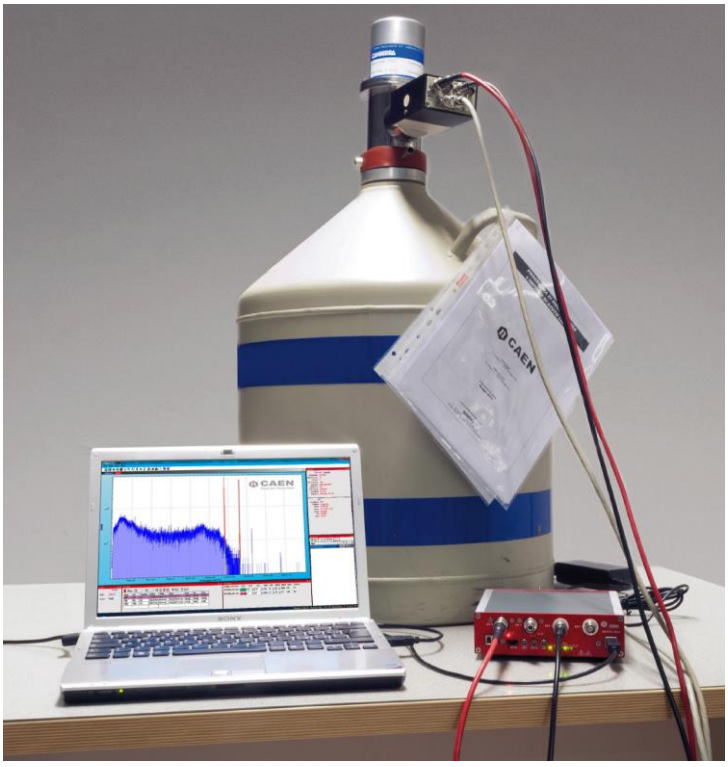
Rev. 6 - December 18th, 2024

DT5780

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



CAEN
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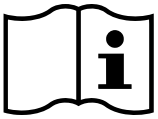
User Manual
UM2606

Purpose of this Manual



This User Manual contains the full description of the DT5780 Dual Digital MCA.

Change Document Record

Date	Revision	Changes
January 25th, 2013	00	Initial release
July 30th, 2014	01	Fully revised and added support to DT5780SD version
February 2nd, 2015	02	Updated the cover picture and Chap **12**
February 02nd, 2016	03	Introduced V_{max} specification in **Tab. 2.1**. Updated V_{max} description in Chap. **6**.
November 30th, 2016	04	Added support to DT5780SC versions. Added a dedicated paragraph on LabVIEW™ support. Updated Chap.**8** and **11**. Removed DPP-PHA Control Software (phased out) description in Chap.**9**.
April 18th, 2024	05	Revised cover and sales network pages. Updated HV ripple values in Chap.**2.** Updated Chap.**12**.
December 18th, 2024	06	Updated inhibit description in Sec. **DETECTOR POWER SUPPLY INHIBIT**

Symbols, abbreviated terms and notation

ADC	Analog to Digital Converter
CSP	Charge Sensitive Preamplifier
DPP	Digital Pulse Processing
DPP-QDC	DPP for Charge to Digital Converter
DPP-PHA	DPP for Pulse Height Analysis
DPP-PSD	DPP for Pulse Shape Discrimination
HPGe	High Purity Germanium
MCA	Multi-Channel Analyzer
NaI	Sodium Iodide
OS	Operating System
PC	Personal Computer
PHA	Pulse Height Analysis
PMT	Photo Multiplier Tube
USB	Universal Serial Bus

Reference Documents

[RD1] GD2512 – CAENUpgrader QuickStart Guide

[RD2] AN2086 – Synchronization of a multi-board acquisition system with CAEN digitizers

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

[RD4] GD2812 – DeskBoot QuickStart Guide

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

[RD6] GD2080 - Introduction to Digitizers

[RD7] UM3182 - DPP-PHA and MC2Analyzer User Manual

[RD8] UM2580 - DPP-PSD User Manual

[RD9] UM4874 - DPP-QDC User Manual

All CAEN documents can be downloaded at:

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

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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

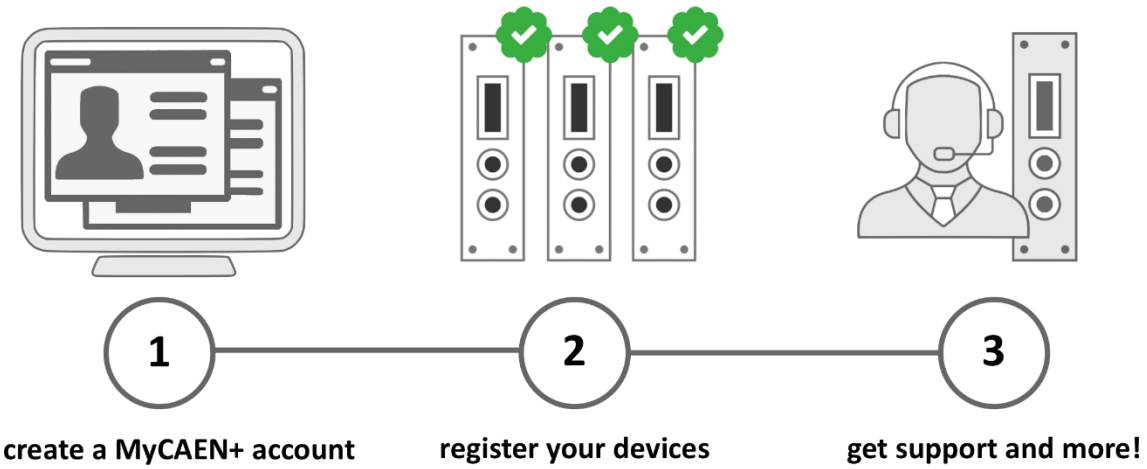
Made in Italy

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).

Register your device

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

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



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1 Introduction

The **DT5780 Dual Digital MCA** is a compact desktop system integrating 2 independent 16k channels Digital MCA and HV/LV power supply capabilities for Gamma and X-ray spectrometry.

The DT5780 MCA represents a digital replacement of Shaping Amplifier and Peak Sensing ADC. Thanks to this digital approach, other functionalities become possible, such as calculating the trigger time tag or making coincidences and anticoincidences.

