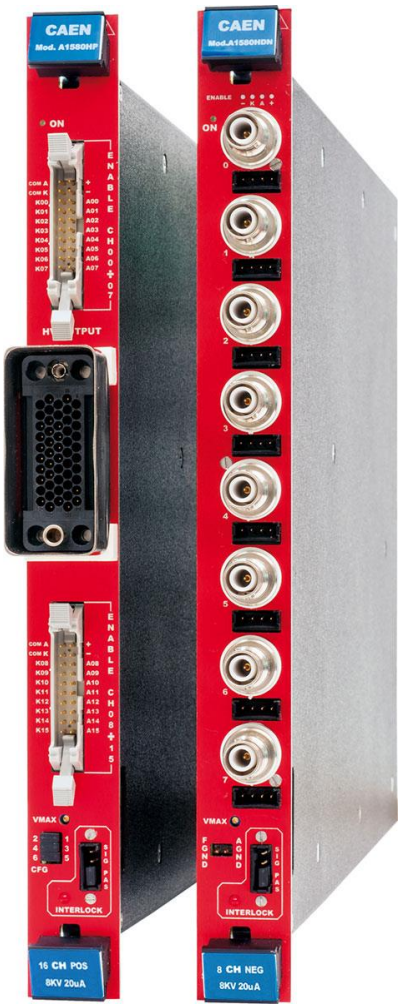
Rev. 4 - 10 Feb 2021

A1560H / A1580H

8/16 Channel 6-8 kV/20 µA Common Floating Return Boards



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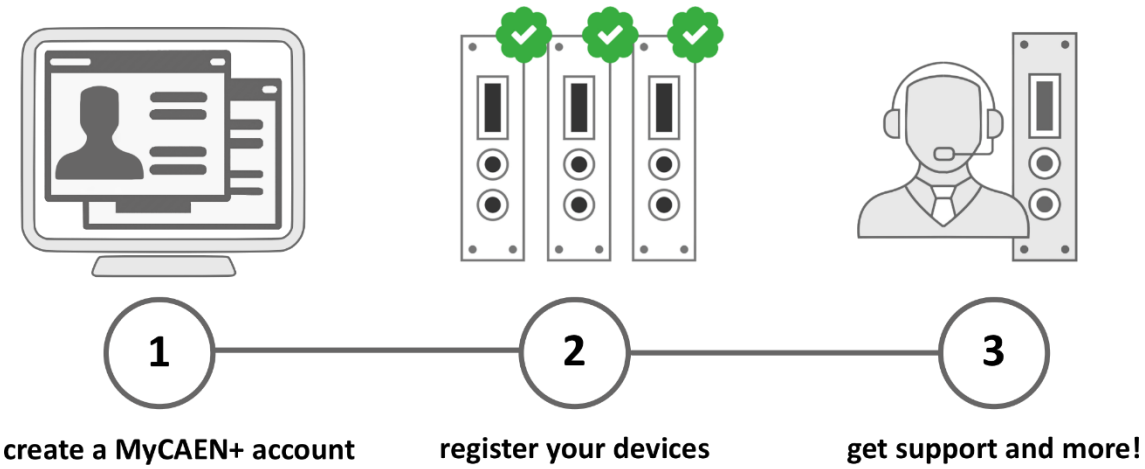

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Purpose of this Manual

This document is the A1560H A1580H 8/16 Channel 6-8 kV/20 µA Common Floating Return Boards user manual; it contains information about the installation, the configuration and the use of the board.

Change Document Record

Date	Revision	Changes
30 January 2015	0	PRELIMINARY Release
6 October 2017	1	Updated Technical Specifications, Operating modes
6 February 2018	2	Updated Technical Specifications
10 July 2019	3	Updated Output control and monitoring
10 February 2021	4	Updated Technical Specifications

Symbols, abbreviated terms and notation

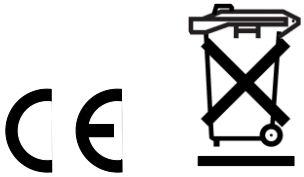
N.A.

Reference Documents

SY4527 User's Manual

SY4527 Quickstart Guide

Precautions for Handling, Storage and Installation of CAEN products



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1. Overview

Functional description

Fig. 1 – A1560H / A1580H family 16 and 8 channel boards

The Mod. A1560H/A1580H and AG560H/AG580H 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). 8 and 16 channel versions are available; all models feature individual channel enable.

