A7030-AG7030 3kV/ 1mA (1.5W) HV Boards

Rev. 7 - 03 September 2019

Purpose of this Manual

This document is the A7030-AG7030 3kV/ 1mA (1.5W) HV Boards user manual; it contains information about the installation, the configuration and the use of the board.

Change Document Record

Date	Revision	Changes
30 March 2015	0	PRELIMINARY Release
9 April 2015	1	Updated Overview and Channel status
5 June 2015	2	Updated Technical Specifications
1 July 2015	3	Update to new range 3kV/1mA
30 July 2015	4	Updated Channel specs p.5, set/mon parameters p.10
10 November 2015	5	Updated with 12, 24, 36 channel versions
13 April 2016	6	Updated pictures and table 2
03 September 2019	7	Updated Table1

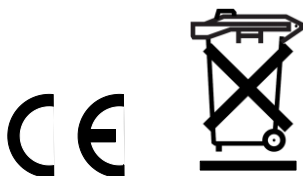# Symbols, abbreviated terms and notation

T.B.D.

Reference Documents

Index

List of Figures

List of Tables

1.   Overview

Functional description

The Mod. A7030 – AG7030 is a family of multi channel HV boards, available with either positive or negative polarity, compatible with the CAEN Universal Multichannel Power Supply System[1] (SY1527, SY2527, SY4527, SY5527).

The A7030 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; the return of the AG7030 channels is wired to the crate Earth reference.

The output voltage range is 0 ÷ 3 kV, with 1 mA maximum output current and 50mV set and 10mV monitor resolution. Maximum delivered output power is 1.5W per channel.

The boards are provided with both current and voltage protections.

Two output current limits are foreseen:

- ISet; software limit, individually set for each channel; if exceeded, the relevant channel is signalled in Overcurrent

- IMax; hardware limit, common to all channels, set via front panel trimmer and monitored via software; if exceeded 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 module to work as current generator.

The maximum output voltage can be fixed, through a trimmer 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 boards have also the safety board interlock (see p. 11).

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 boards are available with 12, 24, 36 and 48 channels; see also table below:

Model	No. of channels	HV connector	Width	Return
A7030D	12	SHV	Single (5TE)	Common Floating
A7030S	24	SHV	Double (10TE)	Common Floating
A7030L	24	Radiall 52pin	Single (5TE)	Common Floating
A7030T	36	Radiall 52pin	Single (5TE)	Common Floating
A7030	48	Radiall 52pin	Single (5TE)	Common Floating
AG7030D	12	SHV	Single (5TE)	Earth
AG7030S	24	SHV	Double (10TE)	Earth
AG7030L	24	Radiall 52pin	Single (5TE)	Earth
AG7030T	36	Radiall 52pin	Single (5TE)	Earth
AG7030	48	Radiall 52pin	Single (5TE)	Earth

[1] Please verify that the Syx527 system is running the latest firmware release

Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A7030 / AG7030 HV Board

Polarity	Positive / Negative depending on purchased version
Output Voltage	0 ÷ 3 kV
Max. Output Current	1mA
VSet Resolution	50 mV
VMon Resolution	10 mV
Current Set Resolution	20 nA
Current Monitor Resolution	2 nA
IMAX hardware	0÷1 mA
IMAX hardware resolution	1 µA
IMAX hardware accuracy	<± 1% of FSR
VMAX hardware	0 ÷ 3 kV common for all the board channels
VMAX hardware resolution	1 V
VMAX hardware accuracy	<± 1% 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 [2] 10 ÷ 1000 Hz	<15 mV typical; 20 mV max
➢ 1000 Hz	<5 mV typical; 10 mV max
VMon vs. VOut Accuracy [3,4]	typical: ± 0.3% ± 0.2 V max: ± 0.3% ± 1 V
VSet vs. VMon Accuracy [2]	typical: ± 0.3% ± 0.2 V max: ± 0.3% ± 1 V
IMon vs. IOut Accuracy [2]	typical: ± 1% ± 100 nA max: ± 1% ± 1 µA
Maximum output power	1.5 W (per channel)
Consumption @ full power	48 channels (A7030): 160 W 36 channels (A7030T): 120 W 24 channels (A7030S, A7030L): 90 W 12 channels (A7030D): 50 W

