CAEN
Tools for Discovery

Electronic Instrumentation

User Manual UM3188

DT5790

Digital Pulse Analyzer

Rev. 0 - 10 July 2014

Purpose of this Manual

This User Manual contains the full description of the DT5790 Digital Pulse Analyzer.

Change Document Record

Date	Revision	Changes
10 July 2014	00	Initial release

Symbols, abbreviated terms and notation

ADC	Analog to Digital Converter
CFD	Constant Fraction Discriminator
DPP	Digital Pulse Processing
DPP-PSD	DPP for Pulse Shape Discrimination
PMT	Photo Multiplier Tube
SiPM	Silicon Photo Multiplier

Reference Documents

[RD1] GD2512 – CAENUpgrader QuickStart Guide

[RD2] UM2580 – Digital Pulse Shape Discriminator User Manual

[RD3] GD2783 – First Installation Guide to Desktop Digitizers & MCA

[RD4] GD2812 – DeskBoot QuickStart Guide

[RD5] GD2827 - How to make coincidences with CAEN digitizers

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

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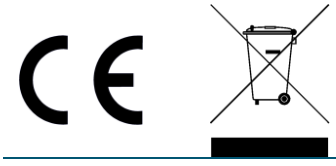

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1 Introduction

The **DT5790** is a complete digital acquisition PSD system for scintillators and other detectors. It is ideally suited for Organic, Inorganic and Liquid Scintillators coupled to photodetectors like PMTs and SiPMs, whose pulses can be directly accepted by the board.

In a compact desktop form factor, the DT5790 houses:

- **250 MS/s 12-bit waveform digitizer** with online Digital Pulse processing capability. Two single ended analog inputs on BNC connectors, 2 V_{pp} of input dynamics and adjustable DC offset via a 16-bit DAC on each channel in the full range.
- **2x ±4 kV 3 mA (4 W max.) bias outputs** on SHV connectors. Channel polarity NEGATIVE, POSITIVE or MIXED selectable by ordering options (**Tab. 1.1**).
- **2x ±12 V 100 mA** and **2x ±24 V 50 mA PREAMP bias outputs** through DB9 connectors for preamplifiers power supply.

The waveform digitizer operates upon the **DPP-PSD** firmware, developed for **Charge Integration** and **Pulse Shape Discrimination**. DPP-PSD is based on an advanced online **Digital Dual Gate Charge Integration** allowing an effective data analysis even at high count rate. It performs input signal baseline calculation, self-triggering and double-gate charge integration with programmable parameters, double integration of both prompt and total charge for Pulse Shape Discrimination and pedestal subtraction for energy calculation.

CAEN provides the DPP-PSD Control Software (see § **9**) to control the DT5790 Digital Pulse Analyzer, as well as a set of C and LabVIEW libraries with demos and examples for developers.

The DT5790 acquisition modes allows to:

- Acquire waveforms, either input signals or the outputs of the internal digital filters, for monitoring and parameters tuning (Oscilloscope Mode).
- Store parameters like charge and time stamp, extracted from the pulse (List Mode).
- Store waveforms and parameters all at once (Mixed Mode, **not managed by the provided DPP-PSD Control Software**).

According to the programmed mode, the relevant data can be available for the software to plot online the waveforms, or to build up charge and time histograms and PSD plots.

Thanks to the 2-input simultaneous acquisition, the DT5790 is able to manage coincidences and anti-coincidences between a pair of detectors, allowing the user, for example, to easily take advantage of background rejection or anti-Compton techniques.

The module has been designed to operate as a scalable multi-input – multi-board acquisition system, offering synchronization capabilities. A CLK IN front panel connector is provided to synchronize the clocks from different boards, as well as digital I/Os can serve for trigger propagation and Start/Stop acquisition management.

The DT5790 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 DT5790 modules to a single Optical Link Controller (Mod. A2818/A3818).

The following list summarizes what can be done by the DT5790 at firmware level and by the relevant DPP-PSD Control Software:

- receive the signals directly coming from Organic, Inorganic and Liquid Scintillators coupled to photodetectors, like PMTs and SiPMs, and digitize them continuously at 250 MS/s;
- Adapt the input pulses to the dynamic by the programmable DC Offset
- calculate the baseline and subtract it from the input signal;
- detect input pulses and generate a local trigger on them;
- calculate the time of arrival of the trigger, perform a dual gate charge integration;
- build an event, according to the readout mode, made of a configurable combination of Trigger Time Stamp, Prompt Charge, Total Charge, or raw waveforms;
- detect and reject pile-up events **(not managed by the provided DPP-PSD Control Software**);
- implement coincidences and anti-coincidences between channels of the same board (refer to **[RD5]**), as well as among channels of different boards through the external trigger and external modules;

- store events (waveforms or lists of charges and time stamp) into a memory buffer and manage the readout through the Optical Link or USB;
- Apply an event suppression based on the PSD value in order to eliminate those events that are identified, for instance, as gammas while the acquisition is looking for neutrons only. This technique can significantly reduce the throughput rate in case of neutron detection in a very high rate gamma field;

Events can be read by the DPP-PSD Control Software, which allows to:

- accumulate, plot and save the histograms (energy spectra associated to Total Charge parameter over 16k bins) from each channel;
- visualize the PSD 2-D Scatter Plot from each channel;
- generate output files (lists, histograms or waveforms) in a binary or ASCII format;
- run the Oscilloscope Mode 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 and monitor the HV power supply of up to two detectors;
- power up to two preamplifiers.
- configure the inhibit logic for HV shut down as input from the amplifier.

