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.

1	2	3
create a MyCAEN+ account	**register your devices**	**get support and more!**

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

Purpose of this Manual

This document is the A7038 1kV / 100µA HV Boards user manual; it contains information about the installation, the configuration and the use of the board.

Change Document Record

Date	Revision	Changes
23 November 2017	0	PRELIMINARY Release
10 February 2022	1	Updated Table 1, Section 3

Symbols, abbreviated terms and notation
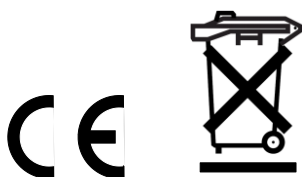
N.A.

Reference Documents

Index

List of Figures

List of Tables

CAEN **Electronic Instrumentation**

1. Overview

Functional description

The power supplies of the A7038 family house 48 or 32 independent high voltage channels. The A7038 is available in different versions equipped with SHV or with DB37 connectors.

The channels share a Common Floating Return, which allows on-detector grounding, reducing the noise level. The board is available with either positive or negative output polarity.

The output voltage range is 0 ÷ 1 kV, with 2 mV monitor resolution. The maximum output current is 100μA, with 500 pA monitor resolution.

Independently programmable for each channel:

 - Output voltage: 0 ÷ 1 kV   step: 20 mV
 - Current limit (Iset):   0 ÷ 100 μA   step: 2 nA
 - V Ramp up/down: 1 ÷ 500 V/sec   step: 1 V/sec
 - TRIP parameter

Safety features includes:

Channels can be enabled or disabled through the Global Interlock logic.

Overvoltage and Undervoltage warning when the output voltage differs from the programmed value.

Hardware VMAX and IMAX: maximum output voltage and maximum current value can be fixed, via front panel potentiometer, at the same common value for all the board channels. IMAX and VMAX values can be read out via software.

Overcurrent detection: when a channel attempts to exceed the programmed current limit (Iset), it signaled to be in "overcurrent" and enter in a TRIP status: the channel is switched off after a programmable TRIP time. The output current is permitted to exceed Iset value, the channel behaves like a current generator only if the IMAX current value is reached.

Safety Board Interlock: this protection disables the HV generation when the HV outputs are not connected to their loads (only for DB37 Connector versions).

The boards are available with 32 and 48 channels; see also table below:

Model	No. of channels	HV connector	Width
A7038AN	48	DB37	Single (5TE)
A7038AP	48	DB37	Single (5TE)
A7038STN	32	SHV	Triple (15TE)
A7038STP	32	SHV	Triple (15TE)

Channel Characteristic Table[1]

