CAEN
Tools for Discovery

Electronic Instrumentation

A1536 AG536 Family Power Supply Boards

Rev. 10 - 11 February 2015

Purpose of this Manual

This document is the A1536 AG536 Family Power Supply Boards user manual; it contains information about the installation, the configuration and the use of the board.

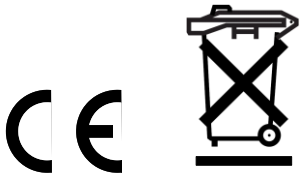
Change Document Record

Date	Revision	Changes
3 January 2012	0	PRELIMINARY Release
11 February 2015	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. AG536
25 July 2013	5	Added SHV versions
15 May 2014	6	Added “H” versions; updated Output Enable
16 July 2014	7	Updated description and technical specifications
4 September 2014	8	Added “V” versions
29 January 2015	9	Updated description and technical specifications
11 February 2015	10	Updated description, technical specifications, Output Enable, Output control

Symbols, abbreviated terms and notation

T.B.D.

Reference Documents



Index

List of Figures

List of Tables

1. Overview

The Mod. A1536 – AG536 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 A1536 and A1536H 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 ±50 V (with a 65 V hardware limit); the return of the AG536 channels is wired to the crate Earth reference.

A1536 and AG536 output range is 0 ÷ 3 kV, with 1 mA maximum output current (800µA for A1536V and AG536V) and 100mV set and monitor resolution. A1536H output channels offer dual current ranges (software selectable): High Power: 0 ÷ 1 mA (Iset res.: 20 nA; Imon res.: 1 nA; 1.5W maximum channel power) and High Resolution: 0 ÷ 100 µA (Iset res.: 20nA; Imon res.: 100 pA); it features also 50mV and 5mV set and monitor resolution respectively.

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 ÷ 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; all other models feature a Radiall 52-pin connector. 24 channel SHV versions are double width boards (10 TE); all other versions are single width (5 TE). “Multipin” versions have also the safety board interlock: this protection allows to disable the primary HV generation when the HV outputs are not connected to their loads.

Tab. 1 – Available versions

Version	Ch Nr.	Polarity	Connector	Return	Size	IMax
A1536DN	12	Negative	SHV	Common Floating	1U	1 mA
A1536DP	12	Positive	SHV	Common Floating	1U	1 mA
A1536DM	12	Mixed	SHV	Common Floating	1U	1 mA
A1536HDN	12	Negative, dual range	SHV	Common Floating	1U	1 mA
A1536HDP	12	Positive, dual range	SHV	Common Floating	1U	1 mA
A1536HDM	12	Mixed, dual range	SHV	Common Floating	1U	1 mA
AG536DN	12	Negative	SHV	Ground	1U	1 mA
AG536DP	12	Positive	SHV	Ground	1U	1 mA
AG536DM	12	Mixed	SHV	Ground	1U	1 mA
A1536LN	24	Negative	Multipin	Common Floating	1U	1 mA
A1536LP	24	Positive	Multipin	Common Floating	1U	1 mA
A1536HLN	24	Negative, dual range	Multipin	Common Floating	1U	1 mA
A1536HLP	24	Positive, dual range	Multipin	Common Floating	1U	1 mA
AG536LN	24	Negative	Multipin	Ground	1U	1 mA
AG536LP	24	Positive	Multipin	Ground	1U	1 mA
A1536SN	24	Negative	SHV	Common Floating	2U	1 mA
A1536SP	24	Positive	SHV	Common Floating	2U	1 mA
A1536SM	24	Mixed	SHV	Common Floating	2U	1 mA
A1536HSN	24	Negative, dual range	SHV	Common Floating	2U	1 mA
A1536HSP	24	Positive, dual range	SHV	Common Floating	2U	1 mA
A1536HSM	24	Mixed, dual range	SHV	Common Floating	2U	1 mA
AG536SN	24	Negative	SHV	Ground	2U	1 mA
AG536SP	24	Positive	SHV	Ground	2U	1 mA
AG536SM	24	Mixed	SHV	Ground	2U	1 mA
A1536N	32	Negative	Multipin	Common Floating	1U	1 mA
A1536P	32	Positive	Multipin	Common Floating	1U	1 mA
A1536HN	32	Negative, dual range	Multipin	Common Floating	1U	1 mA
A1536HP	32	Positive, dual range	Multipin	Common Floating	1U	1 mA
AG536N	32	Negative	Multipin	Ground	1U	1 mA
AG536P	32	Positive	Multipin	Ground	1U	1 mA
A1536VN	32	Negative, dual range	Multipin	Common Floating	1U	800µA
A1536VP	32	Positive, dual range	Multipin	Common Floating	1U	800µA
AG536VN	32	Negative	Multipin	Ground	1U	800µA
AG536VP	32	Positive	Multipin	Ground	1U	800µA

