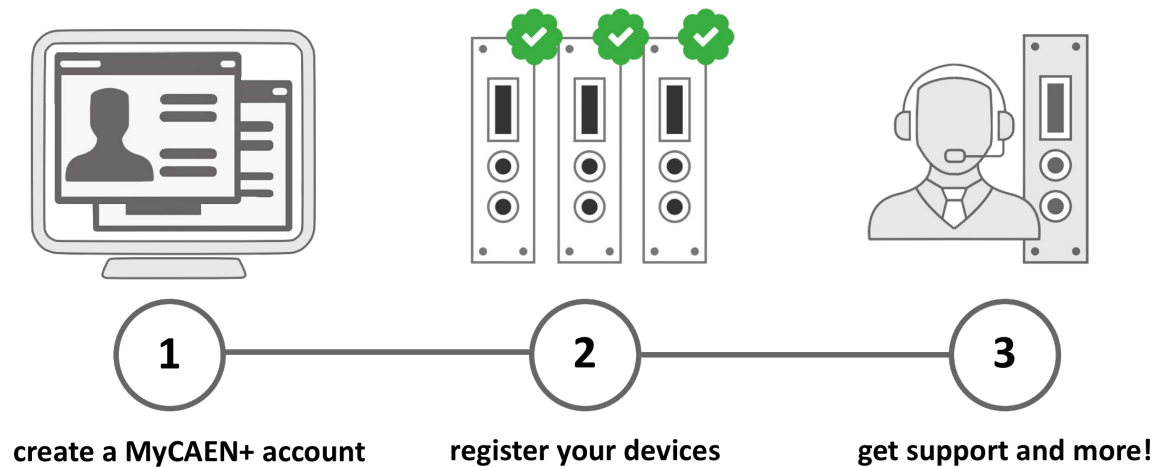




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Purpose of this Manual



This document is the A7435 AG7435 24 Channel 3.5 kV/3.5 mA (9W) 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
7 April 2016	0	PRELIMINARY Release
28 April 2017	1	New SHV versions and Updated Operating Modes
12 September 2018	2	New ground configuration switches
3 September 2019	3	Updated Channel Characteristic Table
18 March 2020	4	Updated Overview and Channel Characteristic Table
11 December 2020	5	Updated Channel Characteristic Table
9 February 2021	6	Updated Channel Characteristic Table
22 February 2021	7	Updated Output control and monitoring
4 March 2022	8	Updated Channel Characteristic Table
1 September 2022	9	Updated Channel Characteristic Table

Symbols, Abbreviated Terms and Notation

N.A.

Reference Documents

SY4527 Universal Multichannel Power Supply System User's Manual

Manufacturer Contacts



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Limitation of Responsibility



If the warnings contained in this manual are not followed, CAEN will not be responsible for damage caused by improper use of the device. The manufacturer declines all responsibility for damage resulting from failure to comply with the instructions for use of the product. The equipment must be used as described in the user manual, with particular regard to the intended use, using only accessories as specified by the manufacturer. No modification or repair can be performed.

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MADE IN ITALY: We remark that all our boards have been designed and assembled in Italy. In a challenging environment where a competitive edge is often obtained at the cost of lower wages and declining working conditions, we proudly acknowledge that all those who participated in the production and distribution process of our devices were reasonably paid and worked in a safe environment (this is true for the boards marked "MADE IN ITALY", while we cannot guarantee for third-party manufactures).

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1. Overview

Functional description

The Mod. A7435 is a family of HV boards, available with either positive or negative polarity, compatible with the CAEN Universal Multichannel Power Supply System (SY1527, SY2527, SY4527, SY5527).

The A7435 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 ± 25 V (with a 65 V hardware limit).

The AG7435 are the “common ground” versions of the boards: the return of the HV channels is wired to the crate Earth reference.