Table 1 – Channel characteristics of the Mod. A7038 HV Board

No. of Channels	32 / 48 (Common Floating Return)
Output Voltage	0÷1 kV
Polarity	Positive / Negative depending on purchased version
Max. Output Current	100 µA
Voltage Set Resolution	20 mV
Voltage Monitor Resolution	2 mV
Current Set Resolution	2 nA
Current Monitor Resolution	500pA
VMAX hardware	0÷1 kV common for all the board channels
VMAX hardware resolution	1V
VMAX hardware accuracy	± 1% of FSR
VMAX software	0÷1 kV settable for each channel
VMAX software resolution	1 V
IMAX hardware	0÷100 µA common for all the board channels
IMAX hardware resolution	1 µA
IMAX hardware accuracy	± 1% of FSR
Trip	Max. time an "overcurrent" is allowed to last (seconds); common to all channels. A channel in "overcurrent" works as a current generator; output voltage varies to keep output current lower than the programmed value. "Overcurrent" lasting more than set value, causes the channel to "trip". Output voltage will drop to zero either at Ramp-down rate or at the fastest available rate, depending on Power Down setting; in both cases the channel is put in the off state. If trip= INFINITE, "overcurrent" lasts indefinitely. TRIP range: 0 ÷ 999.9 s; 1000 s = Infinite. Step = 0.1 s
Ramp Up/Down	1÷500 Volt/sec, 1 Volt/sec step settable for each channel
Voltage Ripple 10 – 1000Hz	<10 mVpp typical; 15mVpp max
Voltage Ripple 1 – 20000 kHz	<3 mVpp typical; 5mVpp max
Voltage Monitor vs. Output Voltage Accuracy	typical: ± 0.3% ± 50 mV; max: ± 0.3% ± 200 mV
Voltage Set vs. Voltage Monitor Accuracy	typical: ± 0.3% ± 50 mV; max: ± 0.3% ± 200 mV
Current Monitor vs. Output Current Accuracy	typical: ± 1% ± 10 nA; max: ± 1% ± 100 nA
Output Current vs. Current Set Accuracy	typical: ± 2% ± 100 nA; max: ± 2% ± 1 µA
Power consumption	48 channels 73 W @ full power 32 channels: 60 W @ full power
Stability	< 150mV (Vset = 750V – No Load – one day after 1 hour warm up)
Long Term Stability	< 300mV (Vset = 750V – No Load – one week after 1 hour warm up)
Temperature Coefficient	±50ppm/°C
Load regulation	< 0.02% (Vset = 900V, Iout from 90µA to 900µA)
Max. Altitude	2000m
Safety Standard – ROHS – Halogen free	ROHS
MTBF	Base: 120000 hours; Channel: 2400000 hours; TOT: 35000 hours

---

[1] Channel characteristics are guaranteed with voltage and current settings >5% of full-scale range
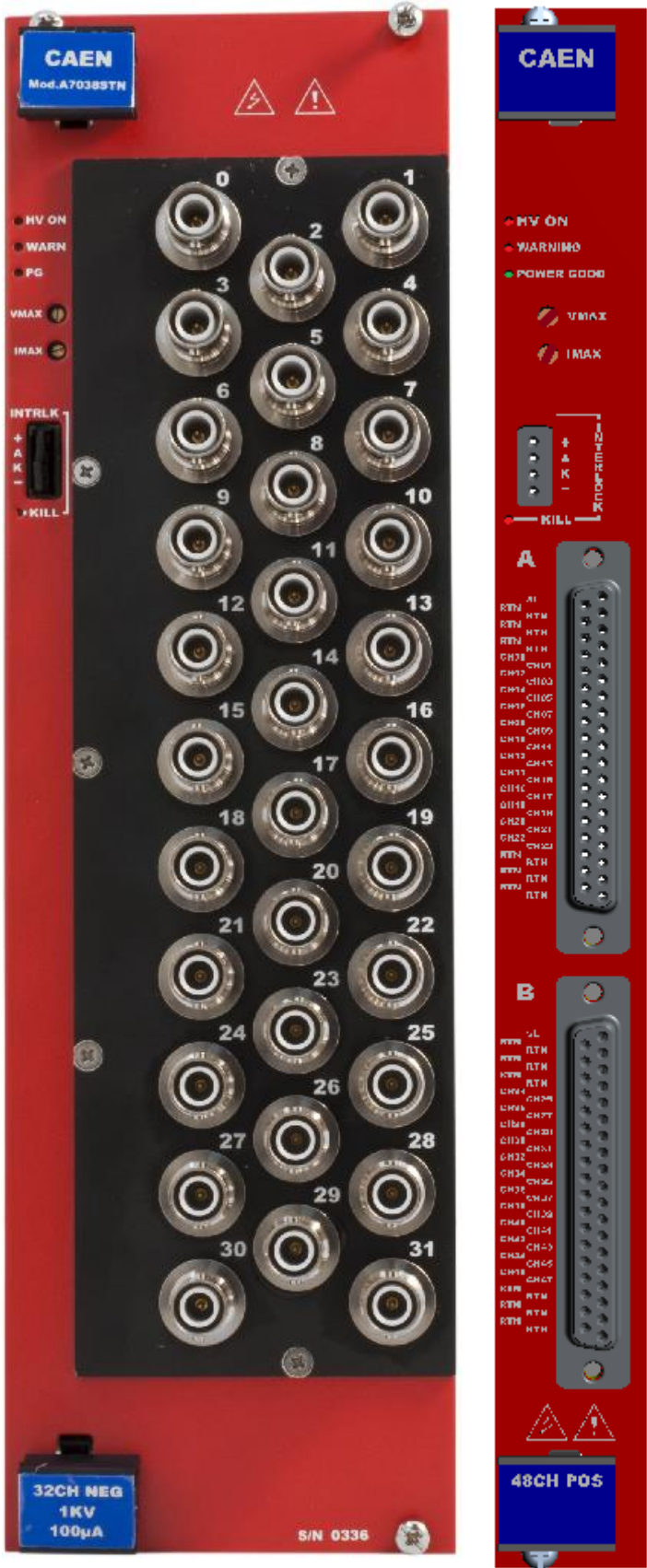
Front Panel