“Mixed” polarity means that half of the channels are negative and half positive

Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A1536 / AG536 HV Board

Version	A1536 / AG536	A1536H
Polarity	Positive or Negative (depending on purchased version)	
Output Voltage	0 ÷ 3 kV	
Max. Output Current	1 mA (800µA for A1536V and AG536V)	High Power: 1 mA; High Resolution: 100 µA
VSet Resolution	100 mV	50 mV
VMon Resolution	100 mV	5 mV
ISet Resolution	50 nA	20 nA
IMon Resolution	50 nA	High Power: 1 nA; High Resolution: 100 pA
VMAX hardware	0 ÷ 3 kV common for all the board channels	
VMAX hardware accuracy	± 2% of FSR	
VMAX software	0 ÷ 3 kV settable for each channel	
VMAX software resolution	1 V	
Ramp Up / Ramp Down	1÷ 500 Volt/sec, 1 Volt/sec step	
Voltage Ripple [1]	<15 mV typical; 30mV max	<10 mV typical; 15mV max
VMon vs. VOut Accuracy [2,3]	typical: ± 0.3% ± 0.25 V	
VSet vs. VOut Accuracy [2]	typical: ± 0.3% ± 2.5 V	
IMon vs. IOut Accuracy [2]	typical: ± 2% ± 500 nA	High Power: typical: ± 2% ± 50 nA High Resolution: typical: ± 2% ± 5 nA
ISet vs. IOut Accuracy [2]	typical: ± 2% ± 1µA	
Maximum output power	3 W (per channel)	1.5W (per channel)
Power consumption	160 W, 120 W, 60W @ full power (32, 24, 12 channel respectively)	80 W, 60 W, 30W @ full power (32, 24, 12 channel respectively)

[1] From 10 Hz to 100 MHz at full load; ripple may exceed such limits whenever OVC and UNV occur (see Output control and monitoring); noise measured with 1m cable length terminated on 2nF capacitance
[2] From 10% to 90% of Full Scale Range
[3] 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

