Technical Information Manual

Revision n.5
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MOD. A1535
24 CH 3.5KV/ 3 mA
COMMON FLOATING
RTN BOARD

NPO:
00113/04:A1535.MUTx/05

CAEN will repair or replace any product within the guarantee period if the Guarantor declares that the product is defective due to workmanship or materials and has not been caused by mishandling, negligence on behalf of the User, accident or any abnormal conditions or operations.

CAEN declines all responsibility for damages or injuries caused by an improper use of the Modules due to negligence on behalf of the User. It is strongly recommended to read thoroughly the CAEN User's Manual before any kind of operation.

CE

CAEN reserves the right to change partially or entirely the contents of this Manual at any time and without giving any notice.

Disposal of the Product

The product must never be dumped in the Municipal Waste. Please check your local regulations for disposal of electronics products.

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1. Introduction

1.1 The CAEN Universal Multichannel Power Supply System

The SY 1527 system is the fully equipped, large scale experiment version of a new line of power supply systems which represent CAEN's latest proposal in the matter of High Voltage and Low Voltage Power Supplying. This system outlines a completely new approach to power generation and distribution by allowing to house, in the same mainframe, a wide range of boards with different functions, such as High/Low Voltage boards, generic I/O boards (temperature, pressure monitors, etc.) and branch controllers, where the latter are used to control other remote generators and distributors.

Modularity, flexibility and reliability are the key-points of its design, enabling this module to meet the requirements of a wide range of experimental conditions. The latter range from those of LHC experiments, in which the model's features find prior application, to those of other less challenging, but still demanding, High Energy Physics experiments.

The mainframe is housed in a 19"-wide, 8U-high euro-mechanics rack and hosts four main sections:

- the *Board Section*, with 16 slots to house boards, distributors and branch controllers;
- the *Fan Tray Section*, housing 6 fans disposed on two rows;
- the *Power Supply Section*, which consists of the primary power supply and up to 3 power supply units;
- the *CPU and Front Panel Section* which includes all interface facilities.

The User interface features the usual friendliness of the previous CAEN systems which now also includes a 7.7" colour LCD. A wide choice of interfaces provides full communication compatibility with the previous systems and the possibility of controlling heterogeneous external devices.

Modularity has been one of the leading criteria in the design and development of the system: both the *Power Supply Section* and the *Board Section* are completely modular. The *Power Supply Section* allows different configurations with up to 3 power supply units per mainframe (up to 2250 W), while the *Board Section* can house up to 16 boards able to fulfil different functions. A new line of boards and distributors, analogous with those available for the SY 527 system, and a set of branch controllers has been specially developed for this new system. The minimum system configuration consists of the primary power supply, one Power Supply Unit and one board.
The concept of modularity has been extended up to the possibility of arranging 'clusters' constituted by one 'intelligent' SY 1527 system able to drive other 'non-intelligent' systems, i.e. systems without CPU (to be implemented). The connections among the systems constituting the cluster are realised through a new CAEN interface, the Local Net.

The extreme flexibility of the system, which allows to house indifferently, inside the same mainframe, boards with different functions, is further enhanced by the possibility of developing *ad-hoc* boards and even complete custom peripheral systems. The latter, actually, can be designed specifically for on-detector installation. All the custom

electronics can be anyway remotely controlled by single boards which are inserted in the SY 1527 mainframe and act as branch controllers.

Fast, accurate set-up and monitoring of system parameters (14-bit resolution on Voltages and Currents with standard boards) is available for each branch controller thanks to the use of one microprocessor per slot. All the operational parameters are stored in a non-volatile memory (EEPROM) to be still available after Power-Off. The parameters can be controlled either via CAEN traditional built-in links (RS232, H.S. CAENET) or via CERN-approved Fieldbuses or via Ethernet (TCP/IP). Programmable handling of parameters and errors is available as well.

Channel trip control on other crates is performed via four external differential trip lines. A sophisticated trip handling via software allows to control and correlate trip conditions on the channels of the crate as well as of other crates connected to it.

Live insertion and extraction of the boards, which reduces the global down time, and easy access to the computing core and peripherals completes the system's flexibility.

Easy interfacing is another key-point of the SY 1527 system. Thanks to the H.S. CAENET interface, the system ensures full communication compatibility with the previous models. Besides the RS232 interface and Ethernet (TCP/IP) provided with the standard version of the system, CAN-bus can be furnished on request, as well as special boards featuring optical links for remote communications. The Power Supply Section and Board Section can be externally synchronised via front panel connectors.