Fig. 1 – A7038 family front panel (A7038ST and A7038A)

Component Specifications

Packaging

A7038ST are triple width (15TE), A7038A are single width (5 TE). Height is 6U.

Displays

HV ON LED	lights up as at least one channel is on; *r*ed: positive polarity*;* yellow: negative polarity.
POWER GOOD	Board correctly powered
WARNING	Warning status detected (over current, over/under voltage, trip, external disable)
KILL LED	*Function:* Red LED. Lights up as the board is in INTERLOCK (channel disabled).

Trimmers

VMAX:	*Function:* it allows to adjust the hardware maximum voltage VMAX common to all the channels. Its value can be read out via software.
IMAX:	*Function:* it allows to adjust the hardware maximum current IMAX common to all the channels. Its value can be read out via software.

External connections

WARNING! HV output connectors produce extremely hazardous voltages at a potentially lethal current level; never connect or disconnect the HV OUT connector with the SYx527 power ON/OFF switch ON; always switch SYx527 power OFF and wait at least 30s before connecting or disconnecting HV cables.

Version	A7038ST	A7038A
Output Connectors	SHV RADIALL R317580 Impedance: 50 Ohm Frequency range: 0 – 2 GHz VSWR: <1.20 + 0.3 F (GHz) – (plug and jack) Test voltage: 10kV DC – 1mn (unmated) 12kV DC – 1mn (mated pairs) Current rating: 10 A	FCI DCPV37S300GT DB37 Contacts diameter on acrive area 1mm Contacts material: copper alloy Contact plating: gold over nickel Operating temperature: -55 ÷ +125 °C Operating current: 7.5A per contact Contact resistance: >5000 MOhm Maximum voltage: 1000Vrms Mechanical endurance: 500 matings for >0.75μ gold plating 200 matings for <0.40μ gold plating Damp heat: 56 days for >0.75μ gold plating 21 days for <0.40μ gold plating
INTERLOCK (see p. 11)	AMP 280371-2	AMP 280371-2

A

SL
RTN
RTN   RTN
RTN   RTN
RTN   RTN
CH00   RTN
CH02   CH01
CH04   CH03
CH06   CH05
CH08   CH07
CH10   CH09
CH12   CH11
CH14   CH13
CH16   CH15
CH18   CH17
CH20   CH19
CH22   CH21
RTN   CH23
RTN   RTN
RTN   RTN
             RTN

B

SL
RTN
RTN   RTN
RTN   RTN
RTN   RTN
CH24   RTN
CH26   CH25
CH28   CH27
CH30   CH29
CH32   CH31
CH34   CH33
CH36   CH35
CH38   CH37
CH40   CH39
CH42   CH41
CH44   CH43
CH46   CH45
RTN   CH47
RTN   RTN
RTN   RTN
             RTN