Table of related items:

Board Model	Description	Product Code
DT5790P	2 Ch. Digital Pulse Analyzer - Positive HV	WDT5790XMAAA
DT5790N	2 Ch. Digital Pulse Analyzer - Negative HV	WDT5790XNAAA
DT5790M	2 Ch. Digital Pulse Analyzer - Mixed HV	WDT5790XPAAA
DPP Firmware	**Description**	**Product Code**
DPP-PSD*(*)*	Digital Pulse Processing for Pulse Height Analysis	WFWDPPNGAA20
Accessory	**Description**	**Product Code**
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

(*) The DT5790 is delivered factory equipped with a licensed version of the DPP-PSD firmware.

2 Technical Specifications

MECHANICAL	**Dimensions** 154 W x 50 H x 164 L mm³ (without connectors) 154 W x 50 H x 194 L mm³ (including connectors)	**Weight** 950 g
ENVIRONMENTAL	**Operational Conditions** 0 – 50°C Temperature Range - EMC compliant	
ANALOG INPUT	**Input Features** ▪ BNC connector ▪ Single ended, DC coupled ▪ Input range: 2 V_{pp} ▪ Impedance: 50 Ω ▪ Positive and negative signals accepted ▪ Bandwidth: DC to 125 MHz ▪ Programmable DC offset adjustment on each input in the full scale range	**Number of Inputs** 2
ADC	**Resolution** 12 bits	**Sampling Rate** 250 MS/s(simultaneously on each input)
DIGITAL SIGNAL PROCESSING	▪ In put baseline calculation and subtraction ▪ Manual trigger threshold adjustment ▪ Dual gate charge integration ▪ Pile-Up detection ▪ Online PSD calculation ▪ Configurable PSD threshold for Neutron-Gamma discrimination ▪ Time Stamp: 4 ns resolution, 32 bit	
PREAMPLIFIER POWER SUPPLY	**Preamp 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** ▪ SHV connector ▪ 4 kV V_{set}, 3 mA I_{set} (4 W power limited) ▪ HV polarity configurable by ordering option ▪ V_{set}, V_{mon} resolution: 0.1 V ▪ I_{set},I_{mon} resolution: 0.05 µA ▪ Voltage ripple: 3 mV_{pp} (Typ.), 5 mV_{pp} (Max.) @1kV/500µA 3 mV_{pp} (Typ.), 5 mV_{pp} (Max.) @2kV/1mA 10 mV_{pp} (Typ.), 15 mV_{pp} (Max.) @4kV/1mA ▪ 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 Outputs** 2
OPERATING MODES	▪ Pulse Shape Discrimination (PSD): histogram of Charge Long (16k) and 2-D scatter plot of PSD parameter (built at software level) ▪ List mode: total charge, prompt charge 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	**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

	TRG-IN (LEMO) External Trigger Input: NIM/TTL, Z_{in} = 50 Ω Can be used either to force the event acquisition from all the channels of the board, or to gate/veto the individual channel self-triggers, or in coincidence/anti-coincidence with the self-triggers, or to propagate the common trigger in multi-board synchronization (in combination with GPO).	**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	Controlled by the DPP-PSD Control Software For developers: general purpose C libraries with demo samples available	
POWER REQUIREMENTS	Operating Supply Voltage: +12 VDC ± 10% Consumptions (@ +12 VDC): 3.2 A (Typ.) with maximum current charge on preamps outputs and 1 kV / 1 mA (1 W) charge on HV outputs; ± 10% tolerance. Power supply unit (+12 VDC, 45 W) included in the kit	

Tab. 2.1: DT5790 Specifications Table

3 Packaging and Compliancy

The unit is a Desktop module housed in an alloy box (weight: 950 g) with the following dimension:

154 W x 50 H x 164 L mm³ (connectors encumbrance not included)

154 W x 50 H x 194 L mm³ (including connectors)

Fig. 3.1: DT5790 front view

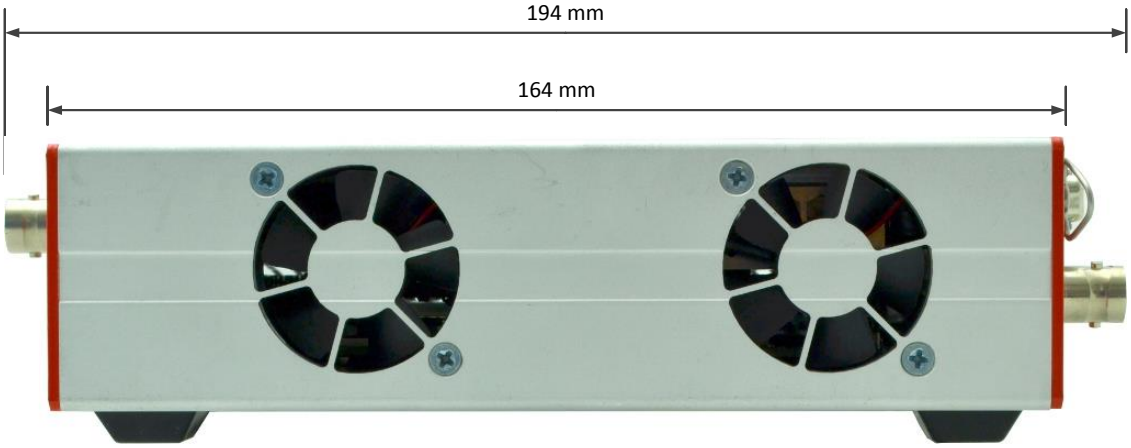


Fig. 3.2: DT5790 side view

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

A potential risk exists if the operating instructions are not followed!

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

4 Power Requirements

The module is powered by the external AC/DC stabilized power supply included in the delivered kit (12 VDC, 3.75 A, 45 W).

Tab. 4.1 reports the recommended supply voltage operating conditions and the current consumptions.