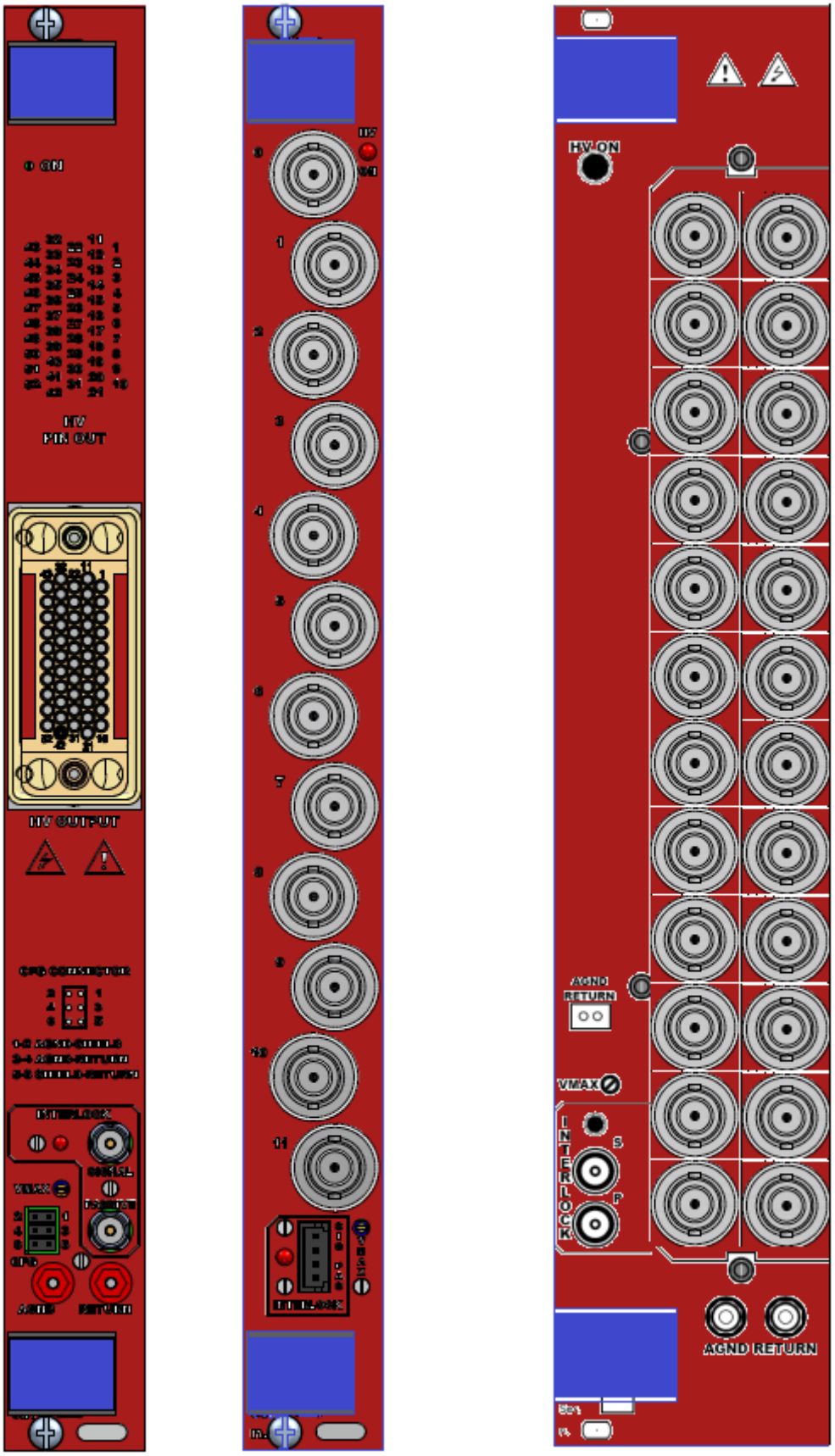


Fig. 1 – A1536, A1536D and A1536S front panel

Technical Specifications

Packaging

24 channel SHV versions (A1536S, AG536S) 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.

Version:	A1536, A1536L, AG536, AG536L	A1536S, A1536D, AG536S, AG536D
Output Channels:	Multipin connector Radiall 691803004 type, 52 pin male (to be mated with Radiall 691802002 [*SCEM 09.41.34.700.2*] type[4]); see Table below	HV coaxial connectors Radiall SHVR317580
Return:	Radiall R921921 socket, Ø 2mm (A1536x only)	Not present on A1536D AG536D
AGND:	Radiall R921921 socket, Ø 2mm (A1536x only)	Not present on A1536D AG536D
PASSIVE INTERLOCK:	00-type LEMO connector	AMP 280371-2 (A1536D, AG536D)
SIGNAL INTERLOCK:	00-type LEMO connector	AMP 280371-2 (A1536D, AG536D)

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	HVOUT24	14	HVOUT18	25	HVOUT13	35	HVOUT7	46	HVOUT1
5	HVOUT25	15	HVOUT19	26	HVOUT14	36	HVOUT8	47	HVOUT2
6	HVOUT26	16	HVOUT20	27	HVOUT15	37	HVOUT9	48	HVOUT3
7	HVOUT27	17	HVOUT21	28	HVOUT16	38	HVOUT10	49	HVOUT4
8	HVOUT28	18	HVOUT22	29	HVOUT17	39	HVOUT11	50	HVOUT5
9	INT_A	19	HVOUT29	30	HVOUT31	40	N.C.	51	N.C.
10	INT_B	20	HVOUT30	31	SHIELD	41	N.C.	52	SHIELD
		21	Return			42	Return		

HV OUT 24 through 31 are “N.C.” on A1536L and AG536L.

Other components

HV ON LED: *Function:* lights up as at least one channel is on
Type: red LEDs for positive polarity version; yellow green LEDs for negative polarity version.

INTERLOCK LED: *Function:* lights up as the board is in INTERLOCK (channel are disabled).
Type: red LED

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

[4] 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.

Configuration jumpers

The Connector Configurator allows to optimize the connection of the shield, of the return and of AGND (Earth); see also p. 11.

