Rev. 11 - 21 January 2022

A704x

A704x 48 Ch. 100V/1mA; 500V/0.5-1mA Boards

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User Manual

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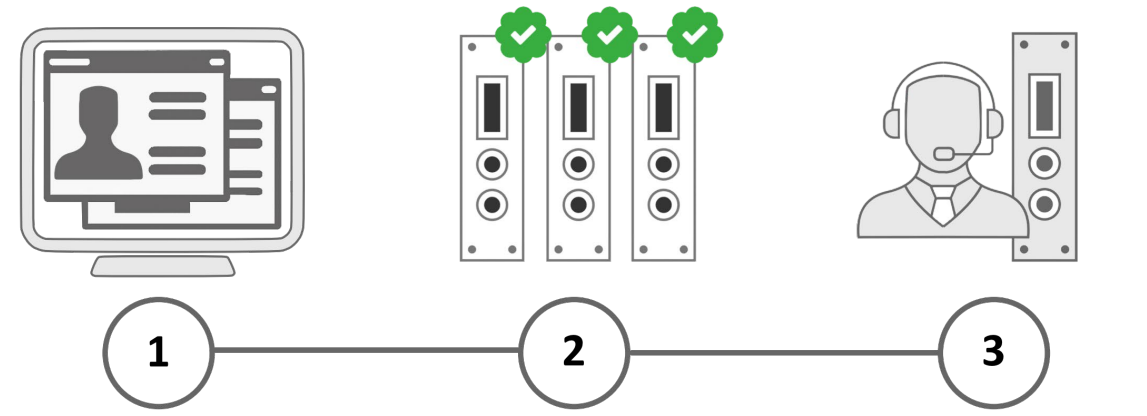

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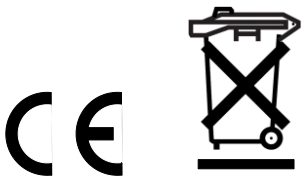
Purpose of this Manual

This document is the A704x 48 Ch. 100V/1mA; 500V/0.5-1mA 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
30 September 2015	1	Updated Technical Specifications
14 April 2016	2	Updated with A7040-AG7040
4 May 2016	3	Updated with A-AG704xA versions (DB37)
15 June 2016	4	Updated Technical Specifications
2 September 2016	5	Discontinuation of AG versions
30 May 2017	6	Updated connector description
26 September 2017	7	Improved connector description
8 April 2020	8	Updated Output control and monitoring
23 March 2021	9	Updated Technical Specifications
27 May 2021	10	Updated with A7042B data
21 January 2022	11	Updated Output control and monitoring

Reference Documents



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1. Overview

Functional description

The Mod. A704x is a family of 48 channel HV boards, available with either positive or negative polarity, compatible with the SYx527 CAEN Universal Multichannel Power Supply System.

The following versions are available:

Model	Voltage range	Max current	Return	Output connector	Width
A7042	0 ÷ 500 V	500 µA	Common floating	Radiall 52pin	5 TE
A7042A	0 ÷ 500 V	500 µA	Common floating	DB37	5 TE
A7042B	0 ÷ 500 V	1 mA	Common floating	DB37	5 TE
A7040A	0 ÷ 100 V	1 mA	Common floating	DB37	5 TE

The common floating return (insulated from the crate earth up to ±30 V) allows on-detector grounding, reducing the noise level.

The boards are provided with both current and voltage protections.

Two output current limits are foreseen:

- ISet; hardware limit, individually set for each channel; 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 channel to work as current generator.
- 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).

Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A704x HV Board

Series		7042	7042A	7042B	7040
Output Connector		Radiall 52p	DB37		
Polarity		Pos. / Neg. depending on purchased version; common floating RTN ±30V			
Output Voltage		0 ÷ 500 V			0 ÷ 100 V
Max. Output Current		500 µA		1 mA	
VSet Resolution		10 mV			2 mV
VMon Resolution		1 mV			0.2 mV
Current Set Resolution		10 nA		20 nA	
Current Monitor Resolution		1 nA		2 nA	
IMAX hardware		0÷500 µA		0÷1 mA	
IMAX hardware resolution		1 µA			
IMAX hardware accuracy		<± 1% of FSR		<± 2% of FSR	
VMAX hardware		0 ÷ 500 V common for all channels			0 ÷ 100 V common for all channels
VMAX hardware resolution		1 V			
VMAX hardware accuracy		<± 1% of FSR			
VMAX software		0 ÷ 500 V settable for each channel			0 ÷ 100 V settable for each channel
VMAX software resolution		1 V			
Ramp Up / Ramp Down		1÷ 100 Volt/sec, 1 Volt/sec step			1÷ 50 Volt/sec, 1 Volt/sec step
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 in order 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			
Voltage Ripple	**20 ÷ 1000 Hz**	<3 mVpp typical; 5mVpp max			
	1 ÷ 20000 kHz	<3 mVpp typical; 5mVpp max			
Accuracy [1,2]	**VMon vs. VOut**	typical: ± 0.1% ± 50 mV max: ± 0.1% ± 200 mV			typical: ± 0.1% ± 10 mV max: ± 0.1% ± 50 mV
	VSet vs. VOut	typical: ± 0.1% ± 50 mV max: ± 0.1% ± 200 mV			typical: ± 0.1% ± 10 mV max: ± 0.1% ± 50 mV
	IMon vs. IOut	typical: ±0.5% ±10nA max: ±0.5% ±100nA		typical: ±0.5% ±10nA max: ±0.5% ±100nA	
	IOut vs. ISet	typical: ±0.5% ±100nA max: ±0.5% ±500nA		typical: ±0,5% ±100nA max: ±0.5% ±1µA	
Channel maximum output power		0.25 W		0.50 W	0.1 W
Max power consumption		75 W		150 W	60 W
Load regulation		<0.01% (VSet = 450V, IOut 50µA ÷450µA)		<0.01% (VSet = 450V, IOut 90µA ÷900µA)	<0.01% (VSet = 90V, IOut 90µA ÷900µA)
Operating temperature		0 ÷ 45°C			
Storage temperature		-10 ÷ 70°C			
Humidity		0 – 80% non-condensing			
Altitude		2000m			
Safety Standard– ROHS – Halogen free		ROHS			
MTBF		Base: 120000 hours; Channel: 2400000 hours; TOT: 35000 hours			
EMC qualification		CE Standards			

[1] From 10% to 90% of Full Scale Range

[2] During operation in Overcurrent or when VMAX Hardware is reached (and/or exceeded), VMON values must be assumed as "indication"; possible monitor drifts are caused by the different regulation mode.