	OPERATING SUPPLY VOLTAGE (nominal)	CONSUMPTIONS (@ +12 VDC)
DT5781	+12 VDC ± 10%	3.2 A(*) (Typ.) ± 10%

(*) measured with maximum current charge on preamps outputs and 1 kV / 1 mA (1 W) charge on HV outputs

Tab. 4.1: Power requirements table

Note: Using a different power supply source, like battery or linear type, it is recommended the source to provide +12 VDC and at least 3.75 A (as for the provided power supply unit); the power jack is a 2.1 mm type, a suitable cable is the RS 656-3816 type (or similar).

Fig. 4.1: AC/DC power supply provided with the DT5790 kit

5 Panels Description

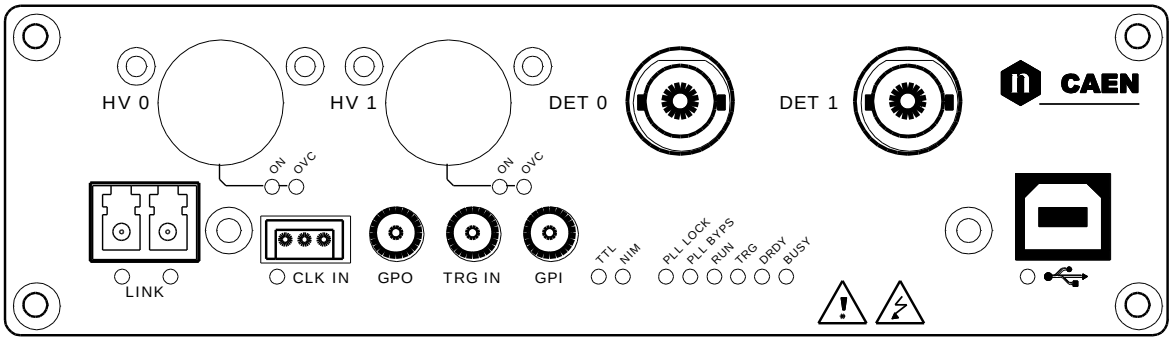


Fig. 5.1: DT5790 front panel view

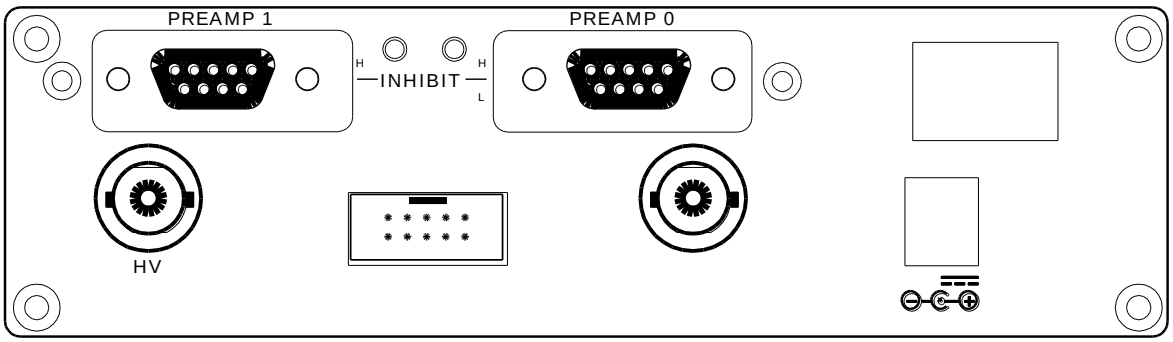


Fig. 5.2: DT5790 rear panel view

Front Panel

ANALOG INPUT

FUNCTION

Input connectors receiving the analog signals from the detector.

ELECTRICAL SPECS

Input dynamics: 2 V

Input impedance (Z_{in}): 50 Ω.

MECHANICAL SPECS

Series: BNC connectors.

Type: R 141 557 000W.

Manufacturer: RADIALL.

HV OUTPUT

FUNCTION

Output connectors providing HV power supply to up to detectors.

ELECTRICAL SPECS

See § **2**

MECHANICAL SPECS

Series: SHV connectors.

Type: R 317 580.

Manufacturer: RADIALL.

HV LEDs (YELLOW/RED): LED **ON** lights up RED (in case of positive output) or YELLOW (in case of negative output) when the output is active; LED **OVC** lights up RED if the output goes in overcurrent.

POLARITY LABEL: POSITIVE (positive HV output); **NEGATIVE** (negative HV output).

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.

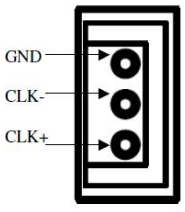
MECHANICAL SPECS

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

Input for the external trigger.

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 connector. 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 flow 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.

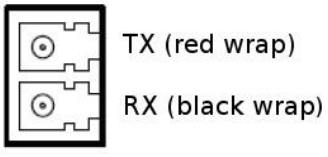
MECHANICAL SPECS

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 flow 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 **[RD2]**).

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.

HAZARD SYMBOLS

CAUTION: indicates the need to consult the operating instructions 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

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 § **6**

INHIBIT POLARITY SWITCH

FUNCTION

Slide switches for the HV output 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 output 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).

SPARE LINK

FUNCTION

Auxiliary connector reserved for CAEN usage.

ELECTRICAL SPECS

Not available.

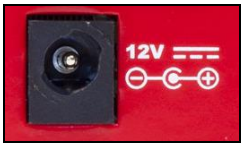
MECHANICAL SPECS

Series: Header connectors.

Type: 7610-5002-5+5.

Manufacturer: 3M.

DC INPUT



FUNCTION

Input power supply (+12 VDC).

ELECTRICAL SPECS

See § **4**.

MECHANICAL SPECS

Series: CC power supply connectors

Type: KLDX-0202-A-LT (DC power jack).