CFG CONNECTOR				
2 ● ● 1 4 ● ● 3 6 ● ● 5	1-2	Agnd - Shield	Connects Agnd (Earth) to HV cable shield	A1536, A1536L
	3-4	Agnd - Return	Connects Agnd (Earth) to HV channels return	A1536, A1536L, A1536S
	5-6	Shield - Return	Connects Shield to HV channels return	A1536, A1536L

On the 1536D, RTN and AGND (Earth) may be connected, by short circuiting JA jumper pins on the motherboard (see figure below). The protection shield must be screwed off in order to access JA.

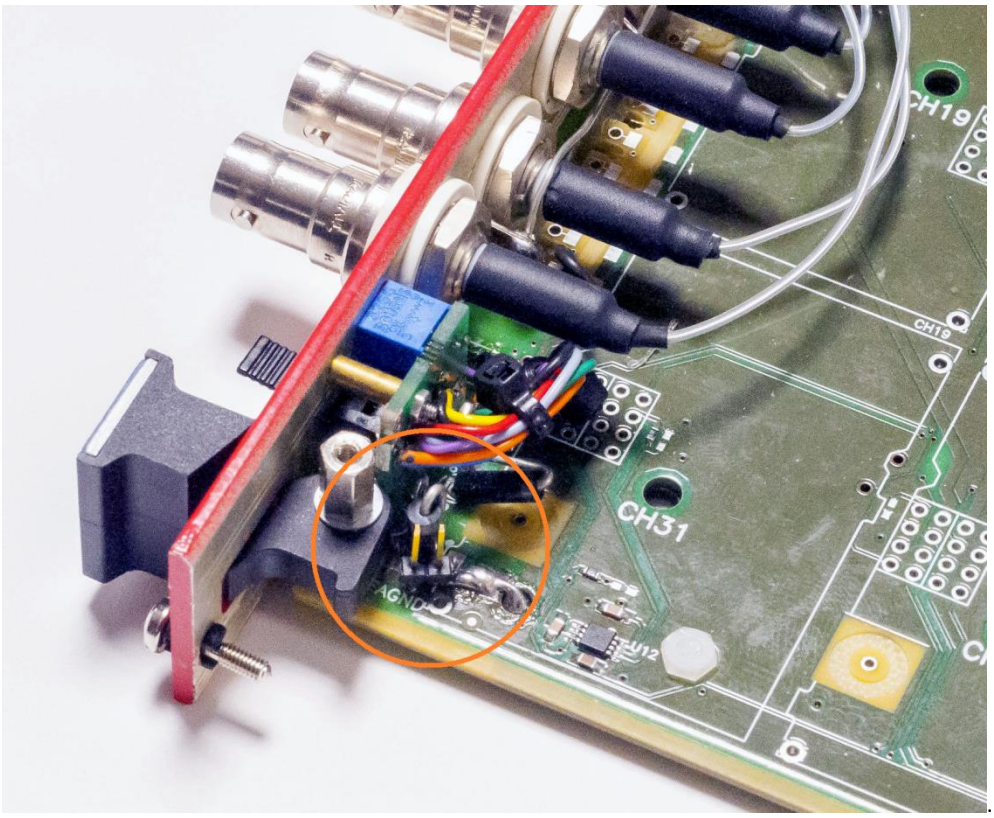


Fig. 2 – JA jumper location

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. A1536 / AG536 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. A1536 / AG536 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.

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
V1SET (settable)	the second of the two allowed voltage programmable values
I1SET (settable)	the second of the two allowed current limit programmable values
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
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 (settable)	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 (settable)	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, 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 UNDERVOLTAGE condition)5
EXTTRIP	(channel OFF due to external TRIP line signal)6
INTTRIP	(channel OFF due to internal OVERCURRENT condition)
EXT_DIS	(channel disabled by board INTERLOCK protection)

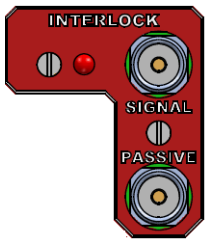
Moreover it is possible to monitor board temperature and to check board status; the following messages may be returned by the SYSTEM when monitoring the board status:

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

Output Enable

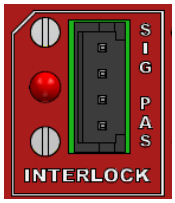
In order to enable the HV output channels, first of all it is necessary that pin 9 and 10 on the Radial 52pin output connector are short circuited (see p.7); if the board features SHV connectors, skip this step.
Then the enable procedure is completed in one of the following ways:

- Boards with LEMO interlock connectors



  - terminating the PASSIVE INTERLOCK [P] (see External connections) connector on 50 Ohm.
  - supplying the SIGNAL INTERLOCK [S] (see External connections) connector with a +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 A1536 channels share a common floating return (RTN), insulated from the crate ground (AGND/EARTH). This feature allows on-detector grounding, thus avoiding loops which may increase noise level. RTN and AGND may be coupled in several ways, according to environment requirements. Examples refer to 32 channel version (A1536).

