



**UM1711**

**A1550 AG550 5kV/1mA HV Boards**

**Rev. 7 - 28 July 2016**

# Purpose of this Manual

This document is the A1550 AG550 5kV/1mA HV Boards; it contains information about the installation, the configuration and the use of the board.

## Change Document Record

Date	Revision	Changes
3 January 2012	0	PRELIMINARY Release
28 July 2016	1	Updated table 1
22 November 2012	2	Updated Output control and monitoring
8 March 2013	3	Updated displays description
18 June 2103	4	Added Mod. AG550
25 July 2013	5	Added SHV versions
25 January 2014	6	Added "H" versions
28 July 2016	7	Removed obsoleted versions

## Symbols, abbreviated terms and notation

T.B.D.

## Reference Documents

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### Disclaimer

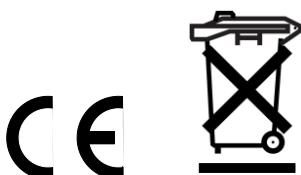
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CAEN declines all responsibility for damages or injuries caused by an improper use of the Modules due to negligence on behalf of the User. It is strongly recommended to read thoroughly the CAEN User's Manual before any kind of operation.  
*CAEN reserves the right to change partially or entirely the contents of this Manual at any time and without giving any notice.*

**Disposal of the Product** *The product must never be dumped in the Municipal Waste. Please check your local regulations for disposal of electronics products.*

**Made In Italy** : We stress the fact that all the boards are made in Italy because in this globalized world, where getting the lowest possible price for products sometimes translates into poor pay and working conditions for the people who make them, at least you know that who made your board was reasonably paid and worked in a safe environment. (this obviously applies only to the boards marked "Made in Italy", we cannot attest to the manufacturing process of "third party" boards).



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# 1. Overview

## Functional description

The Mod. A1550 – AG550 is a family of HV boards, available with either positive or negative polarity, compatible with the CAEN Universal Multichannel Power Supply System (SY1527, SY2527, SY3527, SY4527, SY5527).

The A1550 channels share a common floating return, which allows on-detector grounding reducing the noise level; the floating return is insulated from the crate earth up to  $\pm 50$  V (with a 65 V hardware limit); the return of the AG550 channels is wired to the crate Earth reference.

The output voltage range is  $0 \div 5$  kV, with 1 mA maximum output current and 0.5 V set and monitor resolution; A1550H output channels offer dual current ranges (software selectable): High Power:  $0 \div 1$  mA (Iset resolution: 2 nA; Imon resolution: 2 nA) and High Resolution:  $0 \div 20$   $\mu$ A (Iset resolution: 2 nA; Imon resolution: 50 pA).

The boards are provided with both current and voltage protections. If overcurrent occurs, the relevant channel can be programmed either to turn off after a programmable trip time or to keep on providing the maximum allowed current: this particular feature allows the modules to work as current generator. The maximum output voltage can be fixed, through a potentiometer located on the front panel, at the same common value for all the board channels and this value can be read out via software.

The HV RAMP-UP and RAMP-DOWN rates may be selected independently for each channel in the  $1 \div 500$  V/s range (1 V/s step).

The 12 channel versions output voltages are provided via SHV connectors; 24 channel versions are available with either SHV connectors or Radiall 52-pin connector. 24 channel SHV versions are double width boards (10 TE); all other versions are single width (5 TE). The boards have also the safety board interlock (see p.10): this protection allows to disable the primary HV generation when the HV outputs are not connected to their loads.

**Tab. 1 – Available versions**

Version	Channel Nr.	Polarity	Connector	Return	Size
A1550DN	12	Negative	SHV	Common Floating	1U
A1550DP	12	Positive	SHV	Common Floating	1U
AG550DN	12	Negative	SHV	Ground	1U
AG550DP	12	Positive	SHV	Ground	1U
A1550N	24	Negative	Multipin	Common Floating	1U
A1550P	24	Positive	Multipin	Common Floating	1U
AG550N	24	Negative	Multipin	Ground	1U
AG550P	24	Positive	Multipin	Ground	1U
A1550SN	24	Negative	SHV	Common Floating	2U
A1550SP	24	Positive	SHV	Common Floating	2U
AG550SN	24	Negative	SHV	Ground	2U
AG550SP	24	Positive	SHV	Ground	2U

## Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A1550 / AG550 HV Board

<b>Polarity:</b>	Positive / Negative
<b>Output Voltage:</b>	0 ÷ 5 kV
<b>Max. Output Current:</b>	1 mA
<b>Voltage Set/Monitor Resolution:</b>	0.5 V
<b>Current Set Resolution:</b>	100 nA
<b>Current Monitor Resolution:</b>	100 nA
<b>VMAX hardware:</b>	0 ÷ 5 kV common for all the board channels
<b>VMAX hardware accuracy:</b>	± 2.5% of FSR
<b>VMAX software:</b>	0 ÷ 5 kV settable for each channel
<b>VMAX software resolution:</b>	1 V
<b>Ramp Down:</b>	1 ÷ 500 Volt/sec, 1 Volt/sec step
<b>Ramp Up:</b>	1 ÷ 500 Volt/sec, 1 Volt/sec step
<b>Voltage Ripple:<sup>1</sup></b>	<25 mV typical; 40mV max
<b>Voltage Monitor vs. Output Voltage Accuracy:<sup>2,3</sup></b>	typical: ± 0.3% ± 0.5 V max: ± 0.3% ± 2 V
<b>Voltage Set vs. Voltage Monitor Accuracy:<sup>2</sup></b>	typical: ± 0.3% ± 0.5 V max: ± 0.3% ± 2 V
<b>Current Monitor vs. Output Current Accuracy:<sup>2</sup></b>	typical: ± 2% ± 500 nA max: ± 2% ± 1 μA
<b>Current Set vs. Current Monitor Accuracy:<sup>2</sup></b>	typical: ± 2% ± 500 nA max: ± 2% ± 1 μA
<b>Maximum output power:</b>	5 W (per channel, software limit)
<b>Power consumption:</b>	200 W @ full power (24 channels)

<sup>1</sup> From 10 Hz to 15 MHz at full load; ripple may exceed such limits whenever OVC and UNV occur (see p.9)

<sup>2</sup> From 10% to 90% of Full Scale Range

<sup>3</sup> During operation in Overcurrent or when VMAX Hardware is reached (and/or exceeded), VMON values have to be assumed as "indication"; possible monitor drifts are caused by the different regulation mode.