Front Panel

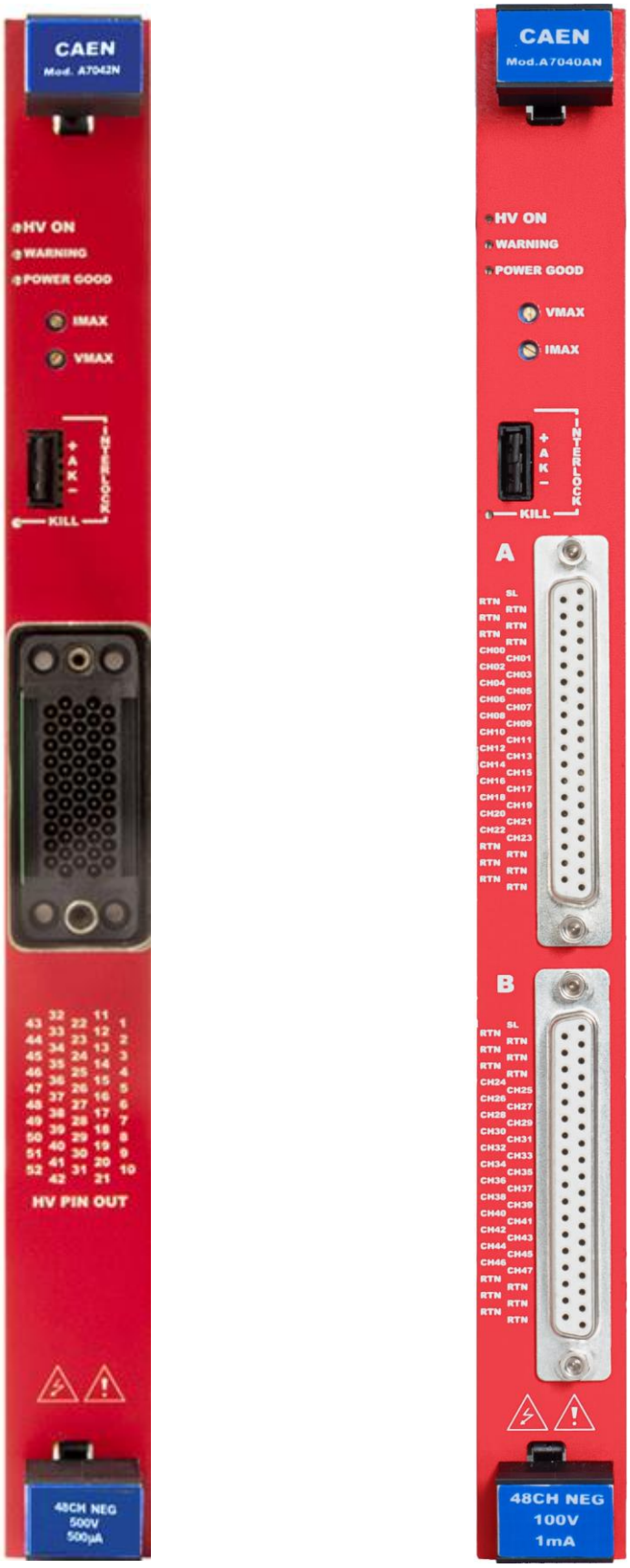


Fig. 1 – A7042 – A704XA-B front panel

Technical Specifications

Packaging

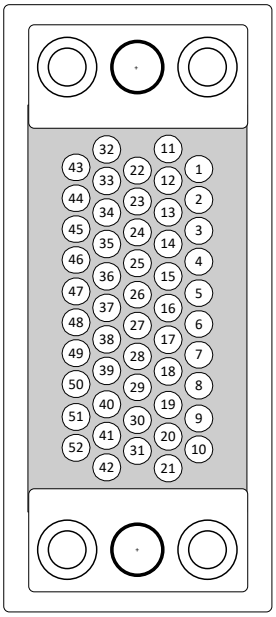
Single width (5 TE); height is 6U.

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	A7042	A7042A-B; A7040A
Output Channels	Multipin connector Radiall 691803004 type, 52 pin male (to be mated with Radiall 691802002 [*SCEM 09.41.34.700.2*] type[3])	FCI DCPV37S300GT DB37
INTERLOCK (see p. 11)	AMP 280371-2	AMP 280371-2

Output connectors pin assignment



1	CH02
2	CH07
3	CH12
4	CH17
5	CH22
6	CH27
7	CH32
8	CH37
9	CH42
10	CH47

11	RETURN
12	CH04
13	CH09
14	CH14
15	CH19
16	CH24
17	CH29
18	CH34
19	CH39
20	CH44
21	RETURN

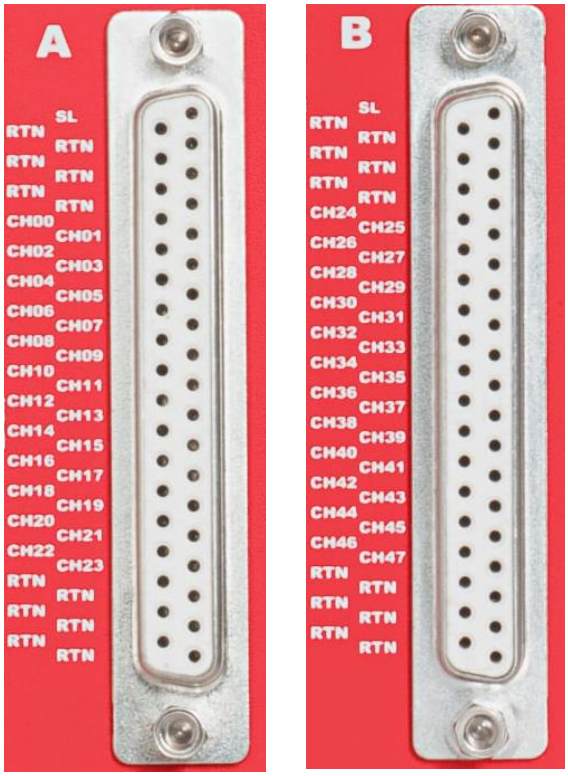
22	CH01
23	CH06
24	CH11
25	CH16
26	CH21
27	CH26
28	CH31
29	CH36
30	CH41
31	CH46

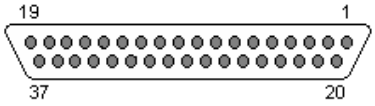
32	RETURN
33	CH03
34	CH08
35	CH13
36	CH18
37	CH23
38	CH28
39	CH33
40	CH38
41	CH43
42	Safety loop

43	CH00
44	CH05
45	CH10
46	CH15
47	CH20
48	CH25
49	CH30
50	CH35
51	CH40
52	CH45

Fig. 2 – 52 pin connector assignment

[3] 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.





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. 3 – DB37 connector pin assignment

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).