DT5780 is ideally suited for high energy resolution detectors, such as **HPGe**, connected to a Charge Sensitive Preamplifier (CSP), but it can also properly work with PMT-based detectors like **NaI**, providing an exponential tail of at least few hundreds of ns. For signals from PMTs, it is usually recommended to use digitizers like 720, 725, 730, 740 or 751 series running specific algorithms for the Digital to Charge Converter (DPP-QDC) or Pulse Shape Discrimination (DPP-PSD). For details, please refer to **[RD8]** and **[RD9]**.

DT5780SD version has been designed specifically for Diamond and Silicon detectors coupled with a CSP, while **DT5780SC** is suited for Scintillators.

The DT5780 houses:

- **2 x 100 MS/s 14-bit ADC** (based on the 724 digitizer series) on single ended inputs with BNC connectors, featuring 4-step configurable input range (0.6 / 1.4 / 3.7 /9.5 V_{pp}) and adjustable DC offset via a 16-bit DAC on each input in the full range.
- **2 x ±5 kV 300 µA HV bias outputs** on SHV connectors. Channel polarity NEGATIVE, POSITIVE or MIXED selectable by ordering options (**Tab. 1.1**).
- **2 x ±12 V (100 mA) and ±24 V (50 mA) PREAMP bias outputs** through DB9 connectors for preamplifiers power supply.

The DT5780SD differs for the HV bias output specifications as follows:

- **2 x ±500 V 3 mA HV bias outputs** on SHV connectors. Channel polarity NEGATIVE, POSITIVE or MIXED selectable by ordering options (**Tab. 1.1**).

The DT5780SC differs for the HV bias output specifications as follows:

- **2 x ±4 kV 3 mA HV bias outputs** (4-W limited) on SHV connectors. Channel polarity NEGATIVE, POSITIVE or MIXED selectable by ordering options (**Tab. 1.1**).

DT5780, DT5780SD and DT5780SC are equipped with a **DPP-PHA Firmware**, that is a Digital Pulse Processing algorithm making the board a spectroscopy acquisition system providing energy (i.e. pulse height) and timing information as well as portions of the waveform and other traces for the fine tuning of the PHA settings.

Thanks to its two inputs of simultaneous acquisition, the DT5780, DT5780SD and DT5780SC can manage coincidences and anticoincidences between pairs of detectors, allowing the user, for example, to easily take advantage of background rejection or anti-Compton techniques.

Multiple Dual Digital MCA boards can be synchronized to a common external clock working as a scalable multi-input – multi-board acquisition system (see **[RD2]** for the synchronization approach).

DT5780, DT5780SD and DT5780SC house 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).

CAEN provides the brand new MC^2 Analyzer software (see Chap. **9**) to fully exploit the Dual Digital MCA features in the Spectroscopy environment.

The following list summarizes what can be done by the Dual Digital MCA and the MC^2 Analyzer supported software:

- receive the signals coming from a charge sensitive preamplifier (CSP) and adapt it to the dynamic range.
- run the signal inspector that plots the waveforms of the input signals as well as of the internal filters to adjust the parameters of the acquisition;
- set manually or automatically parameter configurations.
- identify the time of arrival of the input through a fast discriminator algorithm and calculate the pulse height by means of a digital shaping filter (trapezoidal filter);
- detect pile-up conditions and manage the count loss (dead-time);
- implement coincidences and anticoincidences between channels (refer to **[RD5]**);

- the board can save an event made of Trigger Time Stamp and Energy, and possibly Waveform samples into an internal memory buffer and manage the readout through the Optical Link or USB. A list event is made of Trigger Time Stamp and Energy only.
- the software retrieves the event list from the board and generates the energy spectrum (16k channels).
- generate output files (lists, histograms) in binary or ASCII format.
- 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 compensation, histogram rebin)
- 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
DT5780P	Dual Digital MCA - Positive HV	WDT5780XPAAA
DT5780N	Dual Digital MCA - Negative HV	WDT5780XNAAA
DT5780M	Dual Digital MCA - Mixed HV	WDT5780XMAAA
DT5780SDP	Dual Digital MCA for Silicon & Diamond detectors - Positive HV	WDT5780SDXPA
DT5780SDN	Dual Digital MCA for Silicon & Diamond detectors - Negative HV	WDT5780SDXNA
DT5780SDM	Dual Digital MCA for Silicon & Diamond detectors - Mixed HV	WDT5780SDXMA
DT5780SCP	Dual Digital MCA for Scintillators – Positive HV	WDT5780SCXPA
DT5780SCN	Dual Digital MCA for Scintillators – Negative HV	WDT5780SCXNA
DT5780SCM	Dual Digital MCA for Scintillators – Mixed HV	WDT5780SCXMA
DPP Firmware	**Description**	**Product Code**
DPP-PHA*(*)*	Digital Pulse Processing for Pulse Height Analysis	WFWDPPNGAA20
Accessory	**Description**	**Product Code**
A654	Single Channel MCX to LEMO Cable Adapter	WA654XAAAAAA
A654 KIT4	4 MCX TO LEMO Cable Adapter	WA654K4AAAAA
A654 KIT8	8 MCX TO LEMO Cable Adapter	WA654K8AAAAA
A659	A659 - Single Channel MCX to BNC Cable Adapter	WA659XAAAAAA
A659 KIT4	4 MCX TO BNC Cable Adapter	WA659K4AAAAA
A659 KIT8	8 MCX TO BNC Cable Adapter	WA659K8AAAAA
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

(*) DT5780, DT5780SD, and DT5780SC are delivered already equipped with a licensed version of the DPP-PHA 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 ▪ 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 – 10µs ▪ 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				
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**	**DT5780**	**DT5780SD**	**DT5780SC**	**HV Outputs**
	▪ V_{set}:	5 kV	500 V	4 kV	2
	▪ I_{set}:	300 µA	3 mA	3 mA	
	▪ V_{set}, V_{mon} resolution:	0.1 V	0.01 V	0.1 V	
	▪ I_{set}, I_{mon} resolution:	10 nA	50 nA	50 nA	
	▪ Ripple (20 ÷ 1000 Hz) Typ	< 8 mVpp	< 3 mVpp	< 4 mVpp	
	▪ Ripple (20 ÷ 1000 Hz) Max	< 10 mVpp	< 5 mVpp	< 10 mVpp	
	▪ Ripple (1 ÷ 20000 kHz) Typ	< 2 mVpp	< 2 mVpp	< 2 mVpp	
	▪ Ripple (1 ÷ 20000 kHz) Max	< 5 mVpp	< 5 mVpp	< 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 for DT5780 - DT5780SC, and 1÷100 V/S for DT5780SD, 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 ▪ Voltage limit, V_{max}, software selectable with 20V resolution for DT5780 and DT5780SC models, 2V resolution for DT5780SD models (**Note: for HV firmware revisions less than 2.2, V_{max} resolution for DT5780SD is 20V**)				
OPERATING MODES	▪ Pulse Height Analysis (PHA): pulse height histogram (1k-2k-4k-8k-16k) built at software level ▪ List: pulse height and time stamp for each event ▪ Signal Inspector: input and internal filters waveforms				