## Front Panel

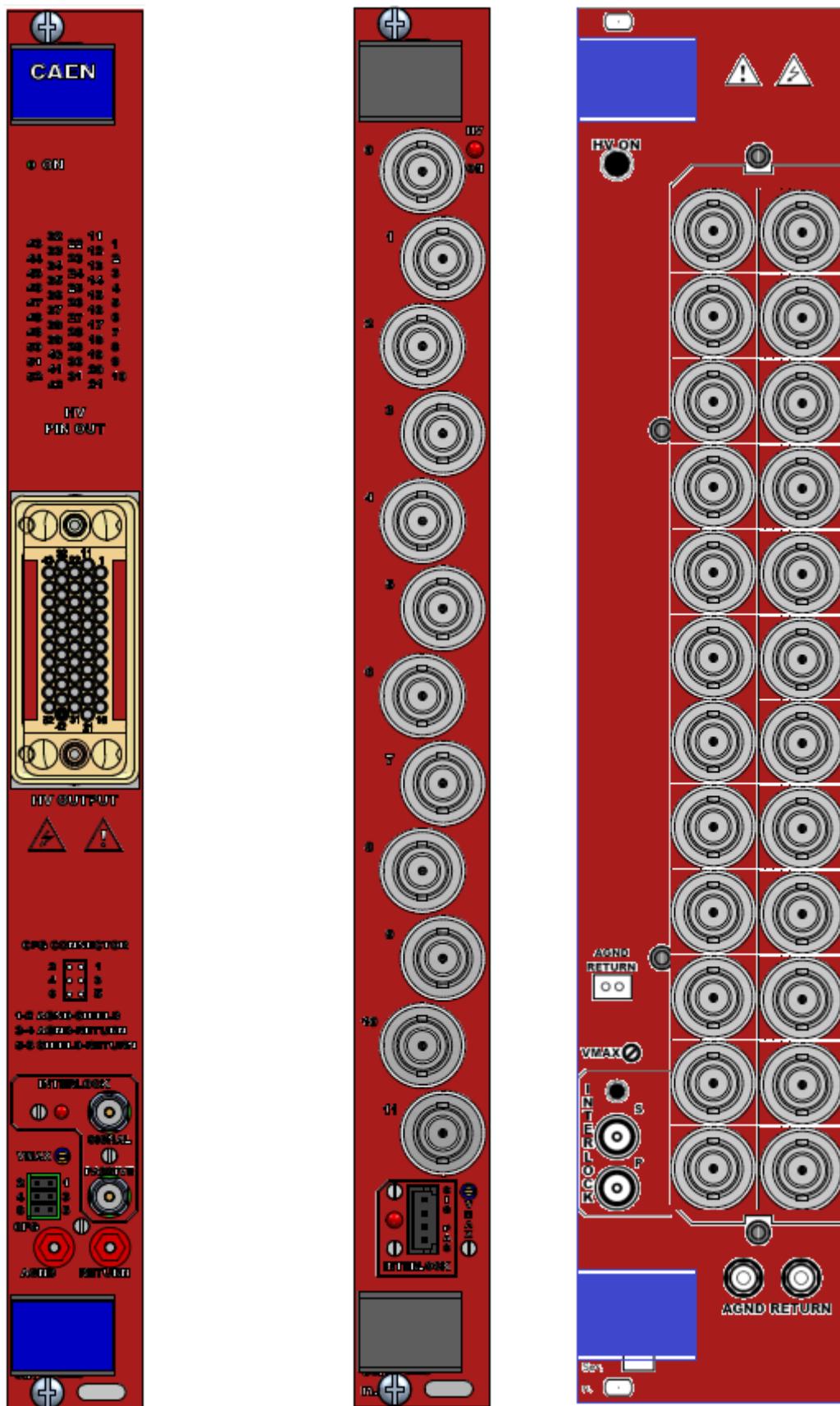


Fig. 1 – A1550 , A1550D and A1550S front panel

## Technical Specifications

### Packaging

24 channel SHV versions (A1550S, AG550550S) are double width boards (10 TE); all other versions are single width (5 TE); height is 6U.

### External connections

The function and electro-mechanical specifications of the external connectors are listed in the following subsections.

<b>Version:</b>	A1550, AG550	A1550S, A1550D, AG550S, AG550D
<b>Output Channels:</b>	Multipin connector Radiall 691803004 type, 52 pin male (to be mated with Radiall 691802002 [SCEM 09.41.34.700.2] type <sup>4</sup> ); see Table below	HV coaxial connectors Radiall SHVR317580
<b>Return:</b>	Radiall R921921 socket, Ø 2mm (A1550x only)	Not present on A1550D AG550D
<b>AGND:</b>	Radiall R921921 socket, Ø 2mm (A1550x only)	Not present on A1550D AG550D
<b>PASSIVE INTERLOCK:</b>	00-type LEMO connector	AMP 280371-2 (A1550D, AG550D)
<b>SIGNAL INTERLOCK:</b>	00-type LEMO connector	AMP 280371-2 (A1550D, AG550D)

### Multipin connector pin assignment

Table 2 – 52 pin connector assignment

1	N.C.	11	Return	22	N.C.	32	Return	43	N.C.
2	N.C.	12	N.C.	23	N.C.	33	N.C.	44	N.C.
3	HVOUT23	13	N.C.	24	HVOUT12	34	HVOUT6	45	HVOUT0
4	N.C.	14	HVOUT18	25	HVOUT13	35	HVOUT7	46	HVOUT1
5	N.C.	15	HVOUT19	26	HVOUT14	36	HVOUT8	47	HVOUT2
6	N.C.	16	HVOUT20	27	HVOUT15	37	HVOUT9	48	HVOUT3
7	N.C.	17	HVOUT21	28	HVOUT16	38	HVOUT10	49	HVOUT4
8	N.C.	18	HVOUT22	29	HVOUT17	39	HVOUT11	50	HVOUT5
9	INT_A	19	N.C.	30	N.C.	40	N.C.	51	N.C.
10	INT_B	20	N.C.	31	SHIELD	41	N.C.	52	SHIELD
		21	Return			42	Return		

### Displays

<b>HV ON LED:</b>	<i>Function:</i> lights up as at least one channel is on <i>Type:</i> red LEDs for positive polarity version; yellow green LEDs for negative polarity version.
<b>INTERLOCK LED:</b>	<i>Function:</i> lights up as the board is in INTERLOCK (channel are disabled). <i>Type:</i> red LED

### Other components

<b>VMAX trimmer:</b>	<i>Function:</i> it allows to adjust the hardware maximum voltage VMAX common to all the channels. Its value can be read out via software.
<b>Shield configuration jumpers (A1550 only):</b> <i>Function:</i> see table below	

Table 3 – Configuration jumpers

1-2	Agnd - Shield	Connects Agnd (Earth) to HV cable shield
3-4	Agnd - Return	Connects Agnd (Earth) to HV channels return
5-6	Shield - Return	Connects Shield to HV channels return

<sup>4</sup> Requires 52 pins Radiall 691804300 [SCEM 09.41.33.830.7] type, to be inserted using the insertion/extraction tool Radiall 282549024 [SCEM 34.95.17.125.3] type.