Secure access to the system via Intranet is foreseen together with a multilevel management of custom User's profiles. In particular, three different access levels have been implemented: *Guest*, *User* and *Administrator*, each of which with password protection.

Handy maintenance and upgrading, which constitute a major issue in the reliability of a system, are further guaranteed by the possibility of accessing and servicing the system via network facilities. Actually, Telnet and WWW access facilities allow remote debugging and technical support of the system, including future firmware upgrading.

For a detailed description of the SY 1527 Universal Multichannel Power Supply System please refer to the *SY 1527 User's Manual* .

1.2 Technical Specifications Table of the SY 1527 system

Table 1.1 – Technical specifications of the SY 1527 mainframe: general

Packaging	- 19"-wide, 8U-high Euro-mechanics rack; - Depth: 720 mm.
Weight	-Mainframe (*): 24 kg -Mod. A1532: 3.2 kg
Power requirements	*Voltage range*: 100/230 V *Frequency*: 50/60 Hz *Power*: 3400 W
Max. number of boards per crate	16
Max. number of power supply units per crate	3
Primary power supply output (Mod. A 1531)	± 12 V, 8 A +5 V, 20 A
Power supply unit output (Mod. A 1532)	+48 V, 15.6 A
Max. output power	2250 W
Operating temperature	From 0°C (dry atmosphere) to +40°C
Storage temperature	From -20°C (dry atmosphere) to +50°C

(*) One Primary Power Supply (Mod. A 1531) and one Power Supply Unit (Mod. A 1532) are included; boards are not included.

2. Mod. A1535 High Voltage Board

2.1 Functional description

The Mod. A1535 is a single width (5 TE wide) board housing 24 HV channels, available with either positive or negative polarity. The 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 output voltage range is 0 ÷ 3.5 kV, with 3 mA maximum output current and 0.5 V set and monitor resolution. The boards is provided with both current and voltage protections. If overcurrent occurs, the relevant channel can be programmed eihter to turn off after a programmable trip time or to keep on providing the maximum allowed current: this particular 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 board channels can be enabled according to the the interlock logic (see § 4.2)

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 Mod. A1535 board is provided with the Radiall 52 pin connector, whose mate cable connector (CAEN Mod. A996) and the relevant insertion/extraction tool (Mod. A995), are also available.

2.2 Channel Characteristic Table

Table 2.1 – Channel characteristics of the Mod. A 1535 HV Board

Polarity:	Positive / Negative depending on purchased version
Output Voltage:	0 ÷ 3.5 kV
Max. Output Current:	3 mA
Voltage Set/Monitor Resolution:	0.5 V
Current Set/Monitor Resolution:	500 nA
VMAX hardware:	0 ÷ 3.5 kV common for all the board channels
VMAX hardware accuracy:	± 2% of FSR
VMAX software:	0 ÷ 3.5 kV settable for each channel
VMAX software resolution:	1 V
Ramp Down:	1÷ 500 Volt/sec, 1 Volt/sec step
Ramp Up:	1÷ 500 Volt/sec, 1 Volt/sec step
Voltage Ripple: [1]	<20 mV typical; 30mV max
Voltage Monitor vs. Output Voltage Accuracy: [2,3]	typical: ± 0.3% ± 0.5 V max: ± 0.3% ± 2 V
Voltage Set vs. Voltage Monitor Accuracy: [2]	typical: ± 0.3% ± 0.5 V max: ± 0.3% ± 2 V
Current Monitor vs. Output Current Accuracy: [2]	typical: ± 2% ± 1 µA max: ± 2% ± 5 µA
Current Set vs. Current Monitor Accuracy: [2]	typical: ± 3% ± 1 µA max: ± 3% ± 5 µA
Maximum output power:	8 W (per channel, software limit)
Power consumption:	310 W @ full power

[1] From 10 Hz to 15 MHz at full load; ripple may exceed such limits whenever OVC and UNV occur (see § 4.1)

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

[3] 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.

