Rev. 5 - 14 April 2020

A1590/AG590

16 Channel 9 kV/50 µA HV Boards

CAEN
Tools for Discovery

User Manual
UM2084

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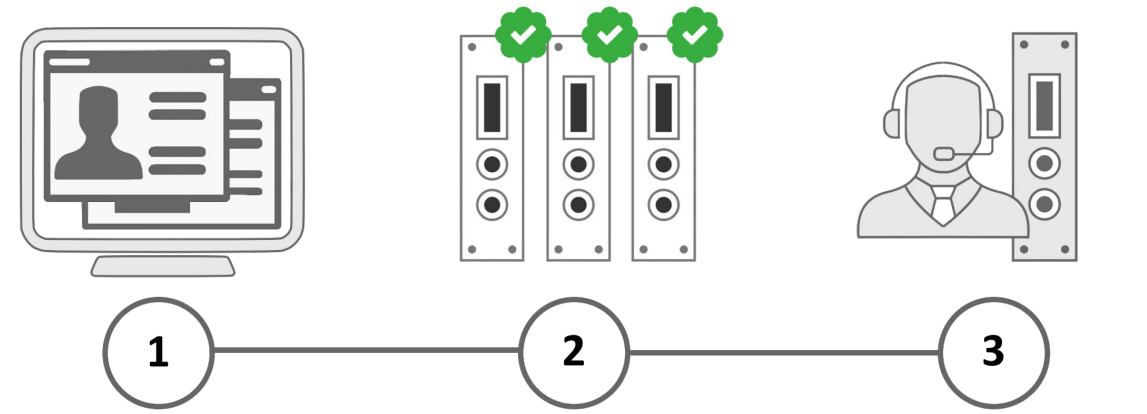

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Purpose of this Manual

This document is the A1590 - AG590 16 Ch. 9kV/50µA Boards user manual; it contains information about the installation, the configuration and the use of the board.

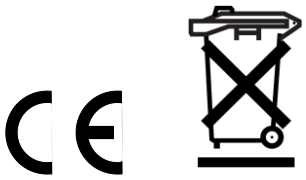
Change Document Record

Date	Revision	Changes
30 January 2015	0	PRELIMINARY Release
11 April 2016	1	Updated technical features
15 June 2016	2	Updated technical features
15 December 2016	3	Updated Radiall HV Connector pin out
5 May 2017	4	Updated images
14 April 2020	5	Updated Overview

Symbols, abbreviated terms and notation

T.B.D.

Reference Documents



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1. Overview

Functional description

The Mod. A1590 and AG590 is a family of HV boards, available with either positive or negative polarity, compatible with the CAEN Universal Multichannel Power Supply System[1] (SY1527, SY2527, SY4527, SY5527). 16 channel versions are available; the output voltage range is 0 ÷ 9 kV, with 50 µA maximum output current and is delivered by Radiall 52-pin connectors.

The A1590 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 AG590 channels is wired to the crate Earth reference.

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 / DOWN rates may be selected independently for each channel in the 1 ÷ 500 V/s range (1 V/s step).

[1] SYx527 shall run the latest available firmware release

Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A1590 / AG590 HV Board

Polarity	Positive or Negative, depending on purchased version
Output Voltage	0÷9 kV
Max. Output Current	50 µA
Voltage Set Resolution	200 mV
Voltage Monitor Resolution	10 mV
Current Set Resolution	1nA
Current Monitor Resolution	100 pA
VMAX hardware	0÷9 kV common to all board channels
VMAX hardware accuracy	± 2% of FSR
VMAX software	0÷9 kV settable for each channel
VMAX software resolution	1 V
Ramp Up/Down	1÷500 Volt/sec, 1 Volt/sec step
Trip	Max. time an "overcurrent" can 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 [2]	10 mVpp (typical); 20 mVpp (maximum)
VMon vs. VOut Accuracy [3,4]	± 0.3% ± 1 V
VSet vs. VMon Accuracy [2]	± 0.3% ± 1 V
IMon vs. IOut Accuracy [2]	± 2% ± 2nA
ISet vs. IMon Accuracy [2]	± 2% ± 20nA

[2] 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
[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 must be assumed as “indication”; possible monitor drifts are caused by the different regulation mode.