## 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**

High Voltage



**WARNING**

Refer to Manual

### Installation

The Mod. A1550 / AG550 is a SYx527 board. 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. A1550 / AG550 board 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.



### WARNING

THE MOD. A1550 / AG550 BOARD REQUIRES  
SYSTEM FIRMWARE VERSION 2.00.01 OR LATER

## Output control and monitoring

For each output channel, it is possible, through the system, to perform the following operations:

- Assign to channel a symbolic name
- Set output voltage (VSET)
- Set max. output current (ISET)
- Set output voltage software limit (SVMAX)
- Set voltage ramp-up rate (RAMP-UP)
- Set voltage ramp-down rate (RAMP-DOWN)
- Set TRIP parameter
- Enable/disable POWER ON option
- Switch channel ON/OFF
- Monitor output voltage (VMON)
- Monitor output current (IMON)
- Monitor channel status

If the POWER ON option is enabled, the channel, at POWER ON, is restored in 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.

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

OFF	(channel turned OFF)
RUP	(channel ramping up)
RDWN	(channel ramping down)
OVC	(channel in OVERCURRENT condition)
OVV	(channel in OVERVOLTAGE condition)
UNV	(channel in UNDERRVOLTAGE condition) <sup>5</sup>
EXTTRIP	(channel OFF due to external TRIP line signal) <sup>6</sup>
INTTRIP	(channel OFF due to internal OVERCURRENT condition)
EXT_DIS	(channel disabled by board INTERLOCK protection)

Moreover it is possible to monitor board temperature and to check board status; the following messages may be returned by the SYSTEM when monitoring the board status:

UNDER_TEMP	(board temperature < 5°C )
OVER_TEMP	(board temperature > 65°C)

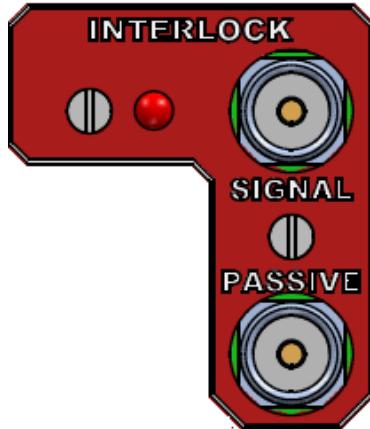
<sup>5</sup> UNV is also reported when Hvmax limit is reached, it is up to the User to verify that VMON value does not exceed HVMAX.

<sup>6</sup> EXTTRIP and INTTRIP parameters are expressed in Hexadecimal format

## Output Enable

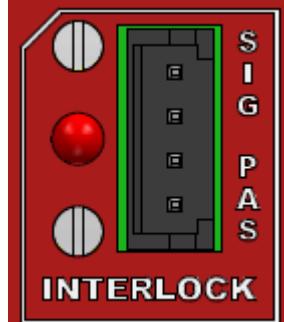
In order to enable the HV output channels, first of all it is necessary that pin 9 and 10 on the Radial 52pin output connector are short circuited (see External connections); if the board features SHV connectors, skip this step. Then the enable procedure is completed in one of the following ways:

- Boards with LEMO interlock connectors



- terminating PASSIVE INTERLOCK (see External connections) connector on 50 Ohm.
- supplying SIGNAL INTERLOCK (see External connections) connector with +5 V (3-4mA) signal.

- Boards with AMP interlock connectors



- Short circuit pin 3 and 4 [the lower ones]. Leave contact open between pin 1 (+) and 2 (-) [upper ones]
- Apply +5 V (3-4mA) differential signal between pin 1 (+) and 2 (-); pin 1 is the upper one. Leave contact open between pin 3 and 4.

The INTERLOCK LED (red) is turned off as one of the actions above is performed.

When the channels are disabled the voltage outputs drop to zero at the maximum rate available; when the output disable cause is removed (see above), the channels remain OFF until the User turns them ON via software.

## Grounding specifications

The Mod. A1550 channels share a common floating return (FAGND, see External connections), available on the front panel multipin connector, insulated from the crate ground (AGND, see External connections), which is available as front panel 2mm socket connector. This feature allows on-detector grounding, thus avoiding loops which may increase noise level. FAGND and AGND may be coupled in several ways, according to environment requirements. Examples refer to 24 channel version (A1550).