The module is single width (5 TE) and features also the safety board interlock: this protection allows to disable the primary HV generation when the HV outputs are not connected to their loads. Output range is $0 \div 3.5$ kV, with dual range 3.5 mA / 350 μ A maximum output current (5mV set and monitor resolution, Iset res.: 10 nA; Imon res.: 10 nA / 1nA; 9W maximum channel power).

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.

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 $1 \div 500$ 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 Radiall 52-pin or SHV connectors. 24 channel SHV versions are double width boards (10 TE); 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.

The full list of the available boards is the following:

Version	No. of channels	Connector	Width	Channel return
A7435	24	Multipin	5TE	Common Floating
AG7435	24	Multipin	5TE	Earth
A7435D	12	SHV	5TE	Common Floating
AG7435D	12	SHV	5TE	Earth
A7435S	24	SHV	10TE	Common Floating
AG7435S	24	SHV	10TE	Earth

Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A7435 / AG7435 HV Board¹

Output Voltage	0÷3.5 kV
Polarity	Positive / Negative depending on purchased version
Max. Output Current	dual range ² : High Power: 3.5 mA High Resolution: 350µA
Voltage Set/Monitor Resolution	5 mV
Current Monitor Resolution	High Power: 10 nA High Resolution: 1 nA
Current Set Resolution	10 nA
VMAX hardware	0÷3.5 kV common for all the board channels
VMAX hardware accuracy	± 1% of FSR
VMAX software	0÷3.5 kV settable for each channel
VMAX software resolution	1 V
IMAX hardware	0÷3.5 mA common for all the board channels
IMAX hardware accuracy	± 1% of FSR
Ramp Up/Down	1÷500 Volt/sec, 1 Volt/sec step settable for each channel
Voltage Ripple	10 ÷ 1000 Hz Typical
	Maximum
	1 ÷ 20000 kHz Typical
	Maximum
Voltage Monitor vs. Output Voltage Accuracy	±0.01% of reading ± 0.03% of Max Output Voltage
Voltage Set vs. Output Voltage Accuracy	±0.01% of setting ± 0.03% of Max Output Voltage
Current Monitor vs. Output Current Accuracy	High Power: ± 0.02% • Imon ± 5 µA
	High Resolution: ± 0.02% • Imon ± 1 µA
Current Set vs. Output Current Accuracy	High Power: ± 0.02% • Iset ± 5 µA
	High Resolution: ± 0.02% • Iset ± 1 µA
Maximum output power	9W per channel (software safety limit)
Consumption @ full power	24 channels (7435, 7435S): 300 W 12 channels (7435D): 155 W

