset adjustment on each input in the full scale range	**Number of Inputs** 2
ADC	**Resolution** 14 bits	**Sampling Rate** 100 MS/s (simultaneously on each input)
DIGITAL SIGNAL PROCESSING	▪ Trapezoidal filter for the energy calculation with adjustable rise time in the range 0 - 10µs and flat top in the range 0 – 5µs ▪ Manual and automated trigger threshold adjustment ▪ Manual and automated Pole-Zero cancellation; decay time up to 6.5 ms ▪ Digital decimation in steps of 2-4-8 allows to extend the time parameters range ▪ Digital fine gain ▪ Pile-up rejection and Live Time correction ▪ Baseline restorer with programmable averaging ▪ Trigger and Timing filter based on integrative-derivative component ▪ Time Stamp: 10 ns resolution, 31 bit and rollover tracking event ▪ Adjustable moving average low pass filter to reduce the high frequency noise	
LOW VOLTAGE POWER SUPPLY	**Low Voltage Features** ▪ DB9 connector ▪ ±12 V,100 mA output (DB9/pin4/pin9) ▪ ±24 V, 50 mA output (DB9/pin6/pin7) ▪ Output voltage tolerance: 2% ▪ Voltage ripple < 5 mV_{pp} **Extra Features** ▪ Aux. analog input, 0 ÷ 10 V (DB9/pin3) ▪ Ext. input for detector's temperature readout (DB9/pin8)	**Preamp Outputs** 2
HIGH VOLTAGE POWER SUPPLY	**HV Features** ▪ V_{set}: 5 kV ▪ I_{set}: 300 µA ▪ V_{set}, V_{mon} resolution: 0.1 V ▪ I_{set}, I_{mon} resolution: 10 nA ▪ Ripple (20 ÷ 1000 Hz) Typ < 8 mVpp ▪ Ripple (20 ÷ 1000 Hz) Max < 10 mVpp ▪ Ripple (1 ÷ 20000 kHz) Typ < 2 mVpp ▪ Ripple (1 ÷ 20000 kHz) Max < 5 mVpp ▪ SHV connector ▪ HV polarity configurable by ordering option ▪ User configurable Ramp-Up/Ramp-Down rates independently for each channel: 1÷ 500 V/s range, in steps of 1 V/s ▪ User configurable HV parameters independently for each channel **Safety Features** ▪ OverVoltage/UnderVoltage alarms ▪ Overcurrent/OverTemperature alarms (Kill or Ramp selectable esc modes) Channel Inhibit on DB9 and dedicated BNC connectors, configurable logic by panel switch	**HV Inputs** 2
OPERATING MODES	▪ Pulse Height Analysis (PHA): pulse height histogram (1k-2k-4k-8k-16k) built at software level ▪ List mode: pulse height and time stamp for each event ▪ Oscilloscope mode: input and internal filters waveforms	
TRIGGER MODES	▪ Uncorrelated: each channel operates independently (based on channel self-trigger) ▪ Correlated: coincidence/anticoincidence among channels and/or an external trigger (TRG-IN) ▪ External: channels are triggered by external trigger only (TRG-IN)	

FRONT PANEL DIGITAL I/O	**CLK-IN (AMP Modu II)** AC coupled differential Input Clock: LVDS, ECL, PECL, LVPECL, CML (single ended NIM/TTL available by orderable cable); Jitter<100ppm requested; Can be used as external clock reference for single board or to synchronize the clocks of multiple boards, provided through a Fan In **TRG-IN (LEMO)** External Trigger Input: NIM/TTL, Z_{in} = 50 Ω Can be used to force the event acquisition from all the channels of the board, to gate/veto the individual channel triggers, or to propagate the common trigger in multi-board synchronization (in combination with GPO)		**GPO (LEMO)** General Purpose Output: NIM/ TTL, Z_{in} = 50 Ω Can be used to propagate the global trigger in multi-board synchronization (in combination with TRG-IN), as output register or Run ON/OFF status **GPI (LEMO)** General Purpose Input: NIM/TTL, Z_{in} = 50 Ω Can be used as SYNC/START in multi-board synchronization or Run ON/OFF Control	
COMMUNICATION INTERFACE	**Optical Link** CAEN CONET proprietary protocol Up to 80 MB/s transfer rate Daisy chain capability: it is possible to connect up to 8 or 32 ADC modules to a single Optical Link Controller (A2818 or A3818 respectively)		**USB** USB 2.0 compliant Up to 30 MB/s transfer rate	
FIRMWARE	Firmware can be upgraded via USB/Optical Link			
SOFTWARE	Fully controlled by DPP-PHA Control Software and the MC² Analyzer spectroscopy software For developers: general purpose C libraries with demo samples available			
POWER REQUIREMENTS	Operating Supply Voltages (nominal ± 10% tolerance)	**+6 VDC**	**-6 VDC**	**+12 VDC**
	Consumptions (Typ. @ full load)	2.2 A	35 mA	2.2 A

Tab. 2.1: Specifications Table

3 Packaging and Compliancy

The module is housed in a 2-unit width NIM.