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 A1536 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

[5] UNV is also reported when Hvmax limit is reached, it is up to the User to verify that VMON value does not exceed HVMAX.
[6] EXTTRIP and INTTRIP parameters are expressed in Hexadecimal format

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:

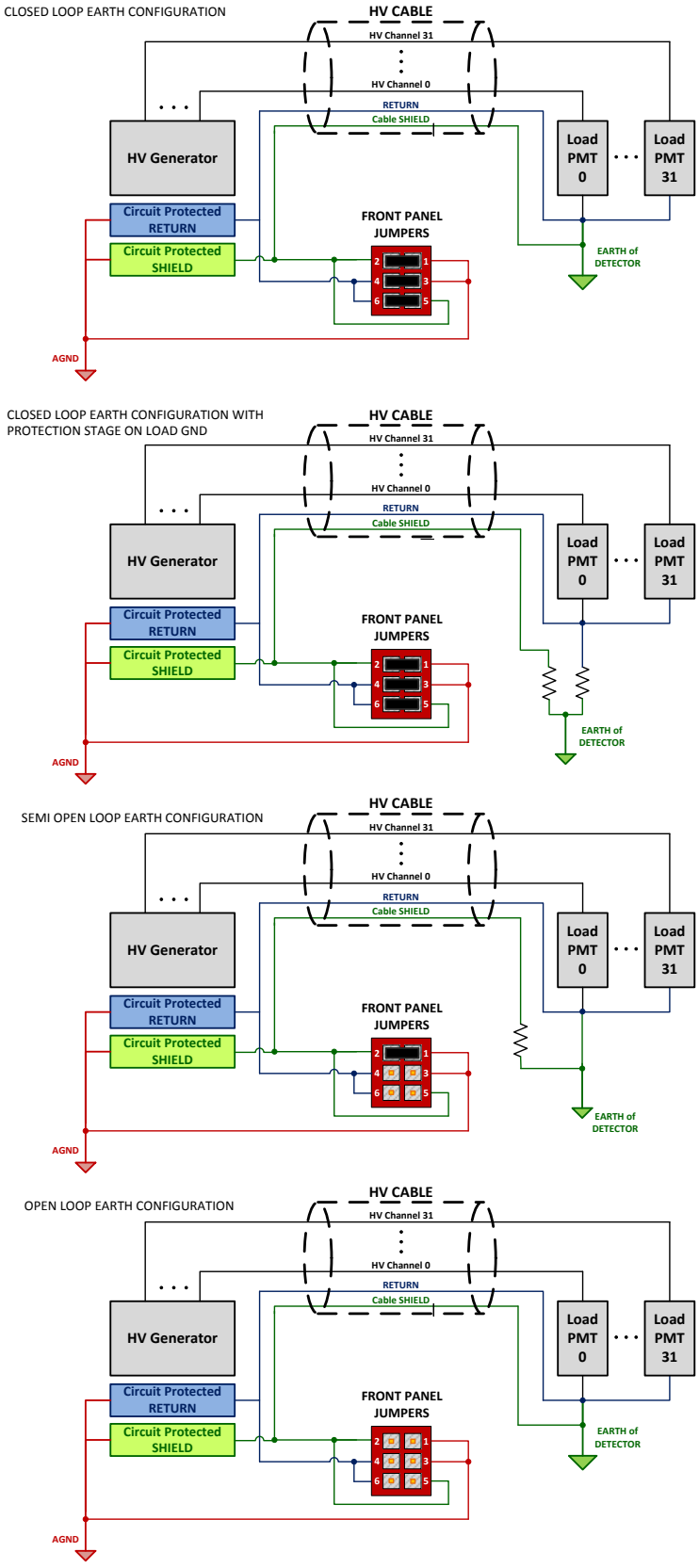


Fig. 3 – Earth configuration connection examples

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.

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

CAEN
Tools for Discovery
Electronic Instrumentation

UM2679 - A1536 AG536 Family Power Supply Boards rev. 10 - 11 February 2015

00109-11-A1536-MUTX