¹ Accuracy values are measured from 10% to 90% of Full Scale Range

² Set via channel parameter IRANGE; see p.9

Front Panel

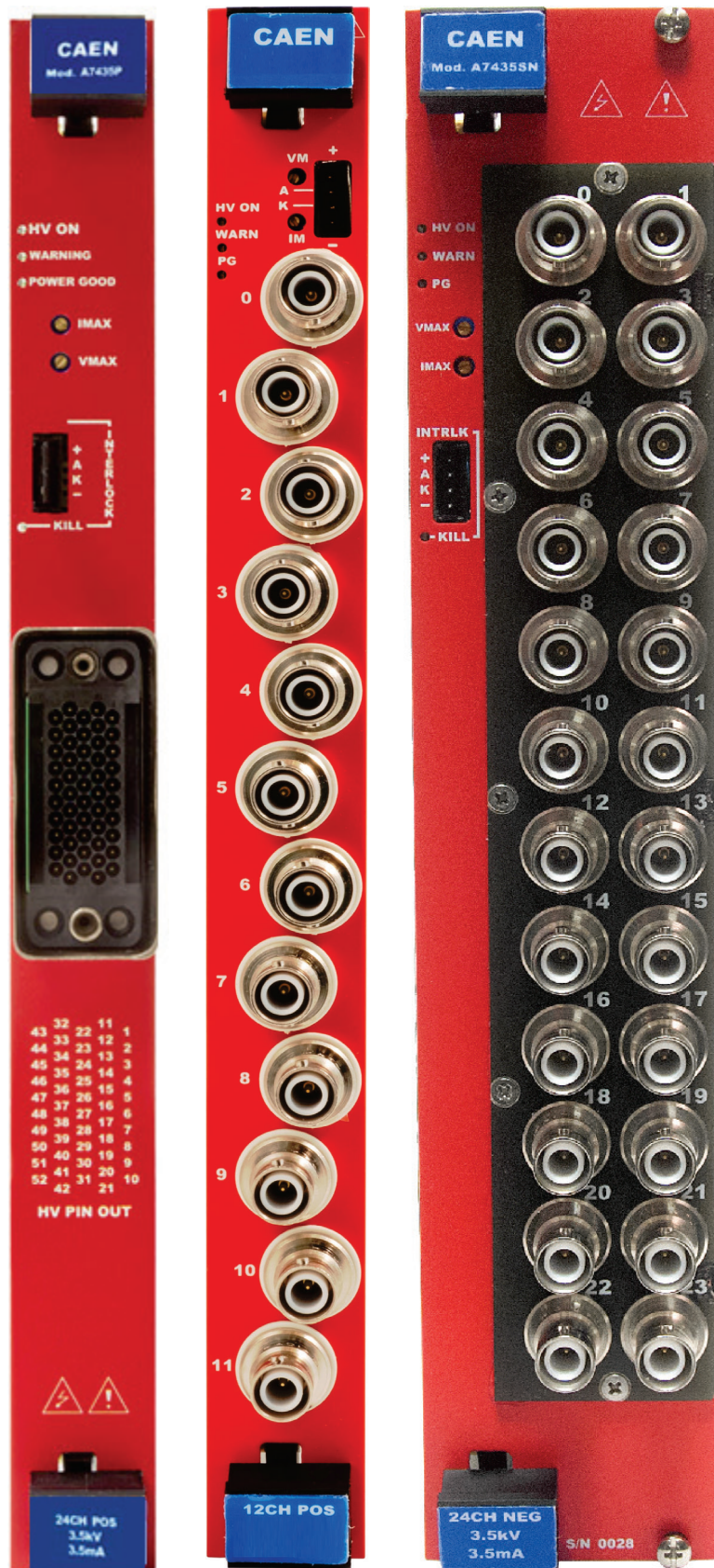


Fig. 1 – A7435 front panel

Component Specifications

Packaging

24 channels SHV boards are double width (10TE), other versions are single width (5 TE). Height is 6U.

Displays

HV ON LED	lights up as at least one channel is on; red: positive polarity; yellow: negative polarity.
POWER GOOD	Board correctly powered
WARNING	Warning status detected (over current, over/under voltage, trip, external disable)
INTERLOCK LED	Red LED. Lights up as the board is in INTERLOCK (channels are disabled).

Trimmers

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

External connections

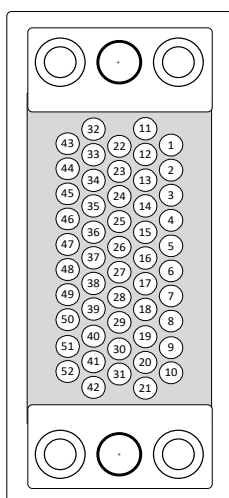
The specifications of the external connectors are listed in the following subsections.



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 OFF and wait at least 30s before connecting or disconnecting HV cables.

Series:	A/AG-7435	A/AG-7435D-7435S
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); Ratings: 12kV DC – 1mn (mated pairs); Current rating: 10 A
INTERLOCK (see p. 11):	AMP 280371-2	AMP 280371-2

Multipin connector pin 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	N.C.	14	HVOUT18	25	HVOUT13	35	HVOUT7	46	HVOUT1
5	N.C.	15	HVOUT19	26	HVOUT14	36	HVOUT8	47	HVOUT2
6	N.C.	16	HVOUT20	27	HVOUT15	37	HVOUT9	48	HVOUT3
7	N.C.	17	HVOUT21	28	HVOUT16	38	HVOUT10	49	HVOUT4
8	N.C.	18	HVOUT22	29	HVOUT17	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.