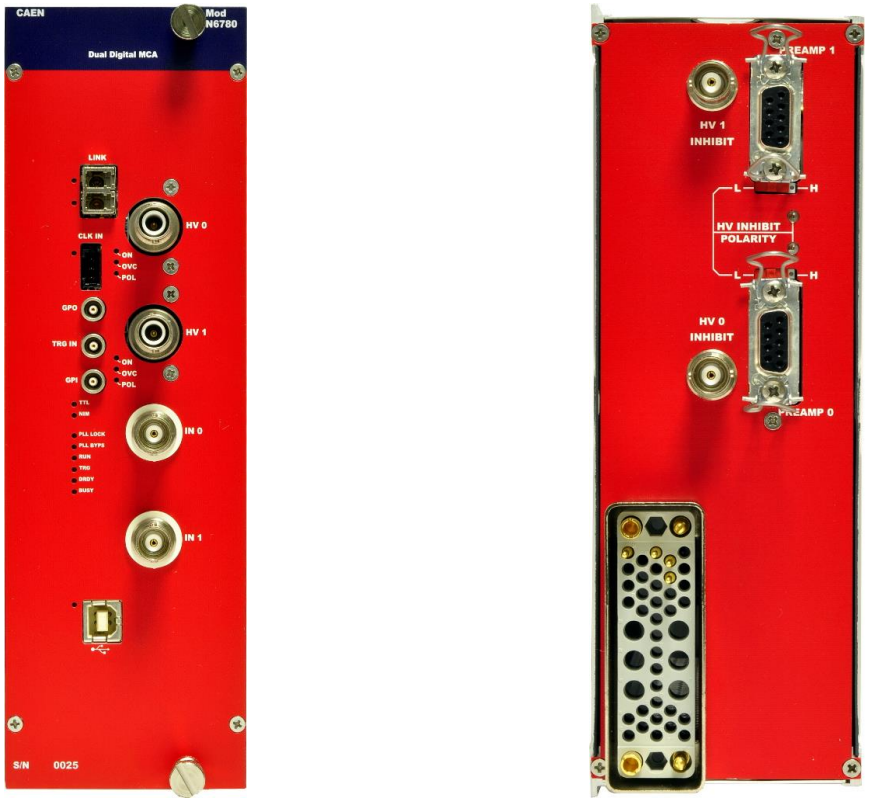


Fig. 3.1: Front and Rear view

Fig. 3.2: Side view

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

A POTENTIAL RISK EXISTS IF THE OPERATING INSTRUCTIONS ARE NOT FOLLOWED!

CAUTION: this product needs proper cooling.

USE ONLY CRATES WITH FORCED COOLING AIR FLOW SINCE OVERHEAT MAY DAMAGE THE MODULE!

CAUTION: this product needs proper handling.

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

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

4 Power Requirements

Tab. 4.1 reports the supply voltage operating conditions and the current consumptions for both the available board versions.

	OPERATING SUPPLY VOLTAGE (nominal)	POWER CONSUMPTIONS (Typical @ full load(*))
N6780	+6 VDC ± 10%	2.2 A
	-6 VDC ± 10%	35 mA
	+ 12 VDC ± 10%	2.2 A

Tab. 4.1: Power requirements table

(*)Full load must be considered as 2 x 5KV @ 280uA for each HV channel and +/-12V @ 100mA, +/-24V @ 50mA for each preamplifier channel.

5 Panel Description

Front Panel

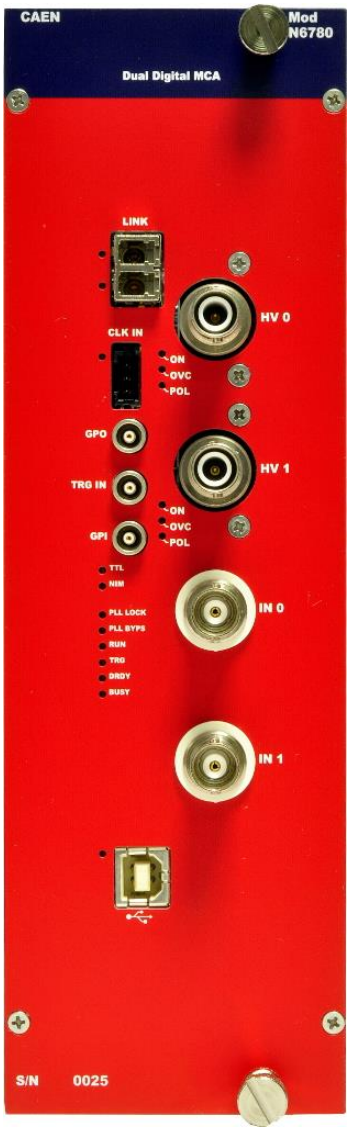


Fig. 5.1: Front Panel

ANALOG INPUT

FUNCTION

Input connectors receiving the analog signals from the detector.

ELECTRICAL SPECS

Input dynamics: 0.6V/1.4V/3.7V/9.5V ranges (software selectable).

Input impedance (Z_{in}): 1 kΩ.

MECHANICAL SPECS

Series: BNC connectors.

Type: R 141 557 000W.

Manufacturer: RADIALL.

EXTERNAL CLOCK IN

FUNCTION

Input for the external clock.

ELECTRICAL SPECS

Sign. type: differential (LVDS, ECL, PECL, LVPECL, CML).

Coupling: AC.

Z_{diff}: 100 Ω.

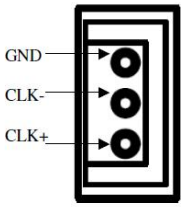
MECHANICAL SPECS

Series: AMPMODU connectors.

Type: 3-102203-4 (3-pin).

Manufacturer: AMP Inc.

PINOUT



CLK IN LED (GREEN): indicates the external clock is enabled.

GENERAL PURPOSE OUTPUT

FUNCTION

General purpose digital output. Can be used to propagate the trigger as well as the GPI signal to other boards connected in Daisy chain.

ELECTRICAL SPECS

Signal level: NIM or TTL.

Requires 50 Ω termination.

MECHANICAL SPECS

Series: 101 A 004 connectors.

Type: DLP 101 A 004-28.

Manufacturer: FISCHER.

Alternatively:

Type: EPL 00 250 NTN.

Manufacturer: LEMO.

EXTERNAL TRIGGER INPUT

FUNCTION

External trigger input.

ELECTRICAL SPECS

Signal level: NIM or TTL.

Input impedance (Z_{in}): 50 Ω.

MECHANICAL SPECS

Series: 101 A 004 connectors.

Type: DLP 101 A 004-28.

Manufacturer: FISCHER.

Alternatively:

Type: EPL 00 250 NTN.

Manufacturer: LEMO.

GENERAL PURPOSE INPUT

FUNCTION

General purpose digital input. Can be used to reset the time stamp or to start/stop the acquisition.

ELECTRICAL SPECS

Signal level: NIM or TTL.

Input impedance (Z_{in}): 50 Ω.

MECHANICAL SPECS

Series: 101 A 004 connectors.

Type: DLP 101 A 004-28.

Manufacturer: FISCHER.

Alternatively:

Type: EPL 00 250 NTN.

Manufacturer: LEMO.

OPTICAL LINK PORT

FUNCTION

Optical LINK connector for data readout and slow control. Daisy chainable. Compliant to Multimode 62.5/125µm cable featuring LC connectors on both sides.

ELECTRICAL SPECS

Transfer rate: up to 80 MB/s.

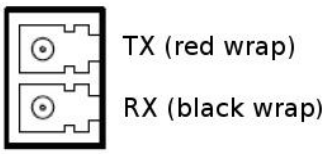
MECHANICAL SPECS

Series: SFF Transceivers.