TRIGGER MODES	▪ Uncorrelated: each channel operates independently (based on its channel fast discriminator output) ▪ Correlated: coincidence/anticoincidence among channels and/or an external trigger (TRG-IN) ▪ External: channels are synchronized with an external pulse on 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; Accepts an external signal as reference clock for a single board or as Fan-in to synchronize the clocks of multiple boards **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 and LabVIEW libraries with demo samples available	
POWER REQUIREMENTS	Power input: +12 VDC, 45 W (by the power supply included in the kit) Operating Supply Voltage: +12 VDC ± 10% Consumptions (@ +12 VDC): 3.3 A (Typ.) for DT5780 (± 10% tolerance) 3.5 A (Typ.) for DT5780SD and DT5780SC (± 10% tolerance)	

Tab. 2.1: DT5780-DT5780xx 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: Unit front view

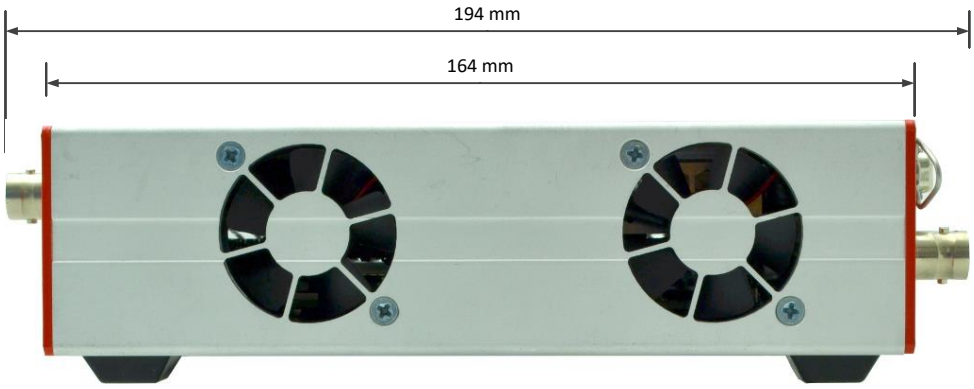


Fig. 3.2: Unit rear view

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

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

HIGH VOLTAGE: possible electric shock hazards. Enclosures marked with this symbol should only be opened by CAEN authorized personnel.

To avoid risk of injury from electric shock, do not open this enclosure!

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 provided with the digitizer and included in the delivered kit (12 VDC, 45 W).

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

	OPERATING SUPPLY VOLTAGE (nominal)	CONSUMPTIONS(*) (@ +12 VDC)
DT5780	+12 VDC ± 10%	3.3 A (Typ.) ± 10%
DT5780SD	+12 VDC ± 10%	3.5 A (Typ.) ± 10%
DT5780SC	+12 VDC ± 10%	3.5 A (Typ.) ± 10%

(*) measured with the module in standby and all the HV and PREAMP channels at the maximum power

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 typical 3.3 A (in case of DT5780) + 10%, or 3.5 A (in case of DT5780SDor DT5780SC) + 10%; 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 DT5780 and DT5780xx kit

5 Panels Description

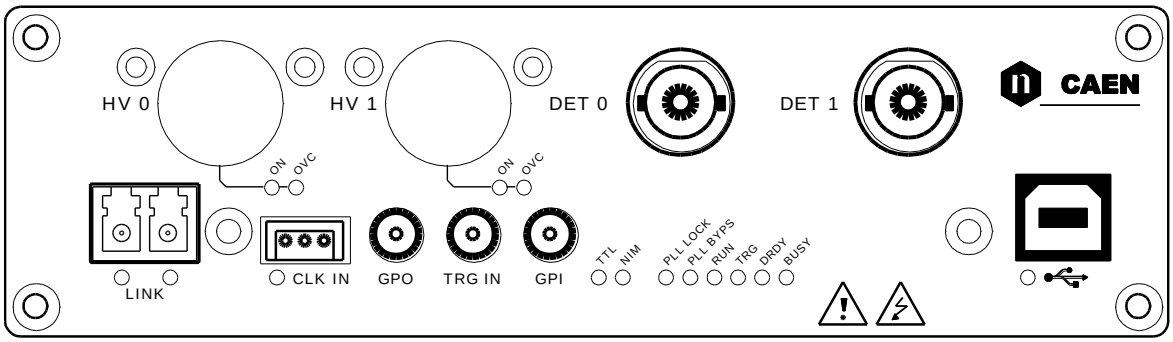


Fig. 5.1: Unit front panel view

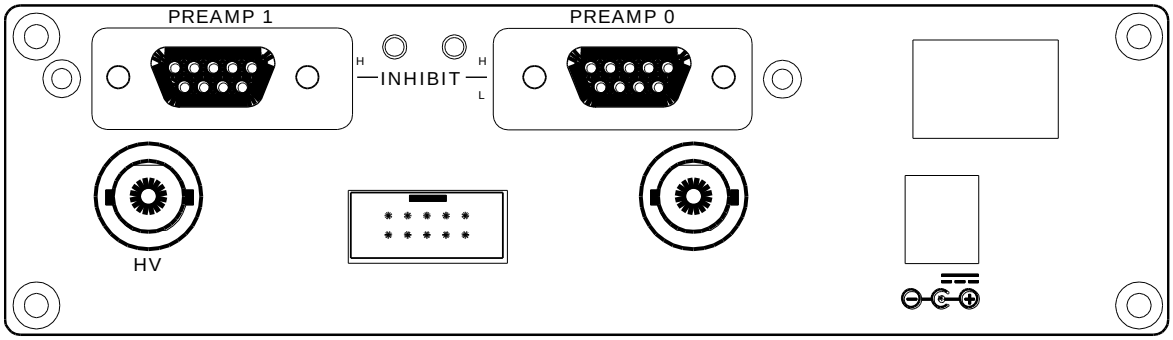
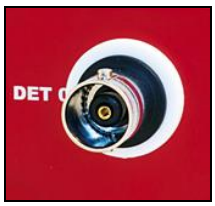


Fig. 5.2: Unit rear panel view

Front Panel

ANALOG INPUT



FUNCTION

Input connectors receiving the analog signals from the detectors.