Other components

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

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. A704x are SYx527 boards. Refer to SYx527 SYSTEM for hardware installation. At power ON the SYx527 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. A704x boards can be controlled, either locally or remotely, through the SYx527 SYSTEM software interface. For details on SYx527 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
ZCDetect (settable)	On/Off: If ON, it stores the present IMon value (IMonZero) into memory for “zero current compensation” purposes (see description below); if OFF, the unit is ready to store IMon as IMonZero. After IMonZero is stored, the parameter returns to OFF
ZCAdjust (settable)	En/Dis: If Enabled, the stored IMonZero value via ZCDetect option is subtracted from the measured, “non compensated” IMON value. The returned “compensated” IMON value will be then the difference between measured and stored values. If Disabled, the returned IMON value is not compensated
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
E-TRIPPED	channel OFF due to external TRIP line signal[4]
I-TRIPPED	channel OFF due to internal OVERCURRENT condition
EXT_DIS	channel disabled by board INTERLOCK protection

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 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

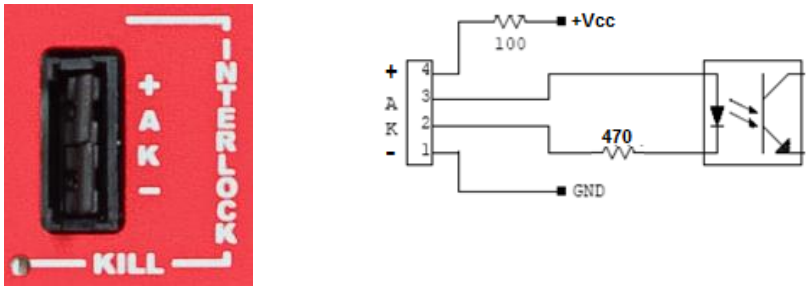


Fig. 4 – INTERLOCK electrical scheme

In order to enable the HV channels, first of all:

- Boards with RADIALL 52 pin connector: short circuit pin 21 and 42 on the 52 pin connector
- Boards with DB37 connectors: short circuit pin 1 (SL) to GND on at least one connector

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. A704x 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).

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

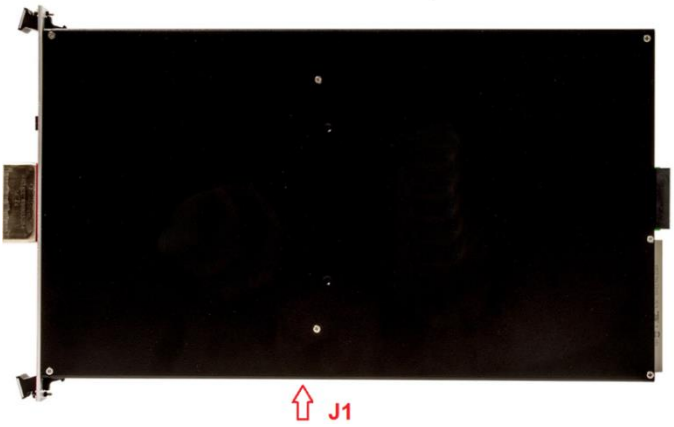


Fig. 5 – J1 jumper location

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 A704x 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)

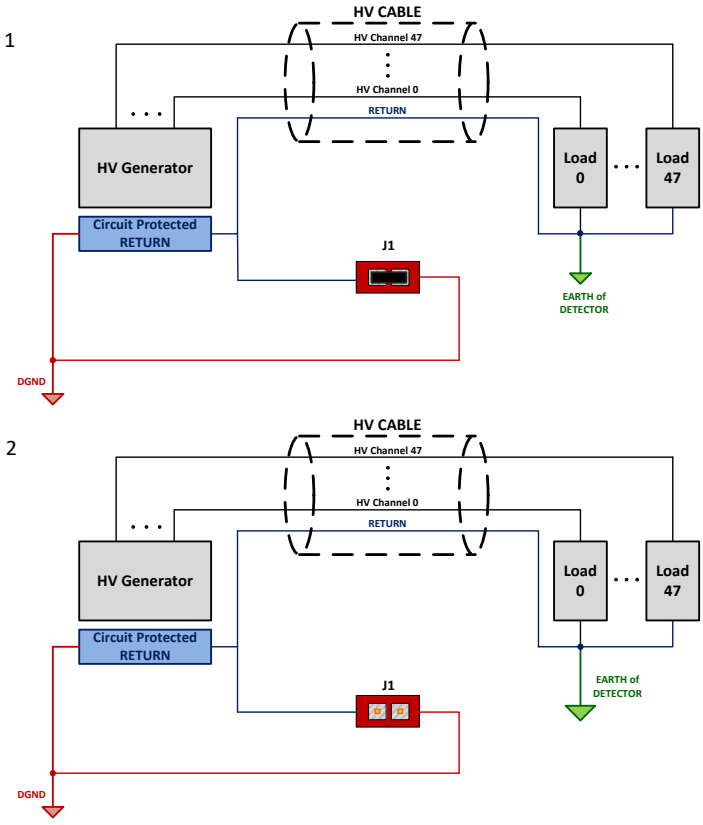


Fig. 6 – Earth configuration connection examples

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