Type: FTLF8519F-2KNL (LC connectors).

Manufacturer: FINISAR.

PINOUT



LINK LEDs (GREEN/YELOW): right LED (GREEN) indicates the network presence, while left LED (YELLOW) signals the data transfer activity.

USB PORT

FUNCTION

USB connector for data readout and slow control.

ELECTRICAL SPECS

Standard: compliant to USB 2.0 and USB 1.0.

Transfer rate: up to 30 MB/s.

MECHANICAL SPECS

Series: USB connectors.

Type: 787780-2 (B-Type).

Manufacturer: AMP Inc.

USB LINK LED (GREEN): indicates the USB communication is active.

DIAGNOSTICS LEDs

TTL (GREEN): indicates GPO, TRG IN, and GPI signals are TTL;

NIM (GREEN): indicates GPO, TRG IN, and GPI signals are NIM;

PLL LOCK (GREEN): indicates PLL is locked to the reference clock;

PLL BYPS (GREEN): indicates the PLL drives directly the ADCs. PLL circuit is switched off and PLL LOCK LED is turned off;

RUN (GREEN): indicates the acquisition is running (data taking). Please, refer to the ACQUISITION_STATUS register description, Chapter 8 of **[RD3]**).

TRG (GREEN): indicates the trigger is accepted.

DRDY (GREEN): indicates the event/data is present in the Output Buffer.

BUSY (RED): indicates all the buffers are full for at least one channel.

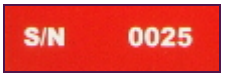
IDENTIFYING LABEL

FUNCTION

Board's identifying label indicating:

- the model;
- the functional description

SERIAL NUMBER LABEL



FUNCTION

Board's Serial Number

Rear Panel

Fig. 5.2: Rear Panel

PREAMPLIFIER I/Os

FUNCTION

I/O connectors for the preamplifiers power supply.

ELECTRICAL SPECS

See § **2**

MECHANICAL SPECS

Series: HD20 connectors.

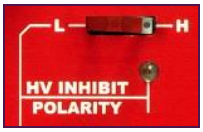
Type: 5747150-2 (D-Sub, female, 9-pole) with clips 5552561-3.

Manufacturer: TYCO Electronics.

PINOUT

See Chapter **0**

INHIBIT POLARITY SWITCH



FUNCTION

Slide switches for the HV channel inhibit polarity setting.

ELECTRICAL SPECS

Active high level range: +2 V ÷ + 24 V.

Active low level range: -24 V ÷ -2 V.

MECHANICAL SPECS

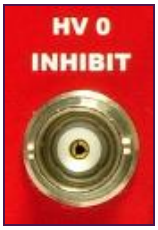
Series: 1K2 slide switches.

Type: 090320102 (1 VIA).

Manufacturer: EAO International.

INHIBIT LED (RED): indicates the status of the inhibit logic. The LED lights up RED in case of inhibit condition.

INHIBIT INPUT



FUNCTION

BNC inputs receiving the HV channels inhibit from the preamplifiers. Inhibit polarity can be selected through a dedicated switch in order to fit the preamplifier's logic.

ELECTRICAL SPECS

Not available.

MECHANICAL SPECS

Series: BNC connectors.

Type: R 141 557 000W.

Manufacturer: RADIALL

Note: The HV channel inhibit input is duplicated on DB9 connectors (see PIN5 description of PREAMPLIFIER I/Os above).

6 Detector & PREAMP Power Supply

Detector Power Supply

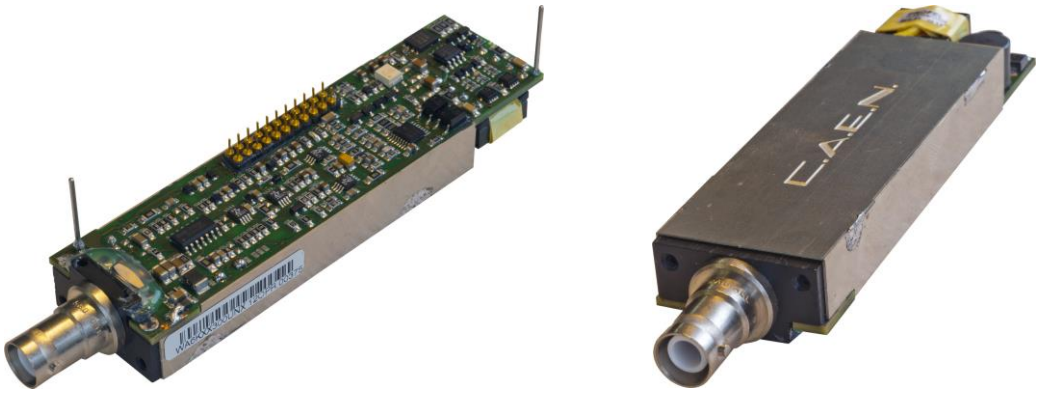


Fig. 6.1: HV output component

The Dual Digital MCA houses High Voltage (HV) outputs to power supply up to two detectors (the HV component is shown in **Fig. 6.1**). The board is orderable with either positive, negative or mixed polarity (see **Tab. 1.1**). HV outputs are delivered through SHV connectors.

Model	HV output	Detectors
N6780	±5 kV / 300 µA	HPGe and other high energy resolution detectors; NaI and other PMT-based detectors

Tab. 6.1: HV channel and detectors association table

The HV output RAMP-UP and RAMP-DOWN rates may be selected independently for each channel in the 1÷ 500 V/s range in steps of 1 V/s for the N6780. Other HV specifications are detailed in § **2**.

Note: HV parameters can be configured and monitored through the CAEN provided MAC^2 Analyzer and DPP-PHA Control Software(see § **9**).

Detector Power Supply Inhibit

Inhibit signal coming from the detector is accepted as input on the DB9 preamp connector and duplicated on a dedicated BNC connector (see § **0**). This causes the HV power supply shut down in event of detector's warming over its safe operating temperature. The polarity can be High or Low, hardware selectable through an external switch:

- Positive Polarity (H): the enabling condition is an open circuit or active high (+2 V ÷ + 24 V); inhibit condition is ground or active low (-24 V ÷ -2 V).
- Negative Polarity (L): the enabling condition is ground or active low (-24 V ÷ -2 V); inhibit condition is an open circuit or active high (+2 V ÷ + 24 V).