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. A7435 – AG7435 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.

Ground Configuration Switches

The Ground Configuration Switches (SW1 and SW2) allows to optimize the connection of the connector shield, of the channel return (HVGND) and of AGND (Earth of detector) on the A7435 boards. The switches can be accessed from the boards' bottom.

Board	A7435			A7435S			A7435D		
Switch	Left	Middle	Right	Left	Middle	Right	Left	Middle	Right
SW1	HVGND - EARTH	HVGND floating	HVGND - DGND	HVGND - EARTH	HVGND floating	HVGND - DGND*	HVGND - EARTH	HVGND floating	HVGND - DGND
SW2	SHIELD - EARTH	SHIELD floating	SHIELD - HVGND	Not available					

DGND is the ground reference of the Crate, which is in its turn connected to Earth, but through a different path.

3. Operating modes

The Mod. A7435 – AG7435 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:

<i>CHANNEL NAME (settable):</i>	descriptive name for the relevant channel
<i>V0SET (settable):</i>	the first of the two allowed voltage programmable values.
<i>I0SET (settable):</i>	the first of the two allowed current limit programmable values (OVC warning only)
<i>V1SET (settable):</i>	the second of the two allowed voltage programmable values
<i>I1SET (settable):</i>	the second of the two allowed current limit programmable values (OVC warning only)
<i>RUp (settable):</i>	the Ramp-Up parameter value, i.e. the maximum voltage programmable increase rate.
<i>RDWn (settable):</i>	the Ramp-Down parameter value, i.e. the maximum voltage programmable decrease rate.
<i>TRIP (settable):</i>	the TRIP parameter value, i.e. the maximum time an Over Current condition can last.
<i>SVMAX (settable):</i>	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.
<i>VMON (monitor):</i>	monitored voltage value
<i>IMON (monitor):</i>	monitored current value
<i>IRANGE (settable):</i>	Sets current range (high or low)
<i>ZCDetect (settable)</i>	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
<i>ZCAadjust (settable)</i>	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
<i>STATUS (monitor):</i>	it displays the channel status.
<i>PW (ON/OFF):</i>	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
<i>POn (EN/DIS):</i>	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
<i>PDwn (Kill/Ramp):</i>	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
<i>TripInt:</i>	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).
<i>TripExt:</i>	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 SYSTEM may return the following messages 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 ⁴
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 (>9W)

After a E-TRIPPED, I-TRIPPED, EXT_DIS and PWR_FAIL 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, IMax and HVMax, and to check board status; the POWER SUPPLY SYSTEM may return the following messages when monitoring the board status:

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

Interlock protection

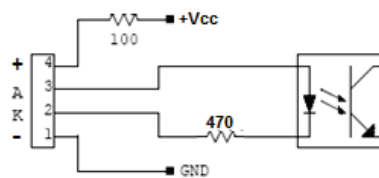


Fig. 2 – INTERLOCK electrical scheme

To enable the HV output channels, first it is necessary that pin 9 and 10 on the Radiall 52pin output connector are short circuited. 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

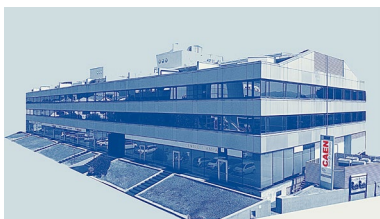
A schematic diagram of the Interlock input is shown in the figure above, where the diode is part of opto-coupler stage. *Interlock* means that channel is hardware disabled.

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.

⁴ EXTTRIP and INTTRIP parameters are expressed in Hexadecimal format

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