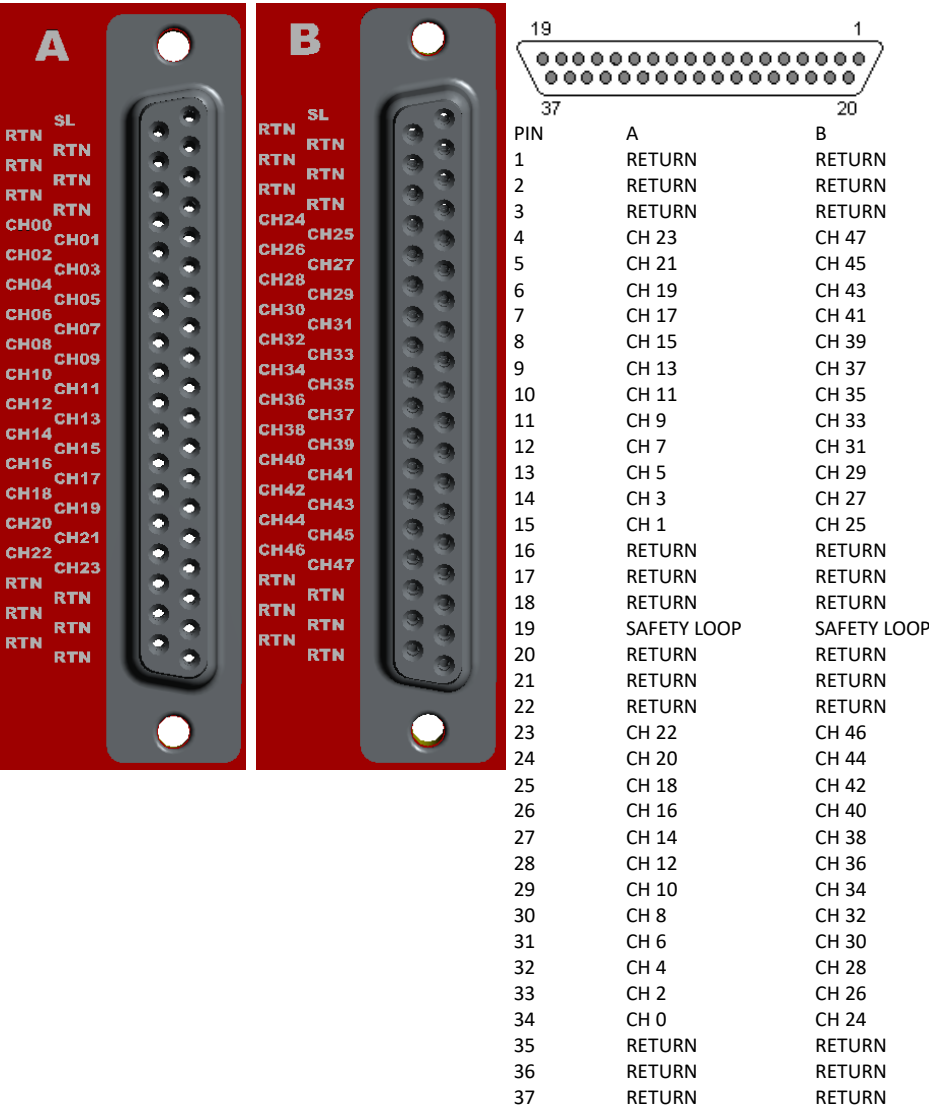| PIN	A	B
1	RETURN	RETURN
2	RETURN	RETURN
3	RETURN	RETURN
4	CH 23	CH 47
5	CH 21	CH 45
6	CH 19	CH 43
7	CH 17	CH 41
8	CH 15	CH 39
9	CH 13	CH 37
10	CH 11	CH 35
11	CH 9	CH 33
12	CH 7	CH 31
13	CH 5	CH 29
14	CH 3	CH 27
15	CH 1	CH 25
16	RETURN	RETURN
17	RETURN	RETURN
18	RETURN	RETURN
19	SAFETY LOOP	SAFETY LOOP
20	RETURN	RETURN
21	RETURN	RETURN
22	RETURN	RETURN
23	CH 22	CH 46
24	CH 20	CH 44
25	CH 18	CH 42
26	CH 16	CH 40
27	CH 14	CH 38
28	CH 12	CH 36
29	CH 10	CH 34
30	CH 8	CH 32
31	CH 6	CH 30
32	CH 4	CH 28
33	CH 2	CH 26
34	CH 0	CH 24
35	RETURN	RETURN
36	RETURN	RETURN
37	RETURN	RETURN

Fig. 2 – DB37 connector pin assignment

2. Safety and installation requirements

General safety information

This section contains the fundamental safety rules for the installation and operation of the board. Read thoroughly this section before starting any procedure of installation or operation of the product.