[2] From 10 Hz to 20 MHz at full load; ripple may exceed such limits whenever OVC and UNV occur (see Output control and monitoring)
[3] From 10% to 90% of Full Scale Range
[4] 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.
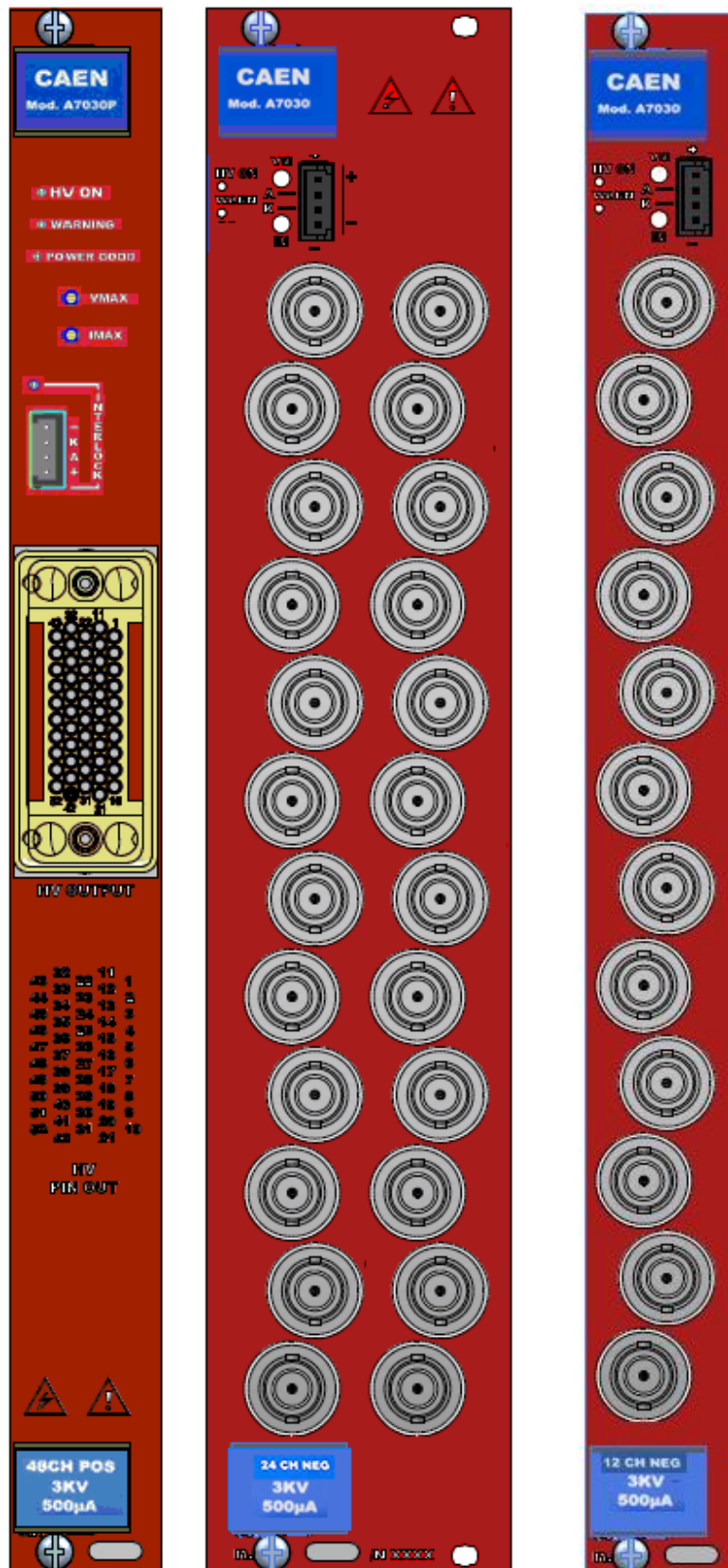
Front Panel

Fig. 1 – A7030 family front panel (48/36/24 Multipin, 24 SHV and 12 SHV channel version)

Component Specifications

Packaging

All models are single width (5 TE), except A/AG-7030S that are double width (10TE). 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)
INTERLOCK LED	*Function:* Red LED. Lights up as the board is in INTERLOCK (channel are disabled)[5].

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

The specifications of the external connectors are listed in the following subsections.

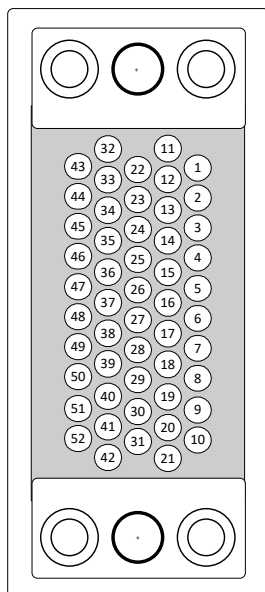| Series:	A/AG-7030-7030L-7030T	A/AG-7030D-7030S
Output Channels:	Multipin connector Radiall 691803004 type, 52 pin male (to be mated with Radiall 691802002 [*SCEM 09.41.34.700.2*] type[6]); see Table below	HV coaxial connectors Radiall SHVR317580
INTERLOCK (see p. 11):	AMP 280371-2	AMP 280371-2

---

[5] Not available on A/AG-7030D-7030S
[6] 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.