ELECTRICAL SPECS

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

Input impedance (Z_{in}): 1 kΩ.

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 Chap. **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 channel) or YELLOW (in case of negative channel) when the channel is active; LED **OVC** lights up RED if the channel goes in overcurrent.

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

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.

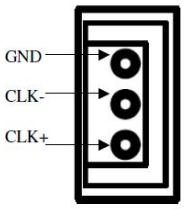
MECHANICAL SPECS

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. 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.

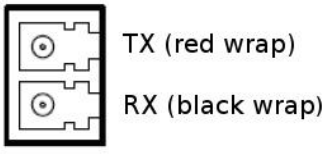
MECHANICAL SPECS

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).

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 Chap. **2.**

MECHANICAL SPECS

Series: HD20 connectors.

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

Manufacturer: TYCO Electronics.

PINOUT

See Chapter **6.**

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 to fit the preamplifier's logic.

ELECTRICAL SPECS

n.a.

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 at Chap. **6**).

SPARE LINK

FUNCTION

Auxiliary connector reserved for CAEN usage.

ELECTRICAL SPECS

n.a.

MECHANICAL SPECS

Series: Header connectors.

Type: 7610-5002-5+5.

Manufacturer: 3M.

DC INPUT

FUNCTION

Input power supply (+12 VDC).

ELECTRICAL SPECS

See Chap. **4**.

MECHANICAL SPECS

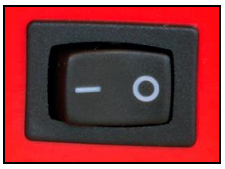
Series: CC power supply connectors.

Type: RAPC722X (DC power jack).

Manufacturer: Switchcraft Inc.

PINOUT

ON/OFF SWITCH



FUNCTION

Panel switch for module power supply ON/OFF:

O → power supply OFF;

I → power supply ON.

ELECTRICAL SPECS

n.a.

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

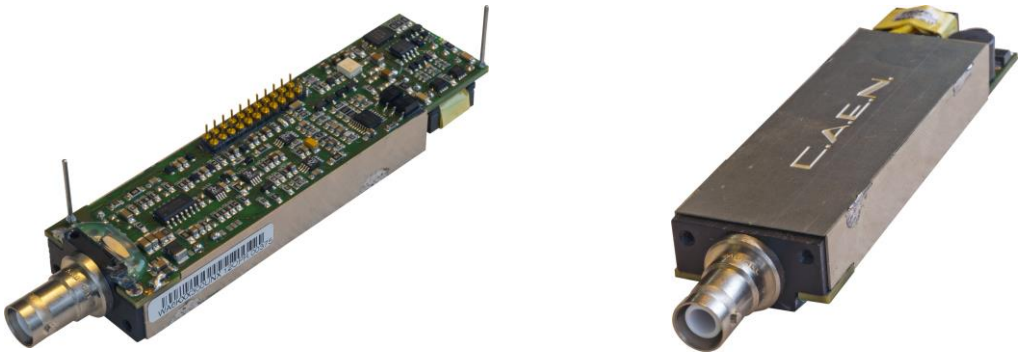


Fig. 6.1: HV output component

The Dual Digital MCA houses High Voltage (HV) outputs to power supply up to two detectors (the HV component is shown in **Fig. 6.1**). DT5780, DT5780SD and DT5780SC differ from the voltage and current bias specifications suited for different kind of radiation detectors. The boards are orderable with either positive, negative or mixed polarity (see **Tab. 1.1**). HV outputs are delivered through SHV connectors.

Model	HV output	Detectors
DT5780	±5 kV / 300 µA	HPGe and other high energy resolution detectors
DT5780SD	±500 V / 3 mA	Silicon and Diamond
DT5780SC	±4 kV / 3 mA (4 W limited)	Scintillators

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 DT5780 and DT5780SC, while in the 1÷100 V/s range in steps of 1 V/s for the DT5780SD. Other HV specifications are detailed in Chap. **2**.

Note: HV parameters can be configured and monitored through the CAEN provided MC^2 Analyzer (see Chap. **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 Chap **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 (**Fig. 6.2**).

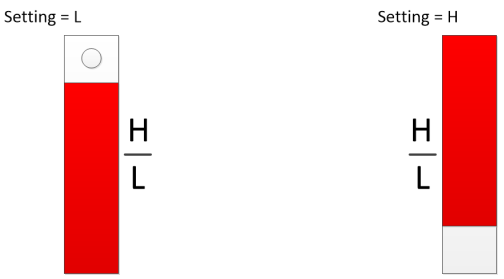


Fig. 6.2: Inhibit polarity settings

- H-Position: The inhibit is active-high. In open-circuit (no input) and with positive input (+2 V up to + 24 V), the HV channel is inhibited (the red LED is on); with normally negative input (-24 V up to -2 V)., the HV channel is enabled red LED is off).
- (L-Position: The inhibit is active-low. In open-circuit and with positive input, the HV channel is enabled; with negative input, the HV channel is inhibited.

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. 50V in case of DT5780, 5V in case of DT5780SD, 40V in case of DT5780SC), 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 **Overcurrent** or **Overtemperature** detection (i.e. a HV output tries to draw a current larger than its programmed limit or its temperature is over the safety limit). The **Voltage Limit** can be configured by software with a resolution of 20 V in case of DT5780 and DT5780SC, while 2 V in case of DT5780SD.

Note: 2V resolution is supported from HV firmware release 2.2 on; previous releases feature 20 V resolution.

PREAMP Power Supply

DT5780 and DT5780xx are 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**.

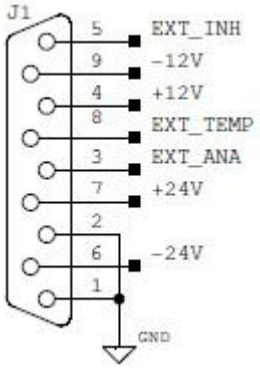


Fig. 6.3: DB9 connector pinout

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 to fit the preamplifier 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.