When the inhibit condition is detected, the related HV output is switched off roughly (KILL) or stepwise (RAMP).

Additional Features

The HV output electronics provide additional safety features like **OverVoltage** and **UnderVoltage** warning when the output voltage differs from the programmed value by more than 1% of the full scale nominal value (i.e. 50V), as well as protection features which cause the switching off of the detector power supply roughly (KILL) or stepwise (RAMP) in event of HV output's **OverCurrent** or **OverTemperature** detection if a HV output tries to draw a current larger than its programmed limit or its temperature is over the safety limit.

PREAMP Power Supply

N6780 is equipped with 2 Low Voltage Power Supply outputs for preamplifiers, providing: ±12 V / 100 mA or ±24 V / 50 mA on DB9 female connectors. Detailed technical specifications are reported in **Tab. 2.1**.

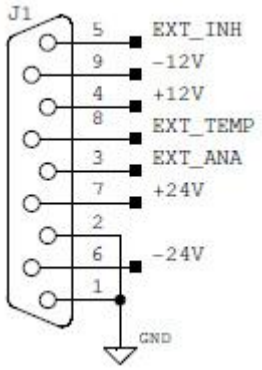


Fig. 6.2: DB9 connector pinout

PINOUT DESCRIPTION:

PIN1-2: ground.

PIN3: spare external analog input with 0 ÷ 10 V dynamics.

PIN4: +12 V / 100 mA power supply output.

PIN5: HV power supply external inhibit input. Inhibit polarity can be selected through a dedicated switch in order to fit the preamplifier's logic (see the description of INHIBIT POLARITY SWITCH above).

Note: The HV power supply inhibit input is duplicated on dedicated BNC connectors.

PIN6: -24 V / 50 mA power supply output.

PIN7: +24 V / 50 mA power supply output.

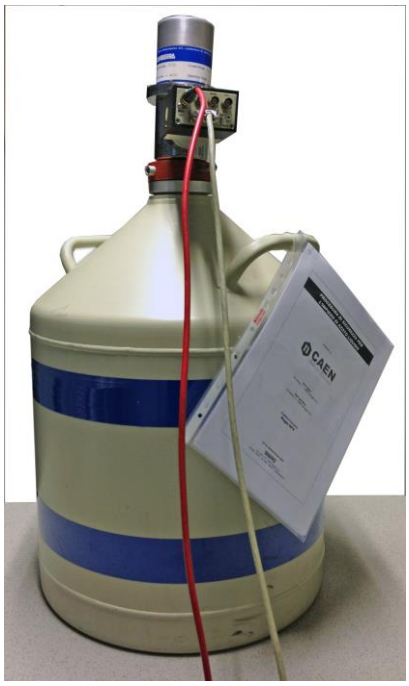
PIN8: external input for detector's temperature readout from a PT100 or PT1000 sensor model **(currently not managed by the DPP-PHA Control Software and MC² Analyzer)**.

PIN9: -12 V / 100 mA power supply output.

Wiring Example

The following wiring example shows the standard connections between a N6780 and a HPGe detector mounting a CSP.

A



B

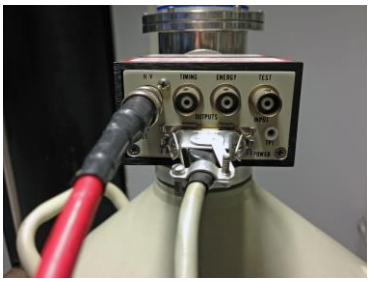
Fig. 6.3: HPGe detector (A) with the integrated CSP (B)

Required cable types:

SHV cable	DB9-connector PREAMP cable
	
	

Tab. 6.2: Table of cables for HV and PREAMP connection

Connections overview:

DT5780		PREAMP	
P1			
	SHV cable connection on the MCA side		SHV cable connection on the PREAMP side
P2			
	PREAMP cable connection on the MCA side		PREAMP cable connection on the PREAMP side

Tab. 6.3: Table of connections

The HV settings and monitoring parameters are managed by the *HV Channels* tab of the MC² Analyzer software (see Chapter **9**).

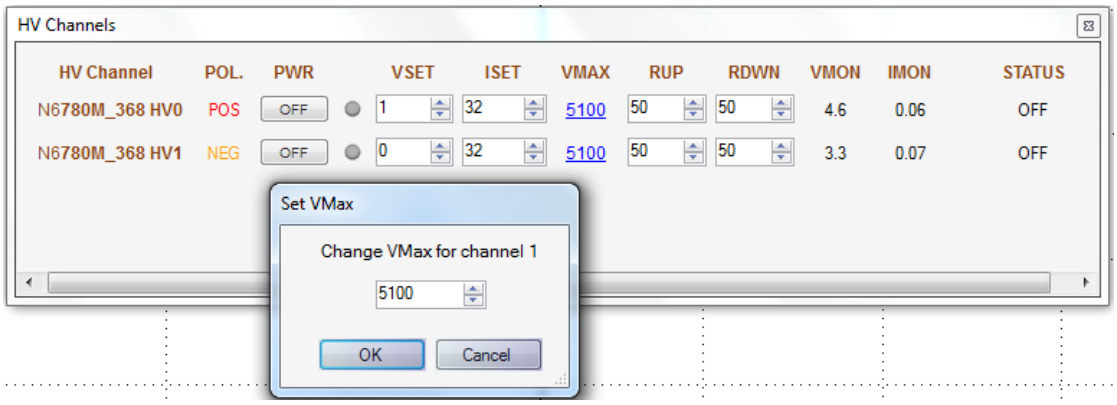


Fig. 6.4: Typical view of the HV configuration section in the MC² Analyzer software

7 Notes on Operating

The N6780 operates on the analog signals provided on its 2/4 inputs the same as a N6724 module equipped with a DPP-PHA Firmware for the Digital Pulse Height Analysis.