Front Panel

Fig. 1 – A1590 – AG590 front panel

Technical Specifications

Packaging

All versions are double width boards (10TE); height is 6 U.

External connections

WARNING! HV output connectors produce extremely hazardous high 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 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.

HV Out	Radiall 691803004 type, 52 pin male (mating with Radiall 691802002 [*SCEM 09.41.34.700.2*][5])
Return	Radiall R921921 socket, Ø 2mm
AGND	Radiall R921921 socket, Ø 2mm
Passive Interlock	00-type LEMO connector
Signal Interlock	00-type LEMO connector

Multipin connector pin assignment

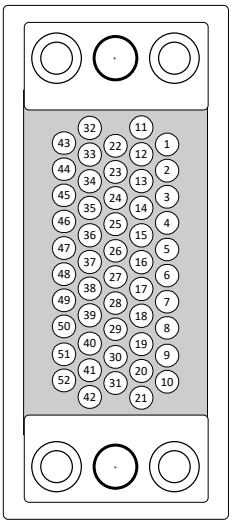


Fig. 2 – Radiall 52 pin connector

Table 2 – 52 pin connector assignment

1	N.C.	11	HVOUT10	22	N.C.	32	HVOUT04	43	N.C.
2	HVOUT13	12	N.C.	23	HVOUT07	33	N.C.	44	HVOUT00
3	N.C.	13	N.C.	24	N.C.	34	N.C.	45	N.C.
4	N.C.	14	HVOUT11	25	N.C.	35	HVOUT05	46	N.C.
5	HVOUT14	15	N.C.	26	HVOUT08	36	N.C.	47	HVOUT01
6	N.C.	16	N.C.	27	N.C.	37	N.C.	48	N.C.
7	N.C.	17	HVOUT12	28	N.C.	38	HVOUT06	49	N.C.
8	HVOUT15	18	N.C.	29	HVOUT09	39	N.C.	50	HVOUT02
9	N.C.	19	N.C.	30	N.C.	40	N.C.	51	N.C.
10	Return	20	INT_A	31	Return	41	N.C.	52	HVOUT03
		21	INT_B			42	N.C.		
Connector case = SHIELD									

[5] 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.

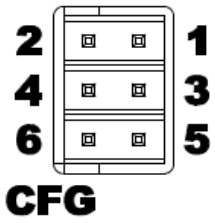
Displays

HV ON LED: *Function:* lights up as at least one channel is on
Type: red LED for positive polarity version; yellow green LED 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.		
	**Shield configuration jumpers (not available on AG590):**	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

N.B. "SHIELD" connection refers to the Radiall HV connector case; therefore, it can be cabled on the load by connecting it to the cable shield.

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. A1590 and AG590 are SYx527 boards. 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. A1590 and AG590 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
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, 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 SYSTEM may return the following messages 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)

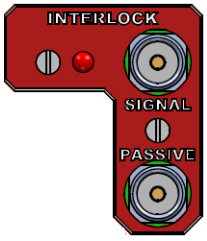
UNV	(channel in UNDERVOLTAGE condition)[6]
E-TRIPPED	(channel OFF due to external TRIP line signal)[7]
I-TRIPPED	(channel OFF due to internal OVERCURRENT condition)
EXT_DIS	(channel disabled by board INTERLOCK protection)

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 SYx527 POWER SUPPLY SYSTEM when monitoring the board status:

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

Board Interlock

In order to enable the HV output channels, first of all it is necessary that pin INT_A and INT_B on the Radiall 52pin output connector are short circuited (see p.7);
Then the enable procedure is completed in the following way:



– 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.