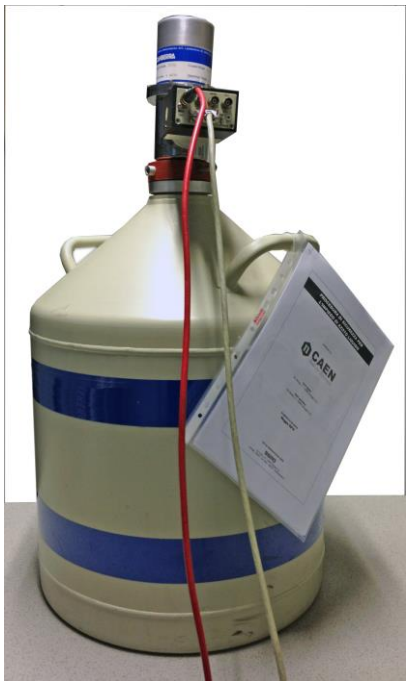
PIN8: external input for detector's temperature readout from a PT100 or PT1000 sensor model **(currently not managed by the MC² Analyzer)**.

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

Wiring Example

The following wiring example shows the standard connections between a DT5780 and a HPGe detector mounting a CSP.

A



B

Fig. 6.4: 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 **0**).

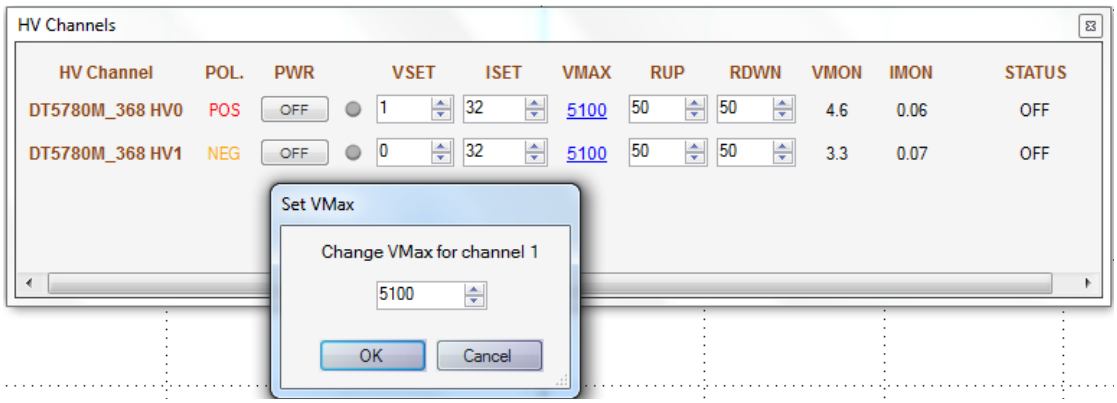


Fig. 6.5: Typical view of the HV configuration section in the MC² Analyzer software

7 Notes on MCA Operating

The DT5780 and DT5780xx operate on the analog signals provided on its 2 inputs the same as a DT5724 module equipped with a DPP-PHA Firmware for the Digital Pulse Height Analysis.

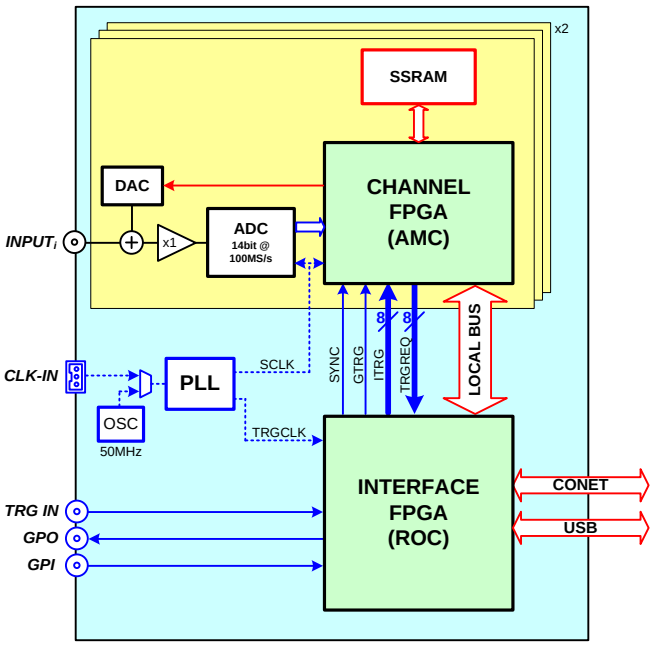


Fig. 7.1: Simplified block diagram of the digitizer block in the DT5780 and DT5780xx

The DT5780 and DT5780xx are acquisition systems that receive the analog signal and perform the 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 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.

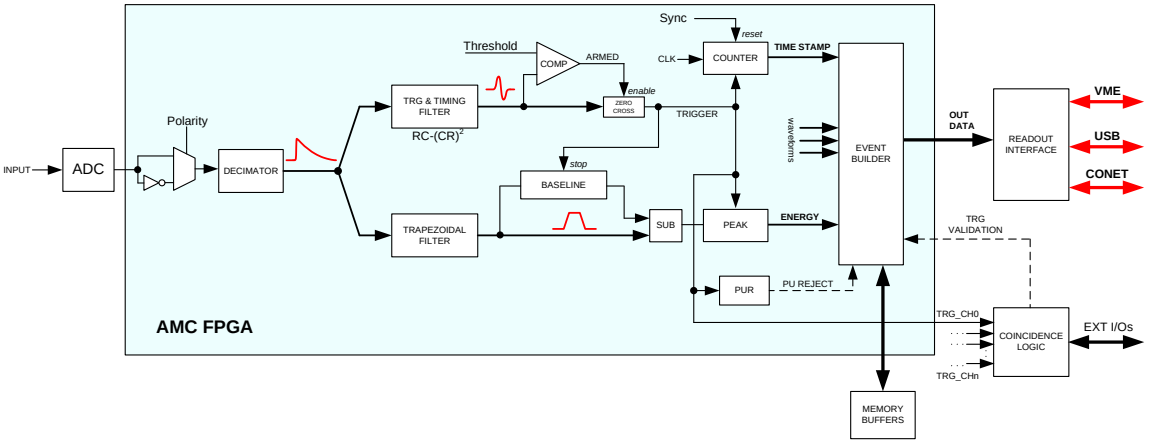


Fig. 7.2: Block Diagram of the processing chain programmed into the digitizer FPGA

Refer to **[RD7]** for a detailed description of:

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

8 Drivers & Libraries

To interface with the DT5780 and DT5780xx, CAEN provides the drivers for all the different types of physical communication channels featured by the boards and compliant with Windows® and Linux® OS, as well as a set of C and LabVIEW libraries.