Injury Precautions

Review the following precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use the product only as specified. Only qualified personnel should perform service procedures.

Avoid Electric Overload.
To avoid electric shock or fire hazard, do not power a load outside of its specified range.

Avoid Electric Shock.
To avoid injury or loss of life, do not connect or disconnect cables while they are connected to a voltage source.

Do Not Operate Without Covers.
To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Do Not Operate in Wet/Damp Conditions.
To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere.
To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Do Not Operate With Suspected Failures.
If you suspect this product to be damaged, have it inspected by qualified service personnel.

Safety Terms and Symbols on the Product

These terms may appear on the product:
DANGER indicates an injury hazard immediately accessible as you read the marking.
WARNING indicates an injury hazard not immediately accessible as you read the marking.
CAUTION indicates a hazard to property including the product.
The following symbols may appear on the product:

	DANGER		**WARNING**
⚡	**High Voltage**	⚠	**Refer to Manual**

Installation

The Mod. A7038 are SYx527 boards. At power ON the SYSTEM, the processor will scan all the slots in the crate to find out where the module is plugged and what kind of module it is.

3.   Operating modes

The Mod. A7038 boards can be controlled, either locally or remotely, through the SYSTEM software interface. For details on SYSTEM operation, please refer to the User's Manual of this product. The following sections contain a description of commands available for the board control and status monitoring.

Output control and monitoring

For each output channel, it is possible, through the system, to access the following parameters:

CHANNEL NAME (settable):	descriptive name for the relevant channel
V0SET (settable):	the first of the two allowed voltage programmable values.
I0SET (settable):	the first of the two allowed current limit programmable values (OVC warning only)
V1SET (settable):	the second of the two allowed voltage programmable values
I1SET (settable):	the second of the two allowed current limit programmable values (OVC warning only)
RUp (settable):	the Ramp-Up parameter value, i.e. the maximum voltage programmable increase rate.
RDWn (settable):	the Ramp-Down parameter value, i.e. the maximum voltage programmable decrease rate.
TRIP (settable):	the TRIP parameter value, i.e. the maximum time an Over Current condition is allowed to last.
SVMAX (settable):	the maximum voltage value programmable for the channel. If the value set as SVMAX is less than the current value of the V0SET/ V1SET parameter, the latter will automatically decrease to the SVMAX value.
VMON (monitor):	monitored voltage value
IMON (monitor):	monitored current value
IMonPeak (monitor):	monitored current peak value
ImAdj	offset value which is added to IMon to adjust its value to zero
STATUS (monitor):	it displays the channel status.
PW (ON/OFF):	the Power parameter shows the ON/OFF channel status. As this parameter is set ON, the channel is switched on (if the INTERLOCK is not active and if the channel is enabled either locally or remotely) highlighted in green when channel ON; onstate = ON; offstate = OFF
POn (EN/DIS):	Power-On option, which can be enabled or disabled. If this option is enabled, at Power-On or after a Restart each channel is restored in the same condition (defined by the Power parameter) it was before the Power-Off or Reset. If this option is disabled, at Power-On or after a Restart all the channels are off, independently from the condition in which they were before the Power-Off or Reset ; onstate = Enabled; offstate = Disabled
PDwn (Kill/Ramp):	Power-Down option, which can be set as KILL or RAMP. It affects the way the channels react at a Power-Off command caused by a TRIP condition. If the KILL option is selected, the relevant channel will be switched off at the maximum rate available. If the RAMP option is selected, the voltage will drop to zero at a rate determined by the value of the Ramp-Down parameter programmed for that channel; onstate = Ramp; offstate = Kill
TripInt:	2N-bit word (hexadecimal) maximum 16 lines, where N is the number of the board's Internal Trip Bus lines. Bits [0;N-1] allow the channel to sense the trip status from the corresponding lines when set to one; in the same way, bits [N;2N-1] allow the channel to propagate the trip status over the Trip Bus: bit N on line 0 and so on (see SY4527 User's manual).
TripExt:	Must be set in the 0÷255 range (hexadecimal). Bits [0;3] allow the channel to sense the trip status from the corresponding lines when set to one; in the same way, bits [4;7] allow the channel to propagate the trip status over the trip bus: bit 4 on line 0 and so on (see SY4527 User's manual).