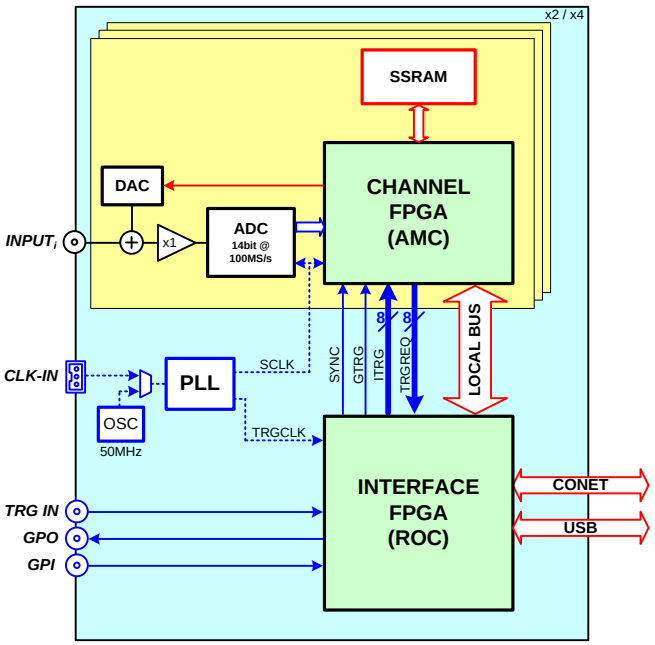


Fig. 7.1: Simplified block diagram of the digitizer block in the N6780

The N6780 is an acquisition system that receives the analog signal and performs a continuous A/D conversion (@100 MS/s, 14 bit) at the input of the module, just after an analog input stage whose purpose is to adapt the signal voltage swing to the dynamic range of the ADC. After the A/D conversion, the stream of samples is managed by an FPGA programmed to perform on-line Digital Pulse Processing in order to implement the MCA based on the Pulse Height Analysis (**DPP-PHA**); the algorithms implemented in the DPP-PHA firmware are based on the trapezoidal filter (Moving Window Deconvolution) for the calculation of the pulse height.

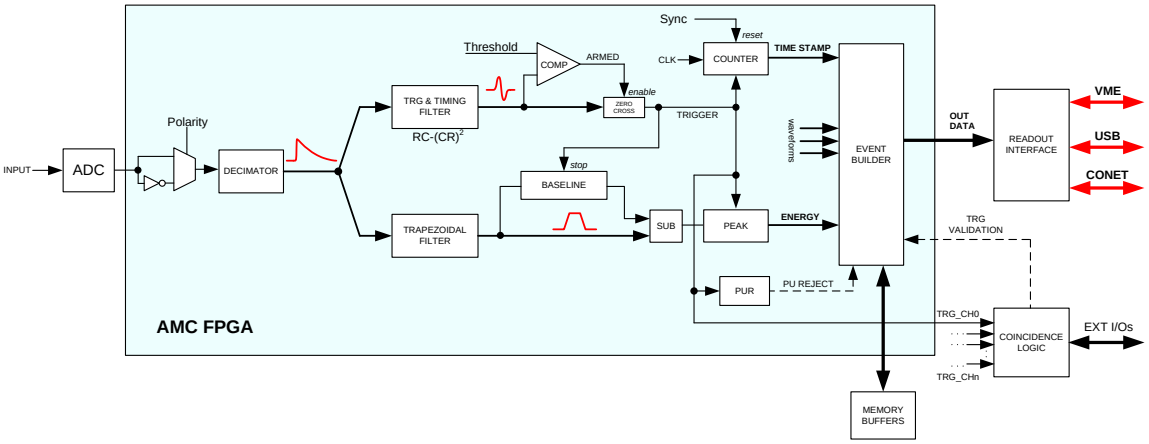


Fig. 7.2: Block Diagram of the processing chain programmed into the digitizer's FPGA

Refer to **[RD11]** for a detailed description of:

- Principle of operation of the DPP-PHA Firmware.
- Acquisition modes supported at firmware level
- Memory organization

8 Drivers & Libraries

Drivers

In order to interface with the N6780, CAEN provides the drivers for all the different types of physical communication channels featured by the N6780 and compliant with Windows and Linux OS:

- **USB 2.0 Drivers** are downloadable on CAEN website (www.caen.it) in the "Software/Firmware" tab at the N6780 web page (**login required**):

Note: For Microsoft Windows OS, the USB drivers installation is detailed in **[RD4]**.

- **Optical Link Drivers** are managed by the A2818 PCI card or the A3818 PCIe card. The driver installation package is available on CAEN website (www.caen.it) in the "Software/Firmware" tab at the A2818 or A3818 web page (**login required**):

Note: For the installation of the Optical Link drivers, refer to the User Manual of the specific Controller.

Libraries

CAEN libraries are a set of middleware software required by CAEN software tools (including MC²A) for a correct functioning. These libraries, including also demo and example programs, represent a powerful base for users who want to develop customized applications for the digitizer control (communication, configuration, readout, etc.):

- **CAENDigitizer** is a library of functions designed specifically for the Digitizer family and it supports also the boards running the DPP firmware, as it happens in the N6780. The CAENDigitizer library is based on the CAENComm library. For this reason, **the CAENComm library must be already installed on the host PC before installing the CAENDigitizer**.

  The CAENDigitizer installation package is available on CAEN website (www.caen.it) in the "Download" tab at the CAENdigitizer Library page. Reference document: **[RD7]**.

- **CAENComm** library manages the communication at low level (read and write access). The purpose of the CAENComm is to implement a common interface to the higher software layers, masking the details of the physical channel and its protocol, thus making the libraries and applications that rely on the CAENComm independent from the physical layer. Moreover, the CAENComm requires the CAENVMELib library (access to the VME bus) even in the cases where the VME is not used. This is the reason why **CAENVMELib has to be already installed on your PC before installing the CAENComm**.

  The CAENComm installation package is available on CAEN website (www.caen.it) in the "Download" tab at the CAENComm Library page. Reference Document: **[RD8]**.

- **CAENDPP** is a high level library of C functions designed to completely control exclusively the digitizers running the DPP-PHA firmware.

  The CAENDPP installation package is available on CAEN website (www.caen.it) in the "Download" tab at the CAENDPP Library page. Reference document: **[RD9]**.

Note: For Windows only, all libraries are automatically installed through the standalone MC²A control software setup. User developing their own software, must install the required CAEN libraries apart.