Manufacturer: KYCON

PINOUT

ON/OFF SWITCH

FUNCTION

Panel switch for module power supply ON/OFF:

O → power supply OFF.

I → power supply ON.

ELECTRICAL SPECS

Not available.

MECHANICAL SPECS

Series: A1 switches.

Type: A11331122000 (Single pole two way)

Manufacturer: Molveno.

IDENTIFYING LABEL

FUNCTION

Board's identifying label indicating:

- the model;
- the serial number (S/N);
- the symbol of the CE conformity marking.

6 Detector & PREAMP Power Supply

Detector Power Supply

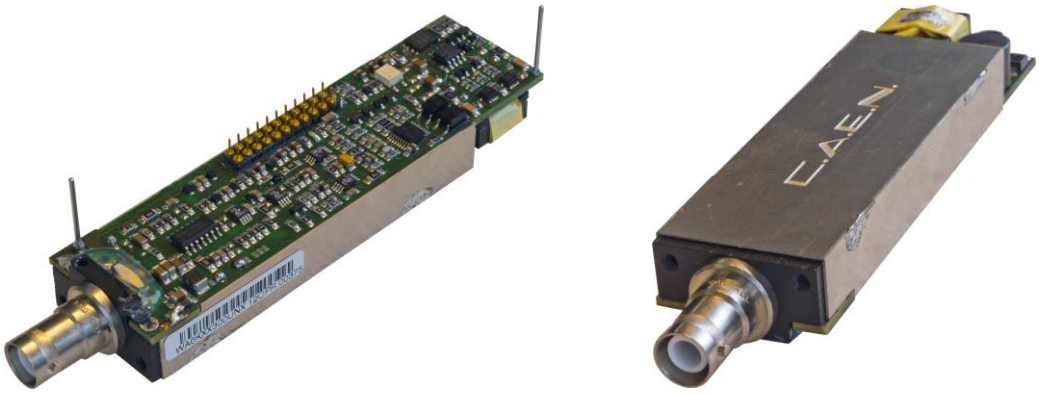


Fig. 6.1: HV output component

The Digital Pulse Analyzer houses High Voltage (HV) Power Supply outputs (4 kV, 3 mA, limited to 4 W) to power supply up to two detectors (the HV component is shown in **Fig. 6.1)**. DT5790 is orderable with either positive, negative or mixed polarity (see **Tab. 1.1**). HV outputs are delivered through SHV connectors.

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. Other HV specifications are detailed in § **2**.

Note: HV channels parameters can be configured and monitored through the CAEN DPP-PSD 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 § **5**). 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 provides 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. 40V), 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

DT5790 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**.

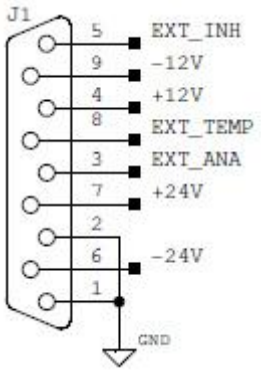


Fig. 6.2: DB9 connector pinout

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 channel 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 channel 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 **(not managed by the DPP-PSD Control Software)**.

PIN9: -12 V / 100 mA power supply output

7 Notes on Digitizer Operating

The DT5790 Digital Pulse Analyzer operates on the analog signals provided on its 2 inputs the same as a CAEN DT5720 digitizer equipped with a DPP-PSD Firmware for the Digital Pulse Shape Discrimination.

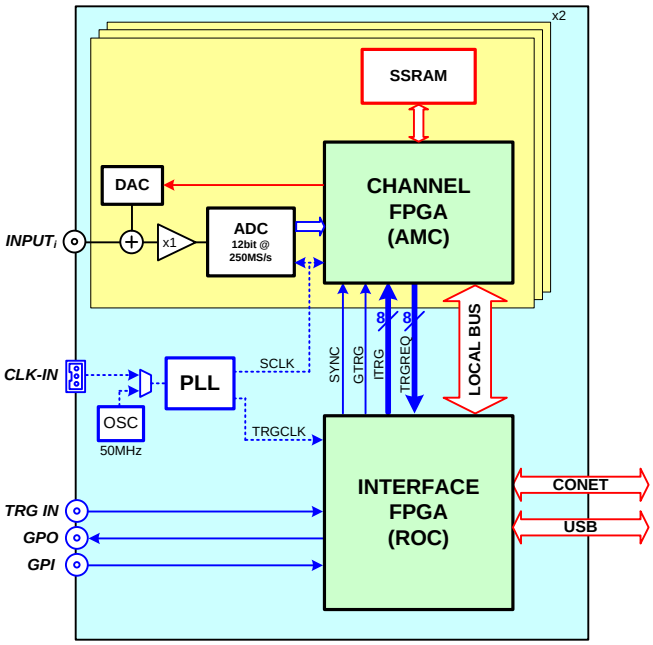


Fig. 7.1: Simplified block diagram of the digitizer block in the DT5790

The DT5790 is an acquisition system that receives the analog signal and performs the A/D conversion (@250 MS/s, 12 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 Digital Pulse Analyzer based on the Pulse Shape Discrimination (**DPP-PSD**); the algorithms implemented in the DPP-PSD firmware are based on the dual gate charge integration for the calculation of the PSD parameter used for the gamma-neutron discrimination.