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 (A1590)

The Mod. A1590 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..

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.

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

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

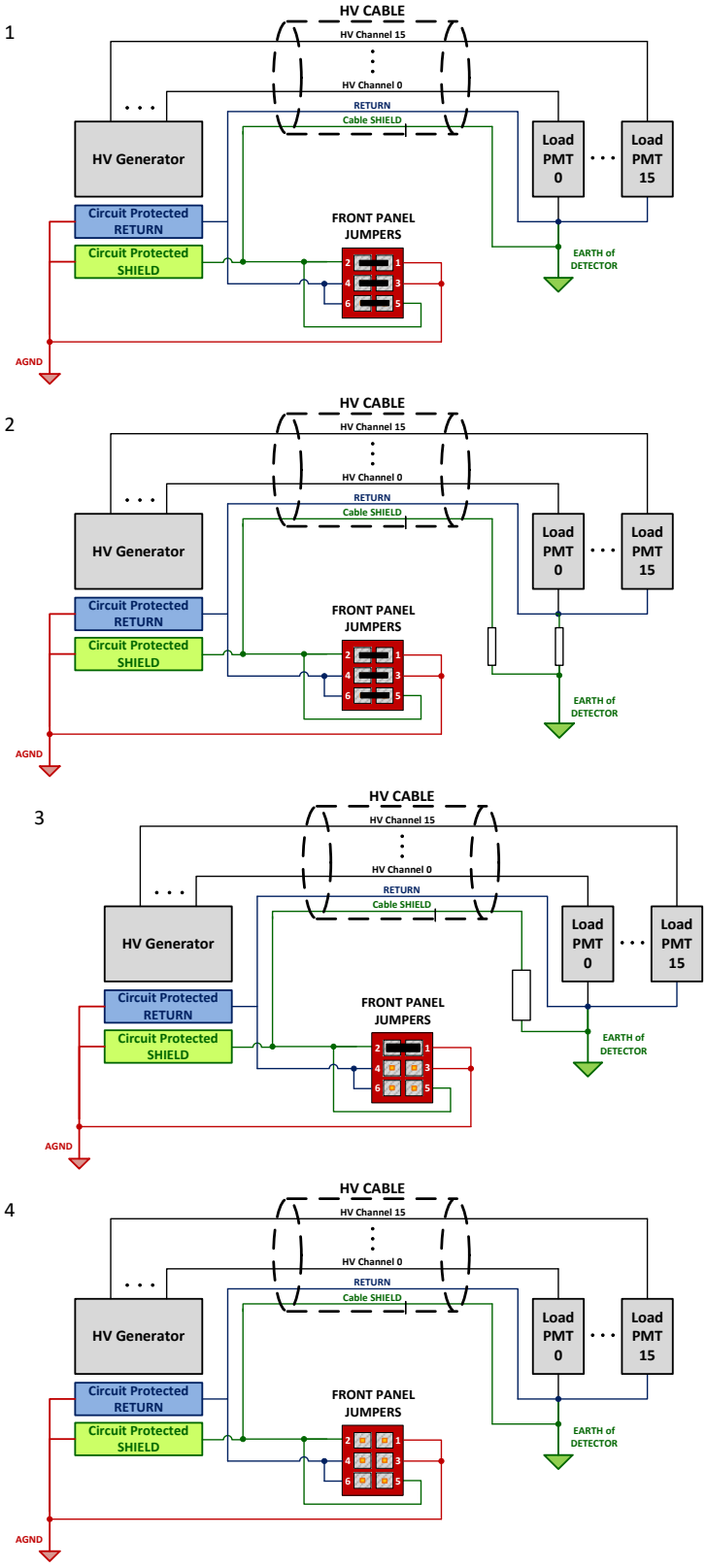


Fig. 3 – Earth configuration connection examples

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