Drivers

COMM LINKS	OS	OS VERSION
USB / OPT LINK	Microsoft Windows®	7 / 8 / 8.1 / 10 (32 and 64-bit)
	Linux®	kernel Rel. 2.6 up to 4.4(*)

(*) Please, refer to the MCA or Controller web page 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 DT5780 web page (**login required**):

Home / Products / Spectroscopy Solutions / Digital Multi Channel Analyzers / Multi Channel Analyzers / DT5780

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

Description	Release	Date	OS-Version	Environment	Download
Driver					
DT57xx-N67xx-DT55xx Win32 USB Driver(a)	3.4.9	July, 2016	7/8/8.1/10 (32-bit)		
Drivers 32.5 KB - Type: .zip					
DT57xx-N67xx-DT55xx Win64 USB driver	3.4.9	July, 2016	8.1/10 (64-bit)		
Drivers 34.61 KB - Type: .zip					
DT57xx-N67xx-DT55xx Win7_8_x64 USB driver	3.4.9	July, 2016	7/8 (64-bit)		
Drivers 35.67 KB - Type: .zip					
DT57xx-N67xx-DT55xx-V1718-N957 Linux USB Driver	1.5.1	August, 2015			
Release Notes 4.14 KB - Type: .txt					
Drivers (Linux kernel 2.6 - 3.x) 8.24 KB - Type: .tgz					

Fig. 8.1: Typical view of the drivers download at the DT5780 web page

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

- **Drivers Optical Link CONET 2 compliant**. These 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 Linux driver	1.6.0	May, 2016			
Release Notes 3.24 KB - Type: .txt					
Drivers (Linux kernel 2.6 - 3.x - 4.4) 15.31 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	May, 2014	x64bit Vista, x64bit 7, 8 (64bit)		
Drivers 6.1 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.
- **CAENDPP** library The CAENDPP is a high-level library of C functions designed to completely control exclusively the digitizers running the DPP-PHA firmware.

As far as the DT5780 is concerned, the supported communication channels are the following:

PC → USB → DT5780/DT5780SD/DT5780SC

PC → PCI (A2818) → CONET → DT5780/DT5780SD/DT5780SC

PC → PCIe (A3818) → CONET → DT5780/DT5780SD/DT5780SC

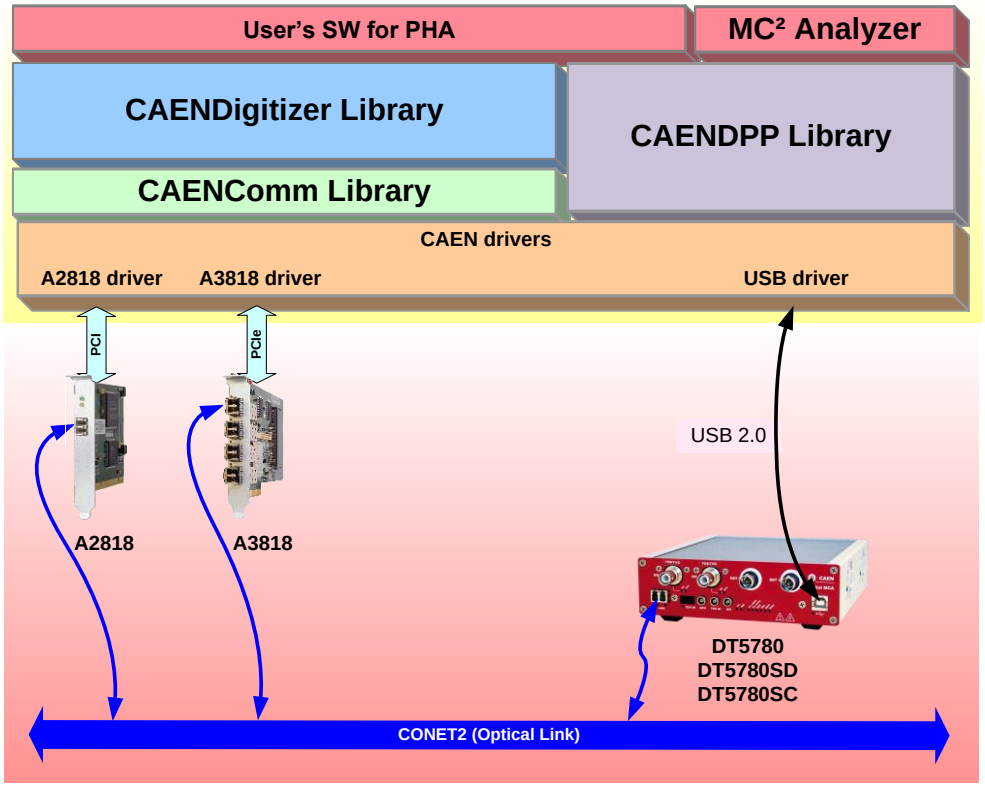


Fig. 8.3: Hardware and software layer scheme

If required to be installed apart by the user (see Chap. **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.

Note: CAENDPP library is stand-alone; no additional software but the drivers are required to be installed.

LabVIEW™ Support

CAEN makes available LabVIEW™ drivers to interface MCA boards in Windows® OS:

- A set of VIs included in the CAENComm and CAENVMElib library packages.
- CAENDigitizer LabVIEW™ library
- A set of demo programs included in CAENDigitizer labVIEW™ library

Users who want to develop software based on LabVIEW™ for DT5780, DT5780SD or DT5780SC must:

1. Install the third-party NI LabVIEW 2009 Development System or higher
2. Install the CAENVMElib library including the VI folder
3. Install the CAENComm library including the VI folder
4. Install the CAENDigitizer LabVIEW™ library

The CAENDigitizer LabVIEW™ Demos" folder provides the DPP-PHA Demo for DT5780xx MCAs. This software can be used as is or can be a helpful base for the user to customize his own DAQ system.

Note: Download CAEN software and documentation for LabVIEW™ platform at:

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

9 Software Tools

CAEN provides software tools to interface DT5780, DT5780SD and DT5780SC, 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 x780xx 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, 725 and 730 families.

The software can 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 x780xx.

Moreover, it can 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.