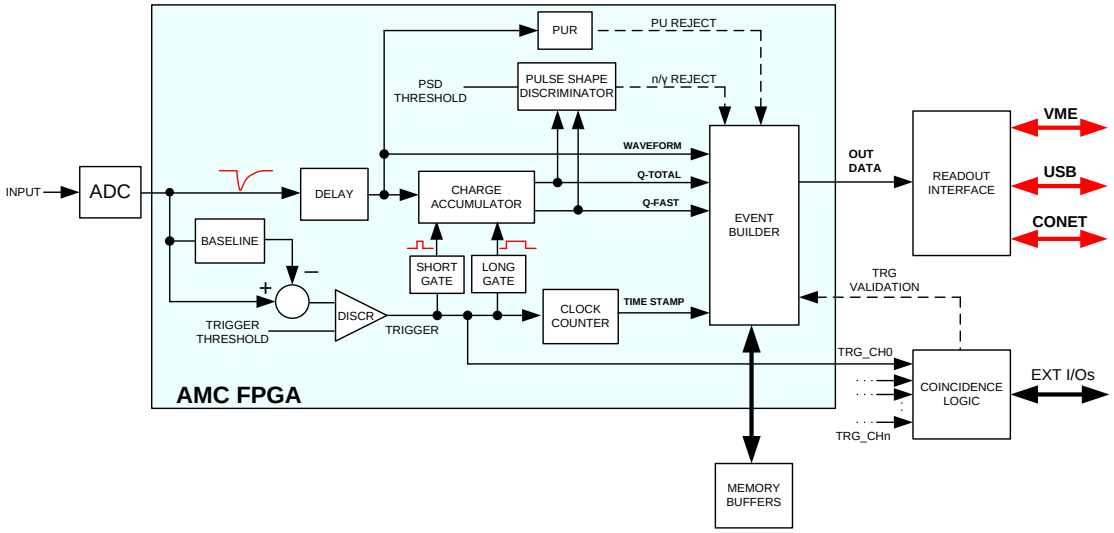


Fig. 7.2: Block Diagram of the processing chain programmed into the digitizer's FPGA

Refer to **[RD2]** for a detailed description of:

- Principle of operation of the DPP-PSD Firmware
- Acquisition modes supported at firmware level and DPP Control Software description
- Memory organization and data format

8 Drivers & Libraries

In order to interface with the DT5790, CAEN provides the drivers for all the different types of physical communication channels featured by the DT5790 and compliant with Windows and Linux OS, as well as a set of C libraries.

Drivers

COMM LINKS	OS	OS VERSION
USB / OPT LINK	Windows	XP / Vista / 7 (32 and 64-bit)
	Linux	kernel Rel. 2.4 / 2.6 / 3.6 / 3.10 / 3.11(*)

(*) Please, refer to the product web page (Board and Bridge) for the specific kernel support

Tab. 8.1: Drivers info table

- **Drivers USB 2.0 compliant**. Drivers updates are downloadable on CAEN website (www.caen.it) in the "Software/Firmware" tab at the DT5790 web page (**login required**):

Home / Products / Spectroscopy Solutions / Digital Systems for Charge Integration / Systems for Charge Integration / DT5790

Overview | Tech. Spec. | Software/Firmware | Compare | Related Products | Ordering Option

Description	Release	Date	OS-Version	Environment	Download
Driver					
DT57xx-N67xx-DT55xx-DT578x Win32 USB Driver[a]	3.4.8	April, 2013	XP, Vista, 7		
Drivers 43.44 KB - Type: .zip					
DT57xx-N67xx-DT55xx-DT578x Win64 USB driver	3.4.3	July, 2013	x64bit XP, x64bit Vista, x64bit 7		
Drivers 37.6 KB - Type: .zip					
DT57xx-N67xx-DT55xx-DT578x-V1718-N957 Linux USB Driver	1.4	January, 2014			
Drivers (Linux kernel 2.6 - 3.6) 7.82 KB - Type: .gz					
Release Notes 3.84 KB - Type: .txt					

Fig. 8.1: Typical view of the drivers download at the DT5790 web page

Note: For Microsoft Windows OSs, the USB drivers installation is detailed in **[RD3]**.

- **Drivers Optical Link CONET 2 compliant**. This drivers are managed by the A2818 PCI card or the A3818 PCIe card. Drivers updates are downloadable on CAEN website (www.caen.it) in the "Software/Firmware" tab at the A2818 or A3818 web page (**login required**):

Home / Products / Modular Pulse Processing Electronics / PCI/PCIe / <Controller>

Overview | Tech. Spec. | Documentation | Software/Firmware | Related Products | Accessories | Ordering Option

Description	Release	Date	OS-Version	Environment	Download
Driver					
A3818 driver	1.5.1	Nov, 2013			
Release Notes 2.65 KB - Type: .txt					
Drivers (Linux kernel 2.6 - 3.11) 23.62 KB - Type: .tgz					
A3818 Win32 Driver(*)	1.2.2	January, 2014	XP, Vista, 7		
Drivers 5.46 MB - Type: .zip					
Release Notes 1.95 KB - Type: .txt					
A3818 Win64 Driver(*)	1.2.2	January, 2014	x64bit XP, x64bit Vista, x64bit 7		
Drivers 6.09 MB - Type: .zip					
Release Notes 1.95 KB - Type: .txt					

Fig. 8.2: Typical view of the drivers download at the A3818 web page.

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

Libraries

CAEN provides a set of libraries required by its DPP-PHA software tools, which are also the basis for users who want to develop their own software.

- **CAENVMELib** is a set of ANSI C functions which permit a user program to use and configure the CAEN Bridges and Controllers V1718/VX1718 (VME-USB2.0 Bridge), V2718/VX2718 (VME-PCI/PCIe Optical Link Bridge), A2818/A3818 (PCI/PCIe-CONET Controller).
- **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 is based in turn on CAENVMElib and it requires the CAENVMELib library (access to the VME bus) even in the cases where the VME is not used.
- **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 DPHA. The CAENDigitizer library is based on the CAENComm which is based on CAENVMELib, as said above.