The A1560H/A1580H 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 AG560H/AG580H channels is wired to the crate Earth reference.

The output voltage range is 0 ÷ 6 kV, with 20 µA maximum output current for the x560H boards and 0 ÷ 8 kV, with 20 µA for the x580H's.

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 feature allows the modules to work as current generator.

Safety features include the hardware "Interlock", that can be configured in several ways.

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 8 channel versions are provided with SHV output connectors; 16 channel versions are available with Radiall 52-pin connector. All versions are available with either positive, negative or "mixed" (half of the channels positive and half negative) polarity.

2. Technical Specifications

Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A1560H / A1580H HV Board

Version		A1560H; AG560H	A1580H; AG580H
Polarity		Positive, Negative or Mixed depending on purchased version	
Output Voltage		0÷6 kV	0÷8 kV
Max. Output Current		20 µA	
Voltage Set Resolution		100 mV	200 mV
Voltage Monitor Resolution		10 mV	
Current Set Resolution		500 pA	
Current Monitor Resolution		50 pA	
VMAX hardware		0÷6 kV common to all board channels	0÷8 kV common to all board channels
VMAX hardware accuracy		± 2% of FSR	
VMAX software		0÷6 kV settable for each channel	0÷8 kV settable for each channel
VMAX software resolution		1 V	
Ramp Up/Down		1÷500 Volt/sec, 1 Volt/sec step	
Voltage Ripple 20 ÷ 1000 Hz	**Typ**	<5mVpp	
	Max	<10mVpp	
1 ÷ 20000 kHz	**Typ**	<3mVpp	
	Max	<5mVpp	
VMon vs. VOut Accuracy [1,2]		± 0.02% ± 1.2 V	± 0.3% ± 0.5 V
VSet vs. VOut Accuracy [2]		± 0.02% ± 1.2 V	± 0.3% ± 2 V
IMon vs. IOut Accuracy [2]		± 0.2% ± 40 nA	± 2% ± 1nA
ISet vs. IOut Accuracy [2]		± 0.2% ± 40 nA	± 2% ± 10nA

[1] From 1% to 100% of Full Scale Range (A1560H; AG560H), From 10% to 90% of Full Scale Range (A1580H; AG580H)
[2] 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