As far as the N6780 is concerned, the supported communication channels are the following:

PC → USB → N6780

PC → PCI (A2818) → CONET → N6780

PC → PCIe (A3818) → CONET → N6780

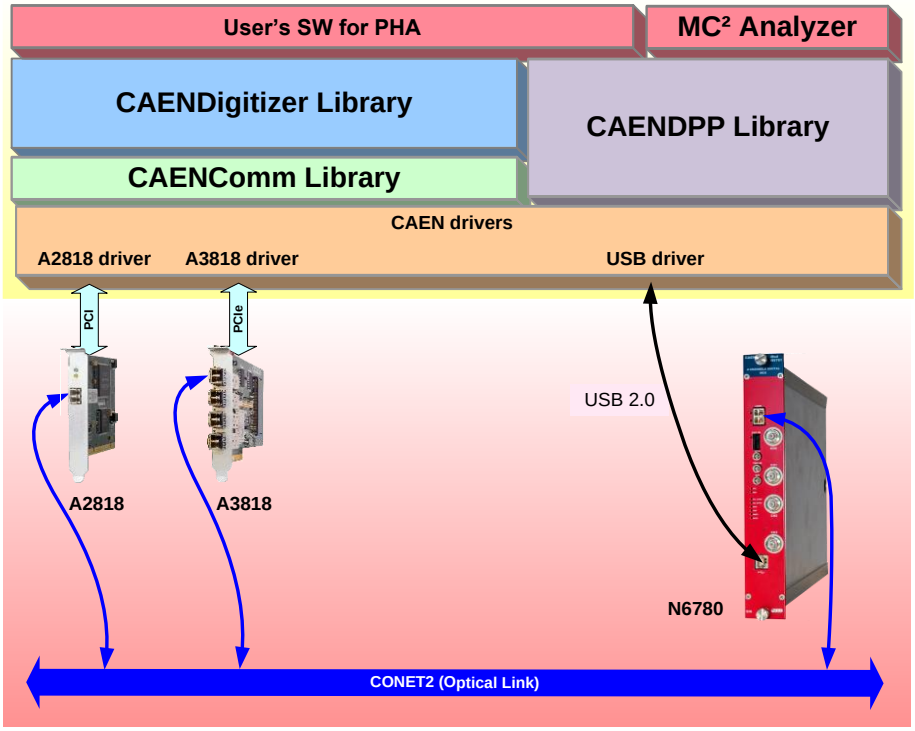


Fig. 8.1: Hardware and software layers scheme

9 Software Tools

CAEN provides software tools to interface the N6780, which are available for free download on www.caen.it at:

Home / Products / Firmware/Software / Digitizer Software

MC² Analyzer (MC²A)

MC² Analyzer (MC²A) is a software specifically designed for x780 Dual Digital MCA, x781 Dual/Quad Digital MCA or digitizers running the DPP-PHA (Digital Pulse Processing for the Pulse Height Analysis) firmware like 724 and 730 families.

The software is able to completely control and manage a set of boards acquiring data simultaneously, making therefore a multi-board system a "Multichannel - Multichannel Analyzer".

MC²A allows the user to set all the relevant DPP-PHA parameters for each acquisition channel (like trigger threshold, shaping parameters, etc.), handle the communication with the connected boards, run the data acquisition and plot both waveforms for on-line monitoring of the acquisition and histograms. It can also control the HV power supplies provided in the x780.

Moreover, it is able to perform advanced mathematical analysis on both the ongoing histograms and collected spectra: peak search, background subtraction, peak fitting, energy calibration, ROI selection, dead time compensation, histogram rebin and other features available.

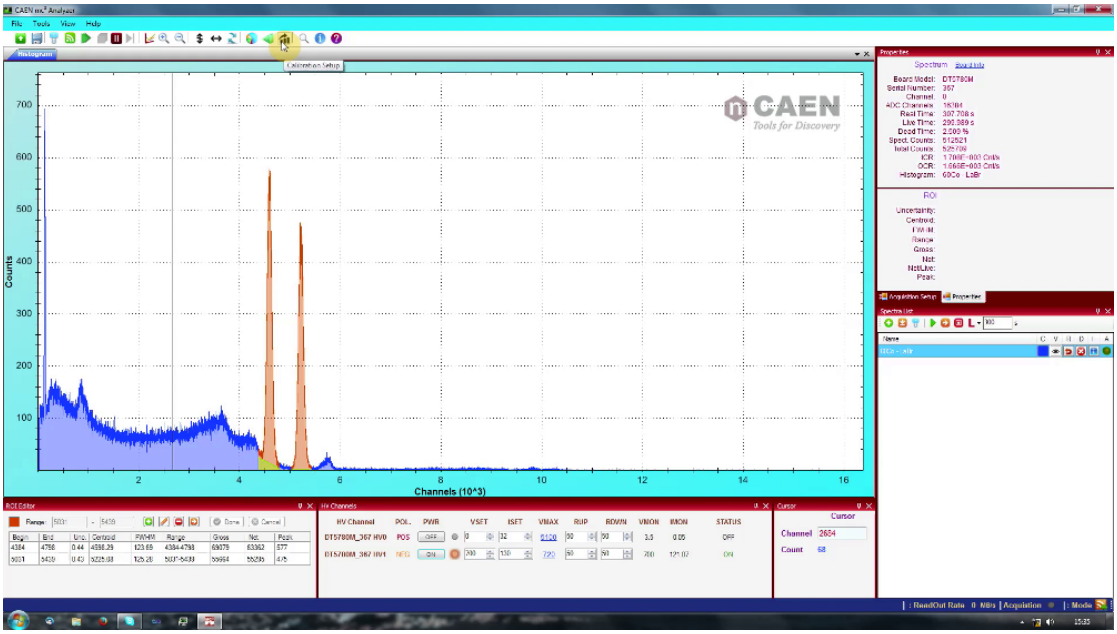


Fig. 9.1: MC² Analyzer (MC²A) software tool

MC² Analyzer is currently available only for Windows platforms. The installation package can be downloaded on CAEN web site (www.caen.it) at:

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

The reference document for installation instructions and program detailed description is **[RD11]**.

Note: Windows version of MC² Analyzer is stand-alone (the required libraries are installed locally with the program; only the communication driver must be installed apart by the user).

CAENUpgrader

CAENUpgrader is a free software composed of command line tools together with a Java Graphical User Interface.

Specifically for the N6780, CAENUpgrader allows in few easy steps to:

- Upload different FPGA firmware versions on the board
- Read the firmware release of the board and the PCI or PCIe controller eventually used with
- Upgrade the internal PLL (firmware file that can only be provided on demand by CAEN)
- Get the Board Info file, useful in case of support

CAENUpgrader can operate with Windows and Linux, 32 and 64-bit OS.