If the POWER ON option is enabled, as the module is turned ON, the channel is restored to the same condition it was before the POWER OFF or RESET; if this option is disabled, at POWER ON or after a RESET, the channel is kept OFF independently from its previous condition.

Channel STATUS Flag

The following messages may be returned by the SYSTEM when monitoring the channel STATUS:

RUP	channel ramping up
RDWN	channel ramping down
OVC	channel in OVERCURRENT condition
OVV	channel in OVERVOLTAGE condition
UNV	channel in UNDERVOLTAGE condition
VMAX	channel reached VMAX condition

E-TRIPPED   channel OFF due to external TRIP line signal[2]
I-TRIPPED   channel OFF due to internal OVERCURRENT condition
EXT_DIS   channel disabled by board INTERLOCK protection
PWR_FAIL   channel OFF due to exceeded power limit (>1.5W)

After a E-TRIPPED, I-TRIPPED, EXT_DIS notification, it is necessary to perform a CLEAR ALARM cycle, before turning the channel ON.

Moreover, it is possible to monitor board parameters, such as measured Temperature, HIMax and HVMax, and to check board status; the following messages may be returned by the POWER SUPPLY SYSTEM when monitoring the board status:
UNDER_TEMP   board temperature < 5°C
OVER_TEMP   board temperature > 65°C
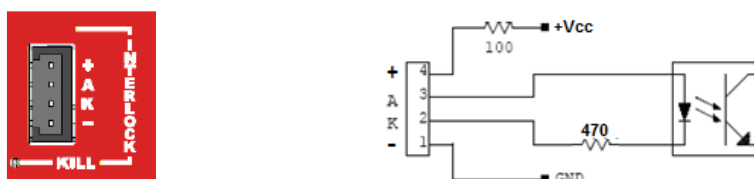
Interlock protection

Fig. 3 – INTERLOCK electrical scheme

In order to enable the HV output channels, first of all it is necessary that SAFETY LOOP pin on the DB37 output connector is short circuited with the next RETURN pin; if the board features SHV connectors, skip this step. Then it is necessary to configure the Interlock connector as follows:

contact open	INTERLOCK
voltage level (0÷1V, ~5mA current) between pin 2 and pin 3	INTERLOCK
short circuit pin 1 with pin 2, and pin 3 with pin 4	ENABLED
voltage level (4÷6V, ~5mA current) between pin 2 and pin 3	ENABLED

A schematic diagram of the Interlock input is shown in the figure above, where the diode is part of opto-coupler stage. *Interlock* means that channel is hardware disabled.

The front panel Interlock LED is ON when the INTERLOCK is active; as INTERLOCK is active, channels are turned off at the fastest available rate, regardless the RAMP DOWN setting.

Grounding specifications

The Mod. A7038 channels share a common floating return (HVGND), insulated from the crate ground (DGND). This feature allows on-detector grounding, thus avoiding loops which may increase noise level. HVGND and DGND may be connected, by short circuiting J1 jumper pins on the motherboard (see figure below).