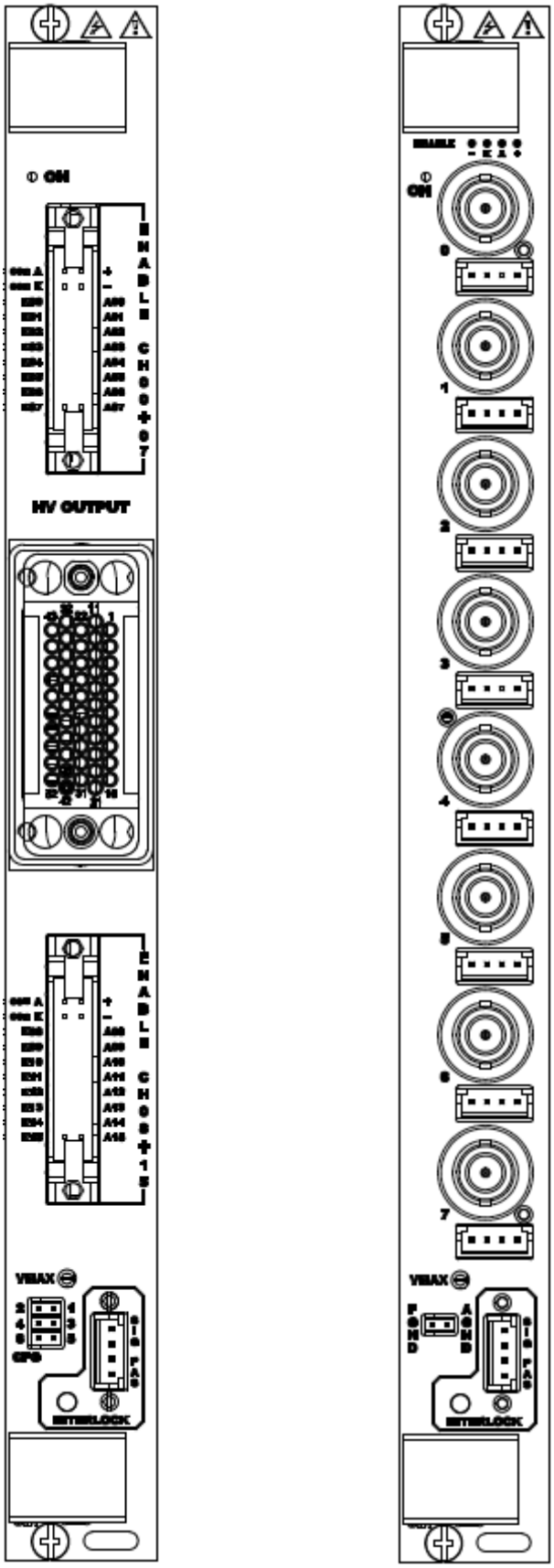


Fig. 2 – 16 and 8 channel version front panel

Packaging

All versions are single width boards (5 TE); height is 6 U.

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.

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

Version:	A1560H, A1580H, AG560H, AG580H	A1560HD, A1580HD, AG560HD, AG580HD
Output Channels:	Multipin connector Radiall 691803004 type, 52 pin male (to be mated with Radiall 691802002 [*SCEM 09.41.34.700.2*] type[3]); see Table below	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 connectors); 12kV DC – 1mn (mated pairs) Current rating: 10 A
Enable	3M 3428-5202	AMP 280371-2
Return:	On Multipin connector Radiall 691803004 type	AMP 280371-2
AGND:	On Multipin connector Radiall 691803004 type	AMP 280371-2
INTERLOCK:	AMP 280371-2	AMP 280371-2

Multipin connector pin assignment

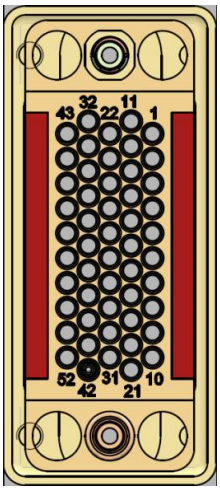


Fig. 3 – Radiall 52 pin connector

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	N.C.	13	N.C.	24	HVOUT12	34	HVOUT6	45	HVOUT0
4	N.C.	14	N.C.	25	HVOUT13	35	HVOUT7	46	HVOUT1
5	N.C.	15	N.C.	26	HVOUT14	36	HVOUT8	47	HVOUT2
6	N.C.	16	N.C.	27	HVOUT15	37	HVOUT9	48	HVOUT3
7	N.C.	17	N.C.	28	N.C.	38	HVOUT10	49	HVOUT4
8	N.C.	18	N.C.	29	N.C.	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		

[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.

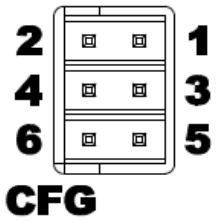
Displays

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 (channels are disabled).
Type: red LED

Jumpers and trimmers

Table 3 – Setting 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.		
	**AGND - Shield configuration jumper (SHV versions; not available on AG5xx's):**	Function: Connects AGND (Earth) to connector shield (HV Channels Return)		
	**Shield configuration jumpers (Radiall 52pin versions; not available on AG5xx's):**	Function: see below		
		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

3. Safety and installation requirements

General safety information

N.B. read carefully the "Precautions for Handling, Storage and Installation" document provided with the product before starting any operation!
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. Mod. A1560H/A1580H and AG560H/AG580H are SYx527 boards. Installation must be performed according to instructions reported in the SYx527 manual. At power ON the SYx527, 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.

N.B.: the ventilation fan speed must be set to MEDIUM at least

4. Operating modes

The Mod. A1560H/A1580H and AG560H/AG580H boards can be controlled, either locally or remotely, through the SYx527 software interface. For details on SYx527 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 into memory for "zero current compensation" purposes, see *ZCAdjust* parameter (this parameter is available only for some versions, please contact CAEN)
ZCAdjust (settable)	(EN/DIS) If enabled, the stored IMON 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 (this parameter is available only for some versions, please contact CAEN)
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).
EnCtr (settable; see p.12)	Drive: channel enabled as the photodiode of ENABLE circuit is driven Undrive: channel enabled as the photodiode of ENABLE circuit is not driven

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.
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)4
E-TRIPPED	(channel OFF due to external TRIP line signal)5
I-TRIPPED	(channel OFF due to internal OVERCURRENT condition)
EXT_DIS	(channel disabled by board INTERLOCK protection)

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)

Output Enable

The A1560H – A1580H output enable takes place at two stages: HV Enable and Interlock. The channels provide output as both stages are enabled.