## Safety Earth connection

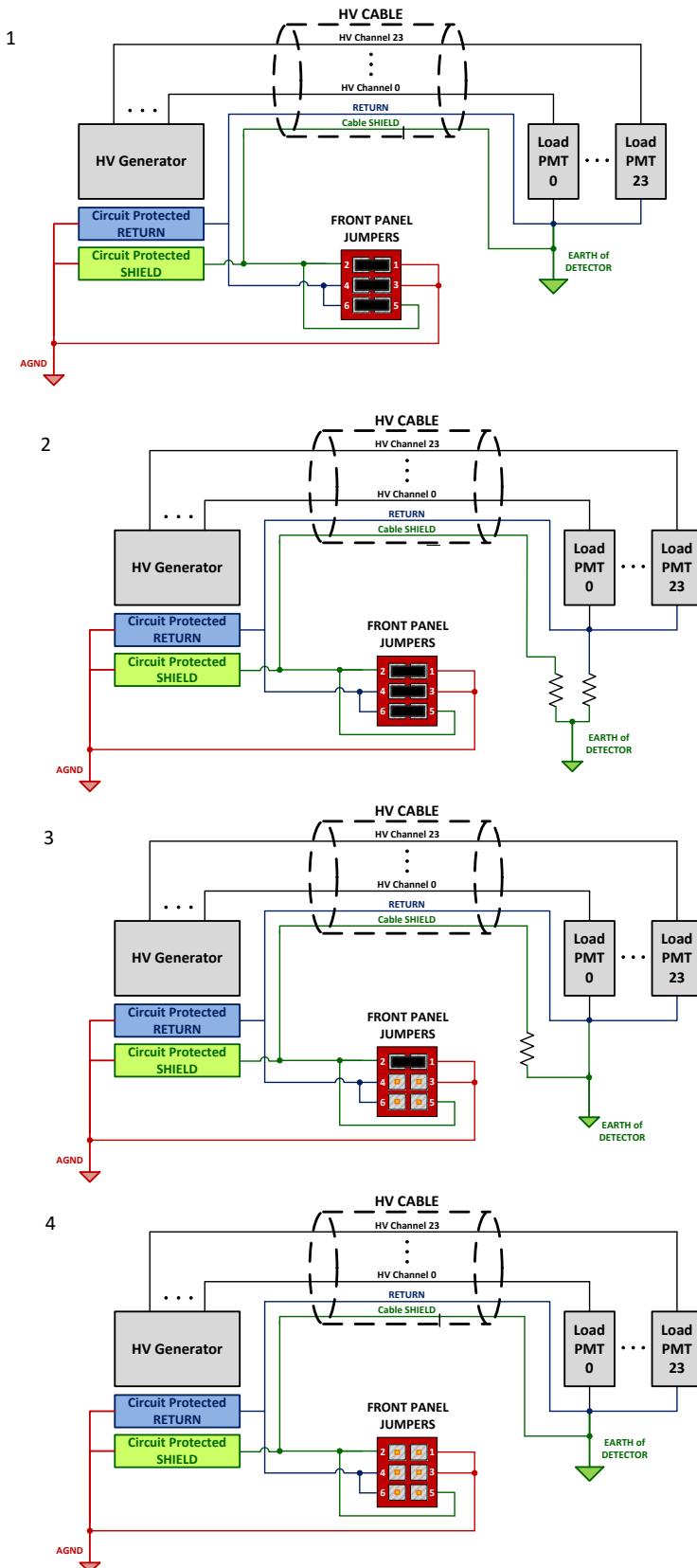
The connection of shield and return to Earth is fundamental for User safety.

The connection must always be at the level of detector or power supply system.

Return and Shield connections even if not present or performed incorrectly, due to protection circuits implemented on the A1550 are bound to Earth; in this case the voltage difference between return and Earth (System), shield and Earth 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 shield, of the return and of AGND (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 four examples of configuration, namely:

1. The “closed loop” Earth configuration
2. The “closed loop” Earth configuration, with protection stage on the load grounding
3. The “semi-open loop” Earth configuration
4. The “open loop” Earth configuration



**Fig. 2 – Earth configuration connection examples**



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**CAEN S.p.A.**

Via Vetraia, 11  
55049 Viareggio  
Italy  
Tel. +39.0584.388.398  
Fax +39.0584.388.959  
info@caen.it  
www.caen.it

**CAEN GmbH**

Klingenstraße 108  
D-42651 Solingen - Germany  
Phone +49 (0)212 254 4077  
Fax +49 (0)212 25 44079  
Mobile +49 (0)151 16 548 484  
info@caen-de.com  
www.caen-de.com

**CAEN Technologies, Inc.**

1140 Bay Street - Suite 2 C  
Staten Island, NY 10305  
USA  
Tel. +1.718.981.0401  
Fax +1.718.556.9185  
info@caentechnologies.com  
www.caentechnologies.com