Fig. 4 – J1 jumper location

---

[2] EXTTRIP and INTTRIP parameters are expressed in Hexadecimal format

Safety Earth connection

The connection of return to Earth is fundamental for User safety. The connection must always be at the level of detector or power supply system. Return connection even if not present or performed incorrectly, due to protection circuits implemented on the A7038 are bound to Earth; in this case the voltage difference between return and Earth (System), is limited to approximately 50V. Please note that this is a status of emergency-protection, not a working one. The Connector Configurator allows to optimize the connection of the return and of DGND (Earth). The best configuration must be determined by the user upon application, the optimal connection depends on many characteristics of the related experiment.
The following diagrams show two examples of configuration, namely:
The "closed loop" Earth configuration (J1 contacts closed)
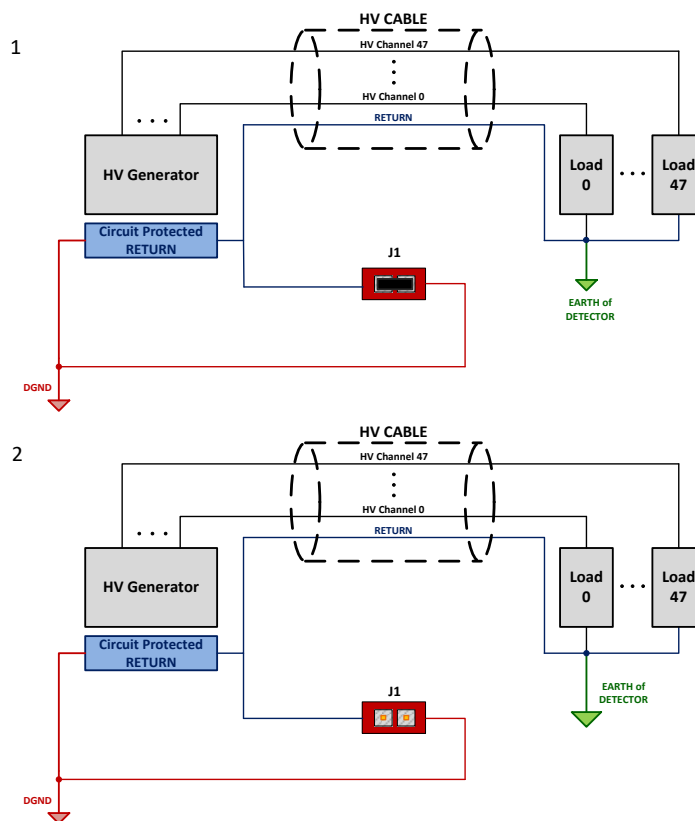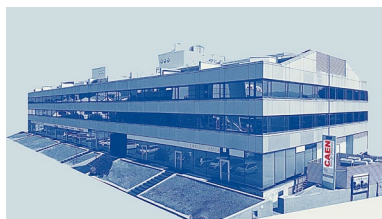The "open loop" Earth configuration (J1 contacts open)

Fig. 5 – Earth configuration connection examples

CAEN GmbH
Brunnenweg 9
64331 Weiterstadt
Germany
Tel. +49 (0)212 254 4077
Mobile +49 (0)151 16 548 484
info@caen-de.com
www.caen-de.com

CAEN Technologies, Inc.
1 Edgewater Street - Suite 101
Staten Island, NY 10305
USA
Phone: +1 (718) 981-0401
Fax: +1 (718) 556-9185
info@caentechnologies.com
www.caentechnologies.com

CAENspa INDIA Private Limited
B205, BLDG42, B Wing,
Azad Nagar Sangam CHS,
Mhada Layout, Azad Nagar, Andheri (W)
Mumbai, Mumbai City,
Maharashtra, India, 400053
info@caen-india.in
www.caen-india.in

CAEN S.p.A.
Via Vetraia 11
55049 - Viareggio
Italy
Phone +39 0584 388 398
Fax +39 0584 388 959
info@caen.it
www.caen.it

CAEN
Tools for Discovery

Electronic Instrumentation