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

HV Enable

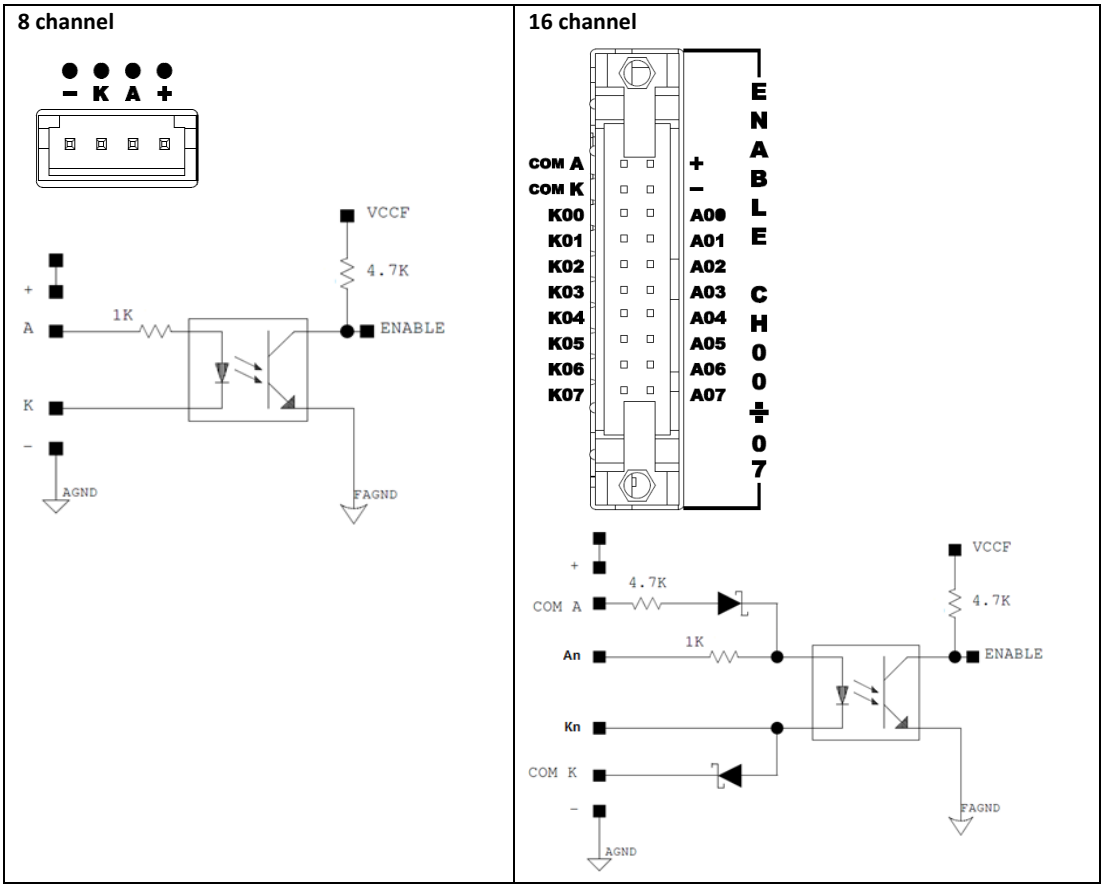


Fig. 4 – Channel HV Enable

The diagram above shows the HV enable stage in the 8 and in the 16 channel versions respectively.
In the 8 channel (SHV) version, the contact are as follows:

"+" Is the dedicated power supply (10V / 100mA)
"-" Is the power supply ground reference
"A" is the anode of the photo diode
"K" is the cathode of the photo diode

The 16 channel version has a different enable stage, where:
"COM A" is the common reference of all anodes in a group (CH00 to CH07 and CH08 to CH15)
"COM K" is the common reference of all the cathodes in a group (CH00 to CH07 and CH08 to CH15)

that is, it is not possible self biasing individually each input exploiting the local power supply, but this can be done for the 2 groups of 8 channels from CH00 to CH07 and CH08 to CH15.