The program requires additional software to be installed: CAENComm and CAENVMELib libraries (see § **8**), and the third-party Java SE6 (or later).

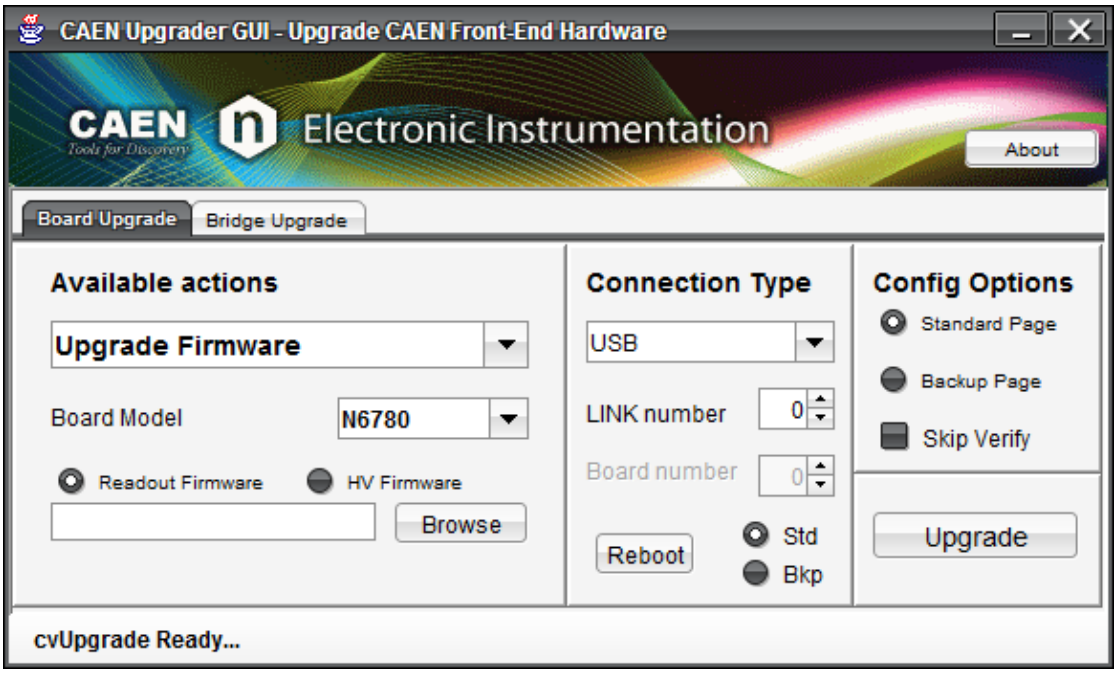


Fig. 9.2: CAENUpgrader Graphical User Interface

CAENUpgrader installation package can be downloaded on CAEN web site (www.caen.it) at:

Home / Products / Firmware/Software / Digitizer Software / Configuration Tools

The reference document for installation instructions and program detailed description is **[RD1]**.

Note: Windows version of CAENUpgrader is stand-alone (the required libraries are installed locally with the program), while the version for Linux needs the required libraries to be already installed apart by the user.

CAENComm Demo

CAENComm Demo is a simple program developed in C/C++ source code and provided both with Java and LabVIEW GUI interface. The demo mainly allows for a full board configuration at low level by direct read/write access to the registers and may be used as a debug instrument.

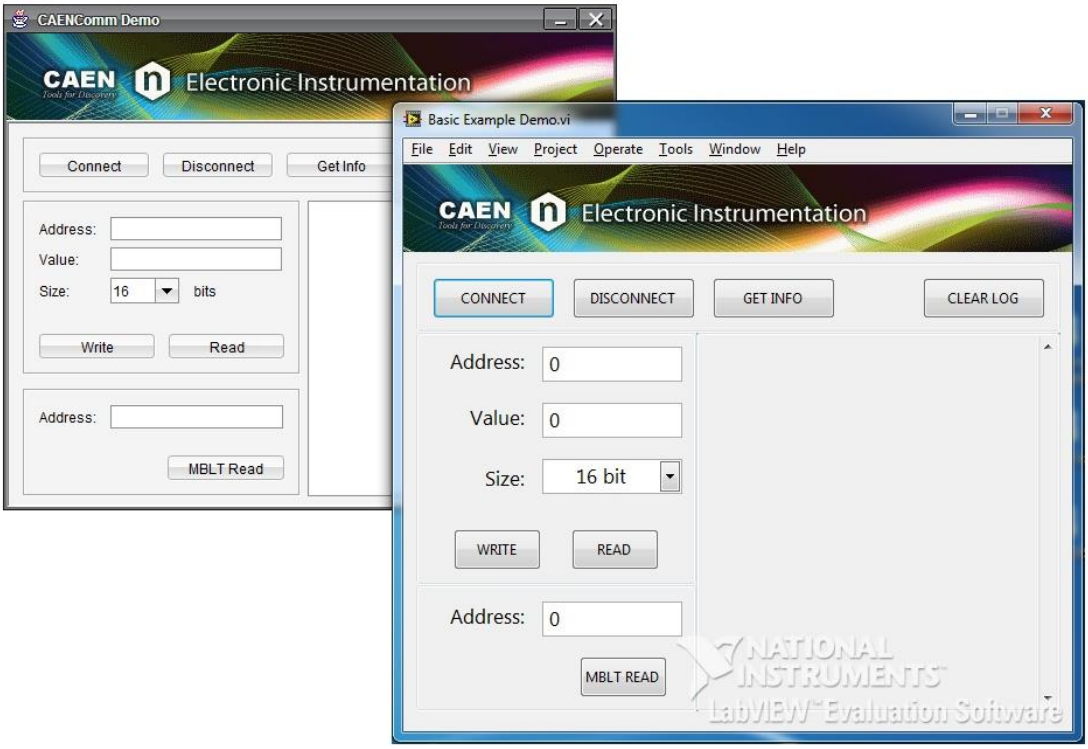


Fig. 9.3: CAENComm Demo Java and LabVIEW graphical interface

CAENComm Demo can operate with Windows OSs, 32 and 64-bit. It requires CAENComm and CAEVMElib libraries as additional software to be installed (see § **8**).