As far as the DT5790 is concerned, the supported communication channels are the following:

PC → USB → DT5790

PC → PCI (A2818) → CONET → DT5790

PC → PCIe (A3818) → CONET → DT5790

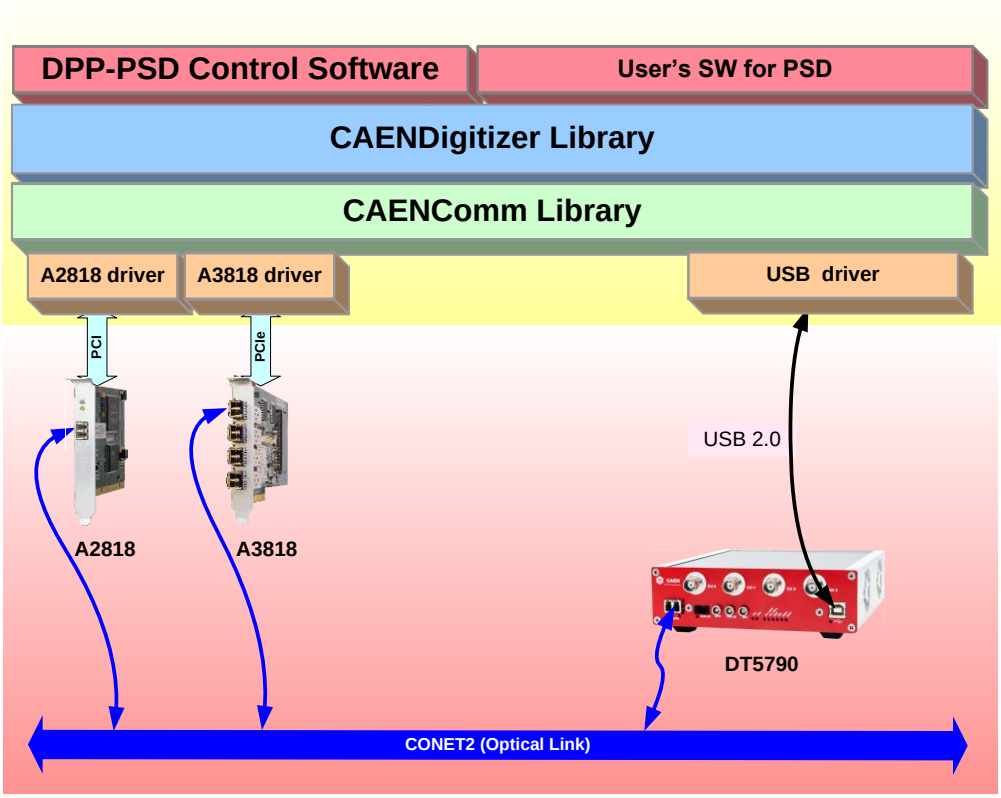


Fig. 8.3: Hardware and software layers scheme

If required to be installed apart by the user (see § **9**), CAEN Libraries are available for download on CAEN web site (www.caen.it) in the "Download" tab at the library web page:

Home / Products / Firmware/Software / Digitizer Software / Software Libraries / <Library>

Install in the order: CAENVMELib → CAENComm library → CAENDigitizer library.

9 Software Tools

CAEN provides software tools to interface the DT5790, which are available for free download on www.caen.it at:

Home / Products / Firmware/Software / Digitizer Software

DPP-PSD Control Software

The DT5790 can be controlled through the **DPP-PSD Control Software**, a software interface for configuration, acquisition, data plotting. It allows the user to set the parameters for the acquisition, to configure the DPP and the HV parameters, to perform the data readout and the HV monitoring, the histogram collection and the spectrum or waveform plotting and saving. The program doesn't feature data analysis, but can be easily interfaced to software tools for offline analysis.