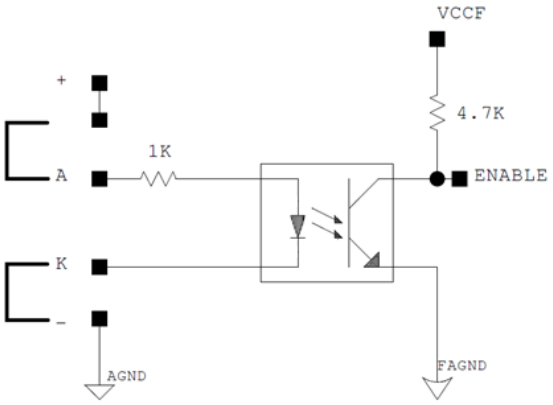
The enable depends on the setting of the EnCtr parameter (see p.10); if EnCtr is set to:

- Drive: channel is enabled as the photodiode of ENABLE circuit is driven
- Undrive: channel is enabled as the photodiode of ENABLE circuit is not driven

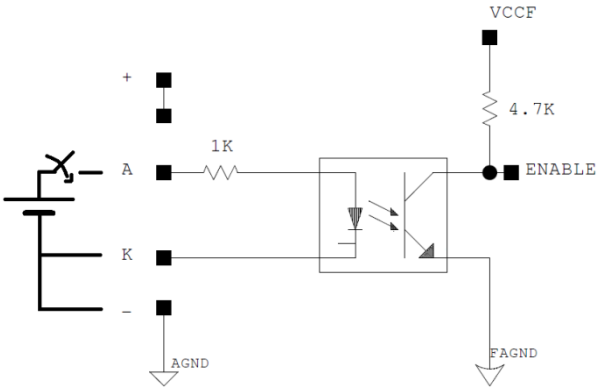
HV Enable examples

This section describes some examples to configure the HV Enable circuit to allow the channels to provide high voltage output:

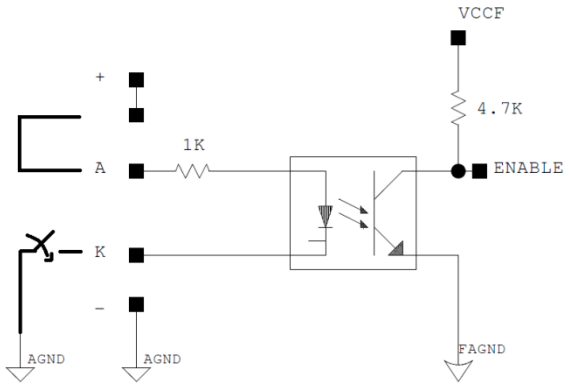
1. Set EnCtr parameter to drive and connect the contacts as follows (local enable):



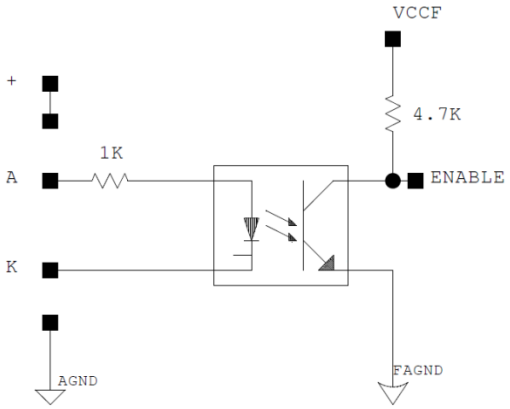
2. Set EnCtr parameter to drive and provide an external TTL, with one of the following connections (remote enable):



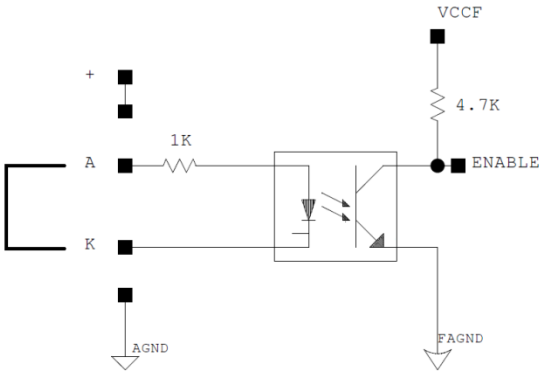
3. Set EnCtr parameter to drive and provide an external shortage (remote enable):