The Demo is included in the CAENComm library installation Windows package, which can be downloaded on CAEN web site (**login required**) at:

Home / Products / Firmware/Software / Digitizer Software / Software Libraries / CAENComm Library

10 HW Installation

- The Module fits into all NIM crates.
- **Use only crates with forced cooling air flow**
- Turn the crate OFF before board insertion/removal
- Remove all cables connected to the front panel before board insertion/removal

CAUTION: this product needs proper cooling:

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

CAUTION: this product needs proper handling.

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

Power ON Sequence

To power on the board, follow this procedure:

1. Insert the module into the crate
2. Power up the crate

Power ON Status

At Power-On, the module is in the following status:

- the Output Buffer is cleared;
- registers are set to their default configuration

After the Power-On, the front panel LEDs status is that only the **NIM** and **PLL LOCK** remain ON (see Fig. **10.1**)

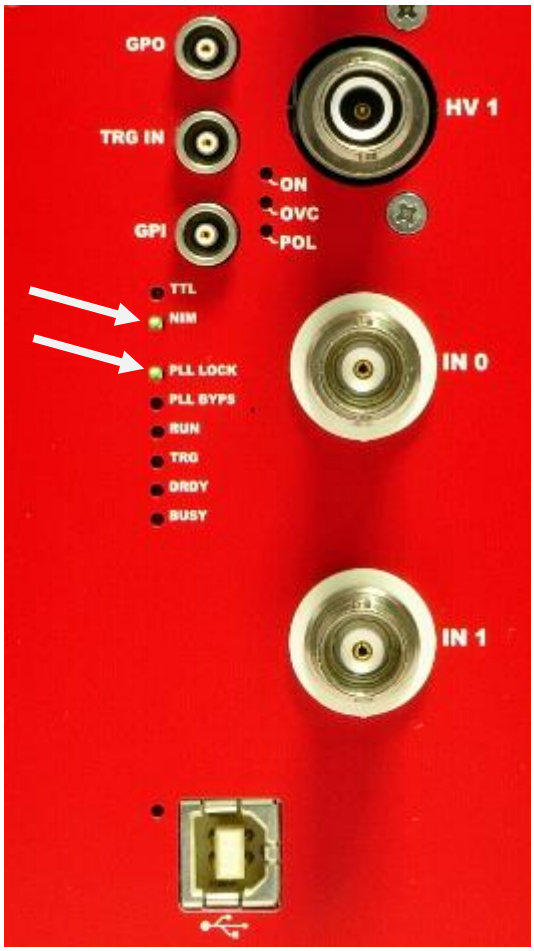


Fig. 10.1: Front panel LEDs status at Power-On

11 Firmware and Upgrades

The N6780 is delivered running a licensed version (i.e. not time limited) of the DPP-PHA Firmware. This means that no license needs to be bought apart by the user when purchasing a N6780.

Firmware updates are available for download on CAEN website (www.caen.it) in the “Software/Firmware” tab at the N6780 web page **(login required)**:

Home / Products / Spectroscopy Solutions / Digital Multi Channel Analyzers / Multi Channel Analyzers / N6780

Note: Upgrades of a DPP-PHA firmware file on the N6780 don’t have effect on the license validity.

The board hosts one FPGA on the mainboard and two FPGAs on the mezzanine (i.e. each FPGA serves 2 channels). The channel FPGAs firmware is identical. A unique file is provided that will updated all the FPGAs at the same time.

ROC FPGA MAINBOARD FPGA (Readout Controller + VME interface):

FPGA Altera Cyclone EP1C20.

AMC FPGA CHANNEL FPGA (ADC readout/Memory Controller):

FPGA Altera Cyclone EP1C20

The firmware is stored onto on-board FLASH memory. Two copies of the firmware are stored in two different pages of the FLASH, called Standard (STD) and Backup (BKP); at power on, a microcontroller reads the FLASH memory and programs the module with the firmware version that is the STD one by default.

It is possible to upgrade the board firmware via USB or Optical Link by writing the FLASH with the CAENUpgrader software (see § **9**)

IT IS STRONGLY SUGGESTED TO OPERATE THE DIGITIZER UPON THE STD COPY OF THE FIRMWARE. UPGRADES ARE SO RECOMMENDED ONLY ON THE STD PAGE OF THE FLASH. THE BKP COPY IS TO BE INTENDED ONLY FOR RECOVERY USAGE. IF BOTH PAGES RESULT CORRUPTED, THE USER WILL NO LONGER BE ABLE TO UPLOAD THE FIRMWARE VIA USB OR OPTICAL LINK AGAIN AND THE BOARD NEEDS TO BE SENT TO CAEN IN REPAIR!

In case of failures while programming the STD page of the FLASH, which compromise the communication with the N6780, the user can perform the following recovering procedure as first attempt:

- Force the board to reboot loading the copy of the firmware stored on the BKP page of the FLASH. For this purpose, the DeskBoot CAEN utility can be used (available for download on CAEN website) or the Reboot option in CAENUpgrader software tool (see § **9**). USB link is needed in both events (Deskboot and the Reboot of CAENupgrader don’t work with optical link)

- Without power-cycling the board, use CAENUpgrader to read the firmware revision (in this case the one of the BKP copy). If this succeeds, it is possible now to communicate again with the board.

- Use CAENupgrader to load again the firmware on the STD page, then power-cycle in order the board to get operative again.

The detailed communication recovery procedure based on this program is described in **[RD5]**. In case also this procedure fails, the board needs to be sent back to CAEN in repair (see § **12**).

Firmware File Description

The programming file, that has the extension ***.cfa*** (CAEN Firmware Archive), is a sort of archive format file aggregating all the DPP firmware files compatible with the same family of digitizers.

The firmware file name follows this general scheme:

x724_xx78x_DPP-PHA_rev_X.Y_128.Z.CFA

where:

- x724_xx78x are all the boards the file is compliant to.
- DPP-PHA is the specific digital algorithm implemented into the firmware.
- X.Y is the major/minor revision number of the mainboard FPGA.
- 128.Z is the major/minor revision number of the channel FPGA. Note that the major revision number (128) is fixed for the specific DPP algorithm (PHA).

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 N6780
Dual Digital Multi Channel Analyzer (HV & Preamplifier Power Supply) NIM

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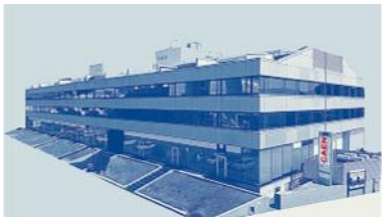

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