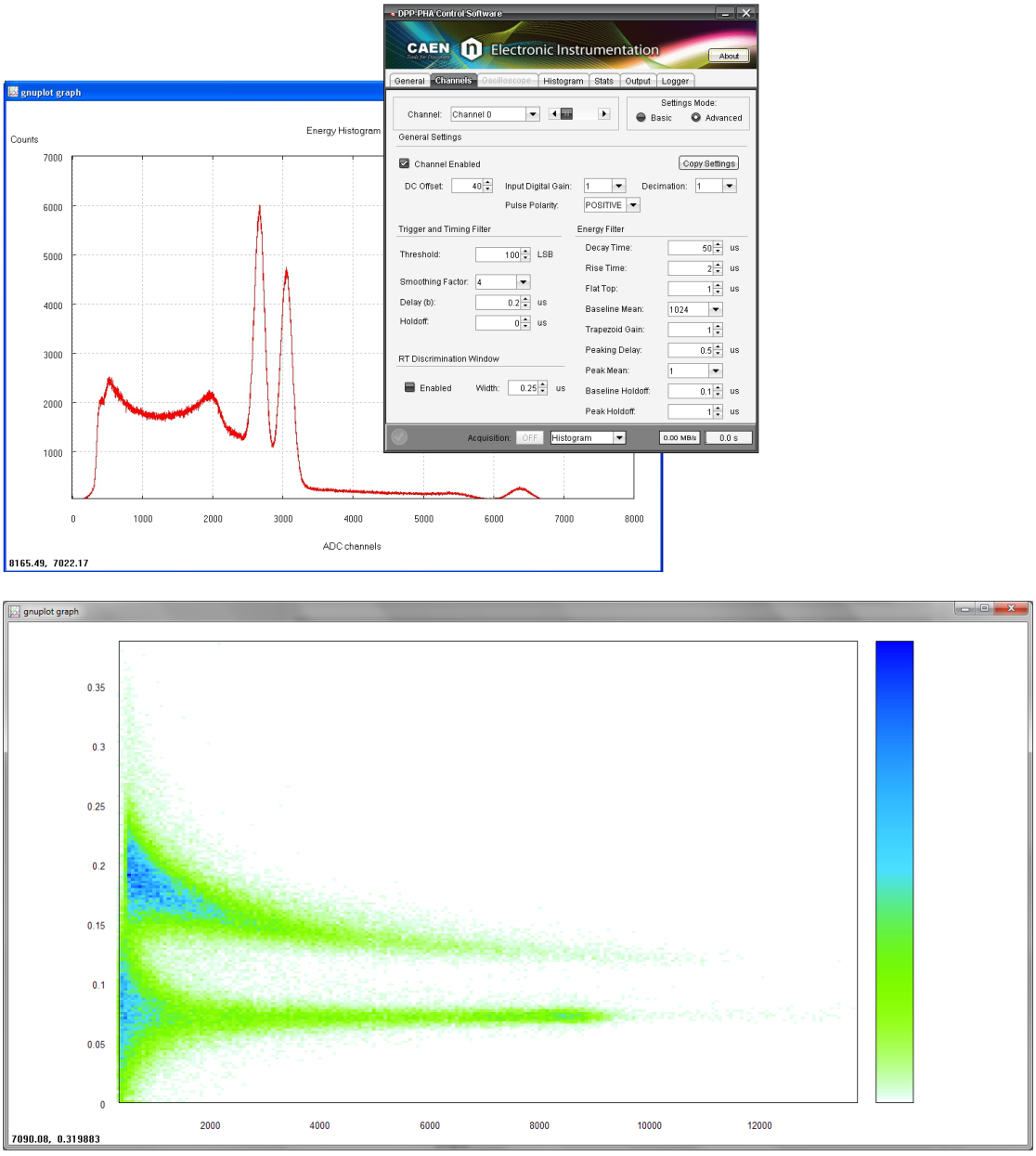


Fig. 9.1: DPP-PSD Control Software: Top – DPP settings Tab and typical ^{60}Co Total Charge Spectrum; Bottom - PSD 2-D Scatter Plot

Fig. 9.2: HV management tab

DPP-PSD Control Software is available both for Windows and Linux 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 **[RD2]**.

Note: Windows version of DPP-PSD Control Software is stand-alone (the required libraries are installed locally with the program; only the communication driver must be installed apart by the user), while the version for Linux needs the required libraries to be already installed apart.

CAENUpgrader

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

Specifically for the DT5790, CAENUpgrader allows in few easy steps to:

- Upload different versions of the Readout and HV firmware on the board
- Read the Readout or HV 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
- Force the board to reboot loading the Standard or Backup copy of the firmware stored on-board

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

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

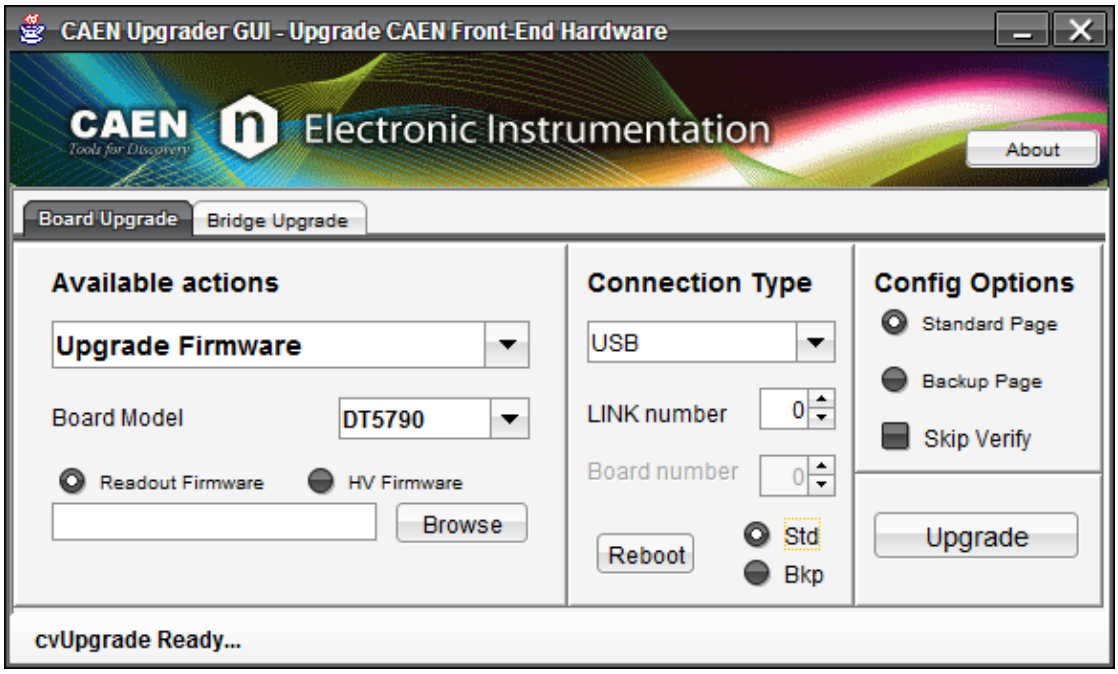


Fig. 9.3: CAENUpgrader Graphical User Interface

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.

Note: DT5790 model is supported by CAENUpgrader software release **1.5** or higher.

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.