4. Set EnCtr parameter to undrive and leave contacts open (local enable):



5. Set EnCtr parameter to undrive and connet A with K (local enable):



Interlock

In order to enable the HV output channels, first of all it is necessary that pin 9 and 10 on the Radiall 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 this way:

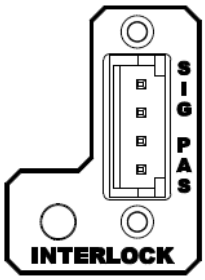


Fig. 5 – Interlock section

- Short circuit pin 3 and 4 [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. A1560H – A1580H channels share a common floating return (FAGND, see p.7), available on the front panel multipin connector, insulated from the crate ground (AGND, see p.7), which is available as front panel reference (see p.7). 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 16 channel versions.

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 board 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 (16 channels versions) 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

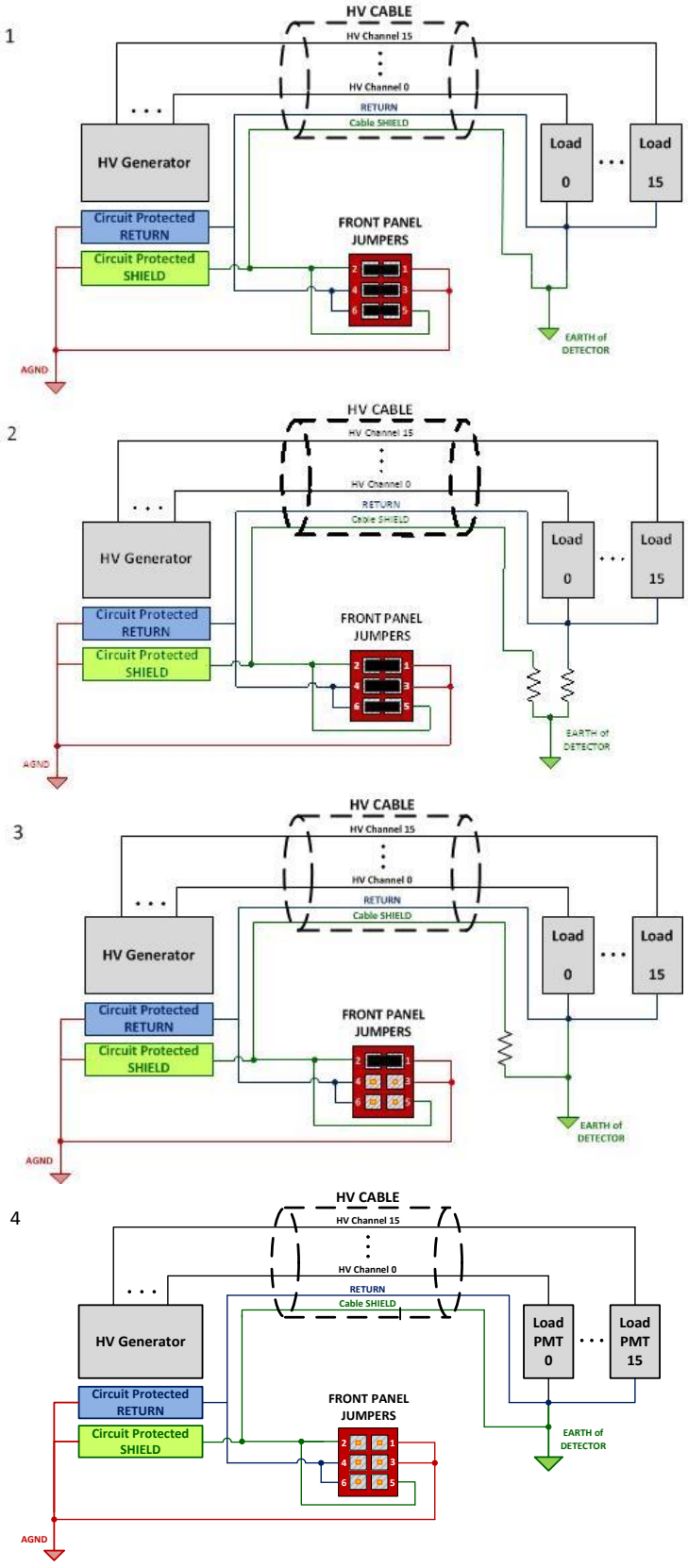


Fig. 6 – Earth configuration connection examples

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