CAEN Electronic Instrumentation

Multipin connector pin assignment

Table 2 – 52 pin connector assignment

A/AG7030 – 7030T (CH36..47 N.C. on A7030T & AG7030T)

#	function	#	function	#	function	#	function	#	function
1	CH02	11	RETURN	22	CH01	32	RETURN	43	CH00
2	CH07	12	CH04	23	CH06	33	CH03	44	CH05
3	CH12	13	CH09	24	CH11	34	CH08	45	CH10
4	CH17	14	CH14	25	CH16	35	CH13	46	CH15
5	CH22	15	CH19	26	CH21	36	CH18	47	CH20
6	CH27	16	CH24	27	CH26	37	CH23	48	CH25
7	CH32	17	CH29	28	CH31	38	CH28	49	CH30
8	CH37	18	CH34	29	CH36	39	CH33	50	CH35
9	CH42	19	CH39	30	CH41	40	CH38	51	CH40
10	CH47	20	CH44	31	CH46	41	CH43	52	CH45
		21	RETURN			42	SAFETY LOOP		

A/AG7030L

#	function	#	function	#	function	#	function	#	function
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	CH23	13	N.C.	24	CH12	34	CH6	45	CH0
4	N.C.	14	CH18	25	CH13	35	CH7	46	CH1
5	N.C.	15	CH19	26	CH14	36	CH8	47	CH2
6	N.C.	16	CH20	27	CH15	37	CH9	48	CH3
7	N.C.	17	CH21	28	CH16	38	CH10	49	CH4
8	N.C.	18	CH22	29	CH17	39	CH11	50	CH5
9	S_ LOOP	19	N.C.	30	N.C.	40	N.C.	51	N.C.
10	RETURN	20	N.C.	31	N.C.	41	N.C.	52	N.C.
		21	RETURN			42	RETURN		

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. A7030 – AG7030 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. A7030 – AG7030 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
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[7]
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
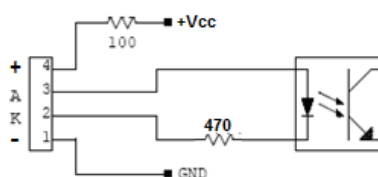OVER_TEMP   board temperature > 65°C

Interlock protection

Fig. 2 – INTERLOCK electrical scheme

In order to enable the HV output channels, first of all it is necessary that SAFETY LOOP pin on the Radiall 52pin output connector is short circuited with the next RETURN pin (pin 21 on A/AG7030 – 7030T; pin 10 on A/AG7030L); 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. A7030 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. 3 – J1 jumper location

[7] 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 A7030 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)
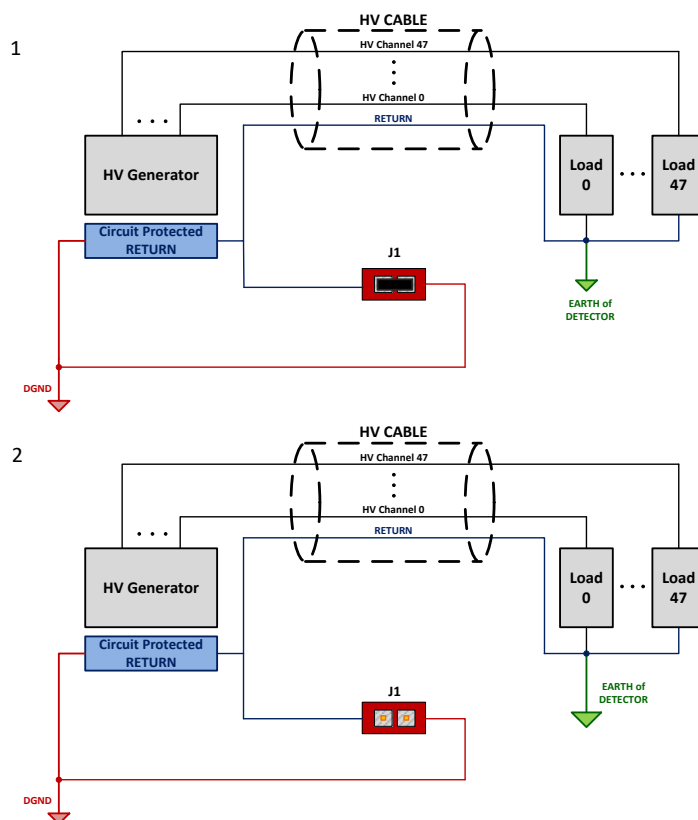
Fig. 4 – Earth configuration connection examples

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 ⬡ Electronic Instrumentation
Tools for Discovery

A7030-AG7030 3kV/ 1mA (1.5W) HV Boards rev. 6 - 13 April 2016