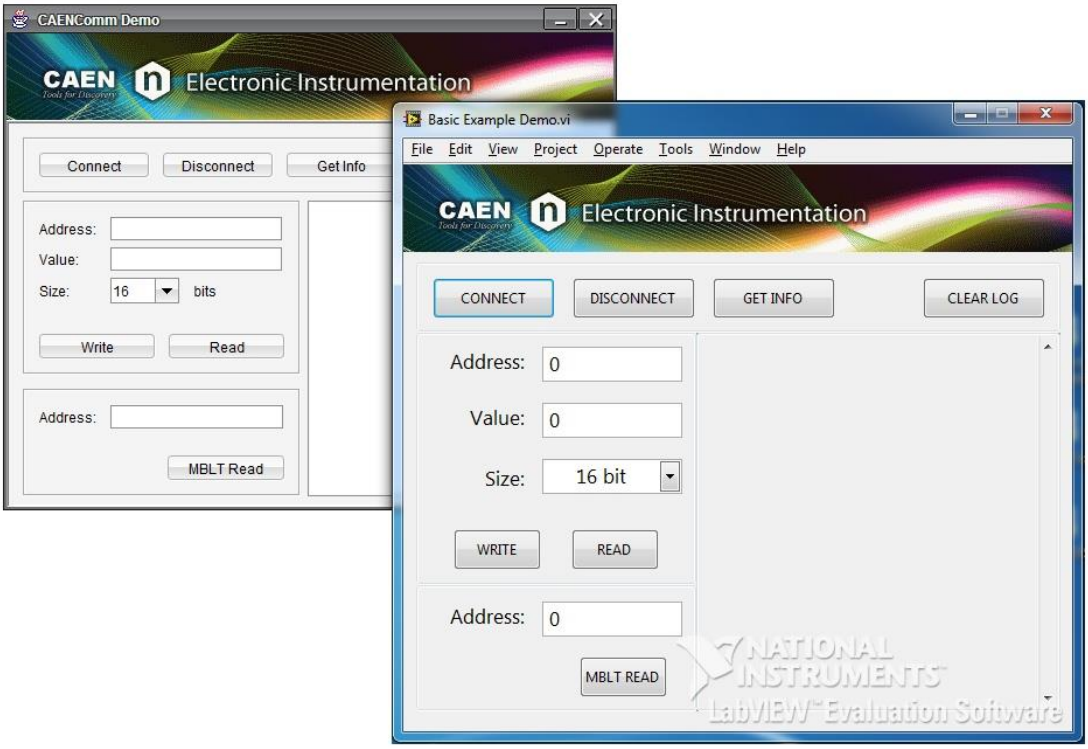


Fig. 9.4: CAENComm Demo Java and LabVIEW graphical interface

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

Power ON Sequence

To power ON the board, follow this procedure:

1. connect the 12V DC power supply to the DT5790 through the DC input rear connector;
2. power up the DT5790 through the ON/OFF rear switch

See § **5** to identify the relevant components

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**)

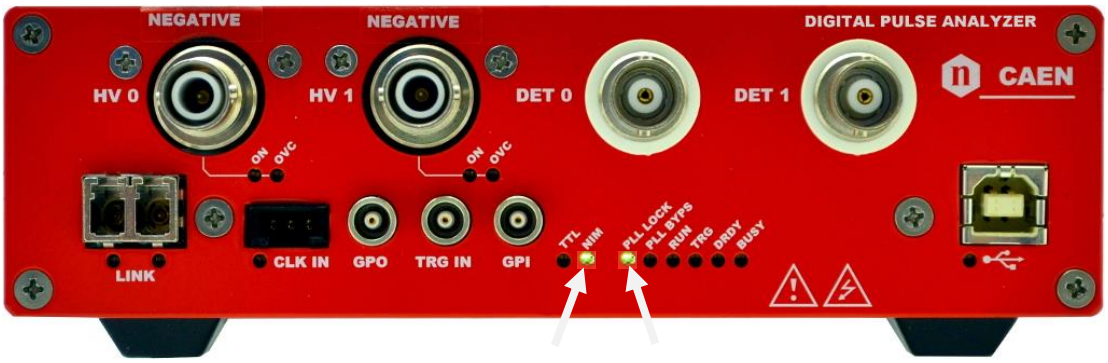


Fig. 10.1: Front panel LEDs status at power ON

11 Firmware and Upgrades

The DT5790 is delivered factory equipped with a licensed DPP-PSD Firmware. This means that no license needs to be bought apart by the user when purchasing a DT5790.

Firmware updates are available for download on CAEN website (www.caen.it) in the “Software/Firmware” tab at the DT5790 web page **(login required)**:

Home / Products / Spectroscopy Solutions / Digital Systems for Charge Integration / Systems for Charge Integration / DT5790

The board hosts one FPGA on the mainboard and one FPGA on the mezzanine. 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 UPGRADE ONLY ONE OF THE STORED FIRMWARE REVISIONS (GENERALLY THE STD ONE): IF BOTH REVISION ARE SIMULTANEOUSLY UPDATED AND A FAILURE OCCURS, IT WILL NOT BE POSSIBLE TO UPLOAD THE FIRMWARE VIA USB OR OPTICAL LINK AGAIN AND THE BOARD MUST BE SENT TO CAEN IN REPAIR!

In case of failures while programming the STD page of the FLASH, which compromise the communication with the DT5790, 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 **[RD4]**. 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:

x720_x790_DPP-PSD_rev_X.Y_131.Z.CFA

where:

- x720_x790 are all the boards the file is compliant to.
- DPP-PSD is the specific digital algorithm implemented into the firmware.
- X.Y is the major/minor revision number of the mainboard FPGA.
- 131.Z is the major/minor revision number of the channel FPGA. Note that the major revision number (131) is fixed for the specific DPP algorithm (PSD).

12 Technical Support

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

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

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

CAEN SpA is acknowledged as the only company in the world providing a complete range of High/Low Voltage Power Supply systems and Front-End/Data Acquisition modules which meet IEEE Standards for Nuclear and Particle Physics. Extensive Research and Development capabilities have allowed CAEN SpA to play an important, long term role in this field. Our activities have always been at the forefront of technology, thanks to years of intensive collaborations with the most important Research Centres of the world. Our products appeal to a wide range of customers including engineers, scientists and technical professionals who all trust them to help achieve their goals faster and more effectively.

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