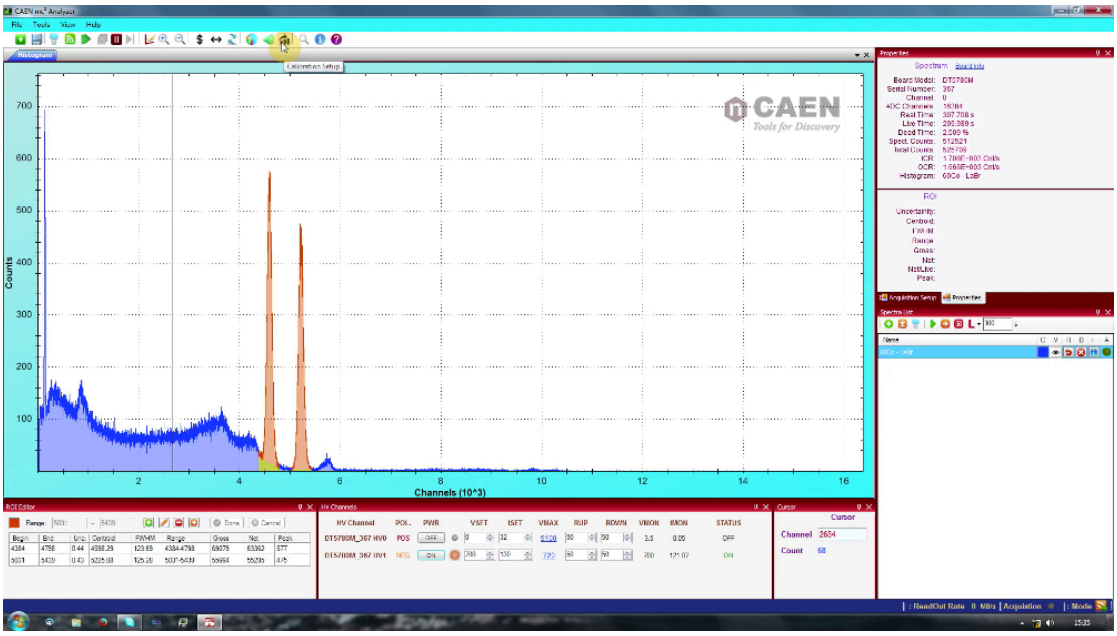


Fig. 9.1: MC² Analyzer (MC²A) software tool

MC² Analyzer is currently available for Windows® platforms only. 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 **[RD7]**.

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-based GUI.

With DT5780, DT5780SD and DT5780SC, CAENUpgrader allows in few easy steps to:

- Upload different versions of the Readout (DPP-PHA) firmware on the board
- Read the Readout or HV firmware release of the board
- Upgrade the internal PLL configuration
- 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 relies on CAENComm and CAENVMELib libraries (see Chap. **8**), and requires the third-party Java SE Runtime Environment 8u40 (or higher).

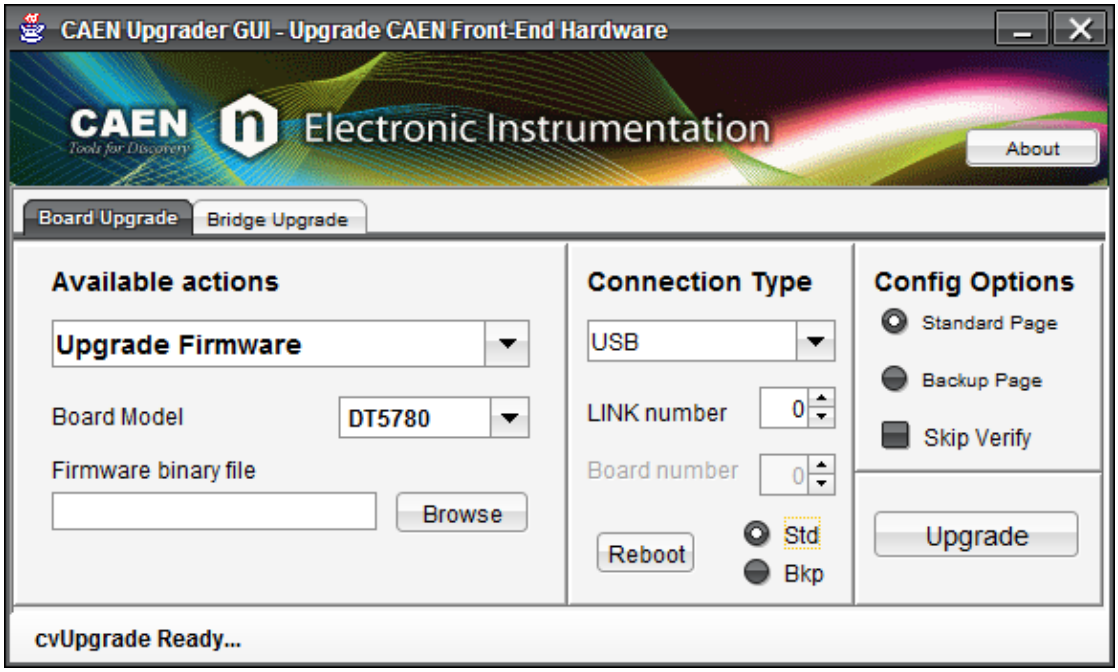


Fig. 9.2: CAENUpgrader Graphical User Interface.

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 a GUI to be used both with a Java® or LabVIEW™ software. 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.

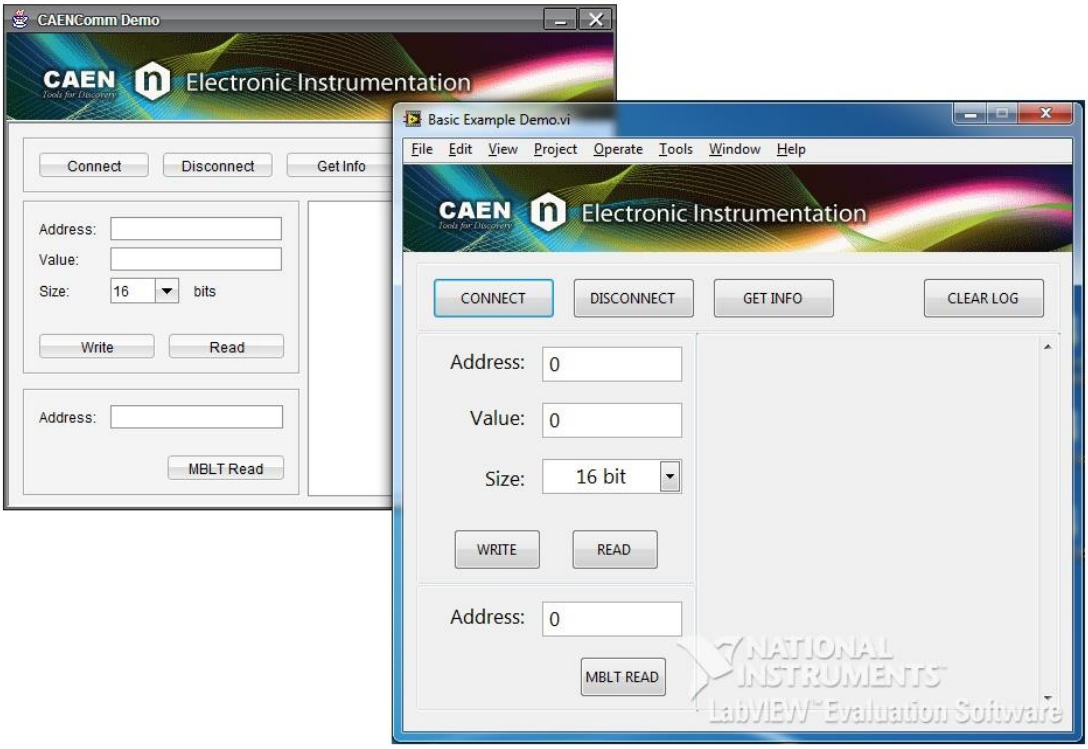


Fig. 9.3: CAENComm demo Graphical User Interfaces

CAENComm Demo can operate with Windows® OS, 32 and 64-bit. It requires CAENComm and CAEVMElib libraries as additional software to be installed (see Chap. **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 DT5780 /DT5780SD / ST5780SC through the DC input rear connector;
2. power up the DT5780 / DT5780SD /DT5780SC through the ON/OFF rear switch

See Chap. **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**)

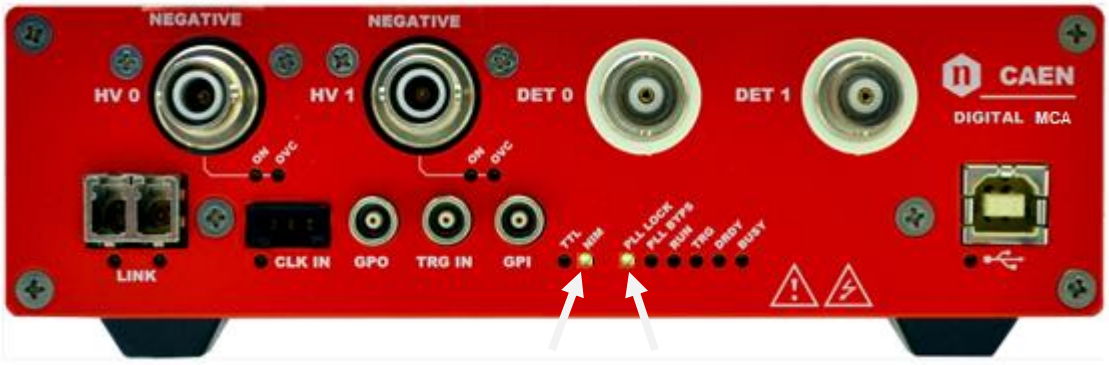


Fig. 10.1: Front panel LEDs status at power-on

11 Firmware and Upgrades

The board hosts one FPGA on the mainboard and one FPGA on the mezzanine (i.e. one FPGA serves 2 analog channels). The channel FPGAs firmware is identical. A unique file is provided, that updates 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 32Mb FLASH memory. Two copies of the firmware are stored in two different pages of the FLASH, referred to as Standard (STD) and Backup (BKP). The Backup page is usually factory equipped with a default firmware intended for recovery usage.

At power-on, a microcontroller reads the FLASH memory starting from the STD page and programs the module automatically loading the first working firmware copy.

DPP-PHA Firmware Upgrade

DT5780, DT5780SD and DT5780SC are 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 these boards.

DPP-PHA firmware updates are available for download on CAEN website (www.caen.it) in the “Software/Firmware” tab at the DT5780 web page **(login required)**:

Home / Products / Spectroscopy Solutions / Digital Multi Channel Analyzers / Multi Channel Analyzers / DT5780

It is possible to upgrade the firmware via USB or Optical Link by writing the FLASH with the CAENUpgrader software (see Chap. **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!

Note: DPP-PHA firmware upgrades on DT5780 / DT5780SD /DT5780SC do not affect the license validity.

DPP-PHA Firmware File Description

The extension of the DPP-PHA programming file is CFA (CAEN Firmware Archive), which 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_x78x_DPP-PHA_rev_X.Y_128.Z.CFA

where:

- x724_x78x are all the boards supported by the file: 724 digitizer family, 780 Digital MCA family and 781 Digital MCA family.
- DPP-PHA is the specific digital algorithm implemented by the firmware.
- X.Y is the major (X) and minor (Y) revision number of the mainboard FPGA.
- 128.Z is the major (128) and minor (Z) revision number of the channel FPGA. Note that 128 is fixed for the specific DPP-PHA algorithm.

Troubleshooting

In case of upgrading failure (e.g. STD FLASH page is corrupted), the user can try to reboot the board: after a power cycle, the system will try to program the board automatically from the alternative FLASH page (e.g. BKP FLASH page) if this is not corrupted as well. The user can then perform a further upgrade attempt on the STD page to restore the firmware copy.

Boards Equipped with 8Mb FLASH

NOTE THAT old versions of DT5780 and DT5780xx used to mount an 8Mb FLASH memory.

There are two ways to read the FLASH type of the board:

1. Use the CAENUpgrader “Get Information” option; the last row in the output file is the Flash Type (1 = 32Mb; 0 = 8Mb).
2. Direct read at 0xF050 register address (0x01 = 32Mb; 0x00 = 8Mb).

In case of 8Mb, the FLASH management is slightly different: at power-on, the microcontroller loads exactly the firmware copy from the STD page of the FLASH; so, if this is somehow corrupted and the communication is compromised, 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, make sure to connect by USB link and use the “Reboot” function of CAENUpgrader software by checking “Bkp” option.
- 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 download again the firmware on the STD page and power cycle the board.

If neitherone the procedures here described succeeds, it is recommended to send the board back to CAEN in repair (see Chap. **12**).

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

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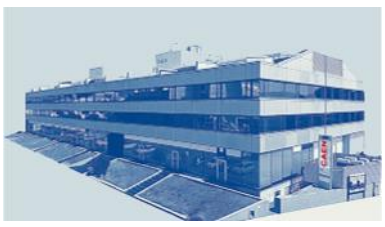

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