2.3 Front Panel

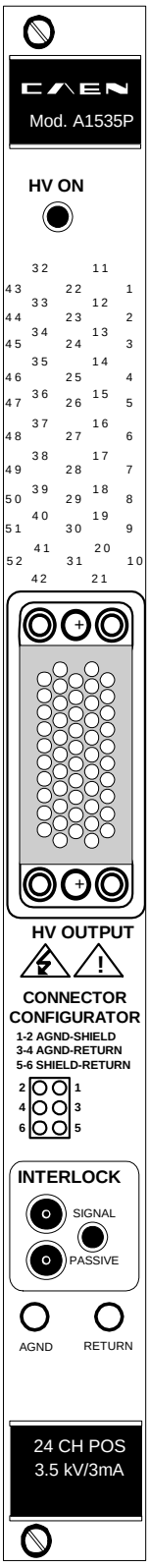

Fig. 2.1 – Mod. A1535 front panel

2.4 Technical Specifications

2.4.1 Packaging

The module is housed in a 1 unit wide, 6U-high mechanics.

2.4.2 External connections

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

Output Channels (0…23); Shield, Return: Multipin connector Radiall 691803004 type, 52 pin male (to be mated with Radiall 691802002 [*SCEM 09.41.34.700.2*] type[4]); see Table 2.2 for pin assignment

Return: Radiall R921921 socket, Ø 2mm

AGND: Radiall R921921 socket, Ø 2mm

PASSIVE INTERLOCK: 00-type LEMO connector

SIGNAL INTERLOCK: 00-type LEMO connector

2.4.2.1 Multipin connector pin assignment

Table 2.2 – 52 pin connector assignment

1	N.C.	14	HVOUT18	27	HVOUT15	40	N.C.
2	N.C.	15	HVOUT19	28	HVOUT16	41	N.C.
3	HVOUT23	16	HVOUT20	29	HVOUT17	42	Return
4	N.C.	17	HVOUT21	30	N.C.	43	N.C.
5	N.C.	18	HVOUT22	31	SHIELD	44	N.C.
6	N.C.	19	N.C.	32	Return	45	HVOUT0
7	N.C.	20	N.C.	33	N.C.	46	HVOUT1
8	N.C.	21	Return	34	HVOUT6	47	HVOUT2
9	INT_A	22	N.C.	35	HVOUT7	48	HVOUT3
10	INT_B	23	N.C.	36	HVOUT8	49	HVOUT4
11	Return	24	HVOUT12	37	HVOUT9	50	HVOUT5
12	N.C.	25	HVOUT13	38	HVOUT10	51	N.C.
13	N.C.	26	HVOUT14	39	HVOUT11	52	SHIELD

[4] 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.

2.4.3 Displays

HV ON LED: *Function:* lights up as at least one channel is on.
Type: red LEDs for positive polarity version; yellow LEDs for negative polarity version

INTERLOCK LED: *Function:* lights up as the board ia in INTERLOCK (channel are disabled).
Type: red LED

2.4.4 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.

Shield configuration jumpers: *Function:* see table below

Table 2.3 – Configuration jumpers

Jumper	Connector configuration	Function
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

Internal switches (SW1): *Function:* SW1 (if installed) shall be used only for test purposes; keep on OFF position during normal use, otherwise TEMPERATURE sensor might not work properly.

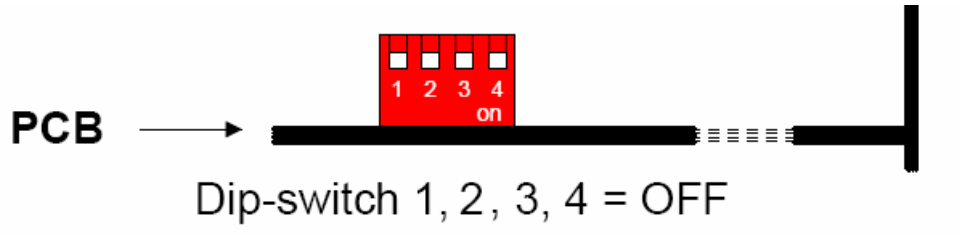

Fig. 2.2 – SW1 Internal dip switches

3. Safety information and installation requirements

3.1 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.

3.1.1 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.

3.2 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

3.3 Installation

The Mod. A 1535 is a double-width board. At power ON the SY 1527 system processor will scan all the slots in the crate to find out where the module is plugged and what kind of module it is.

4. Operating modes

The Mod. A 1535 board can be controlled, either locally or remotely, through the SY 1527 software interface. For details on SY 1527 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.

WARNING

THE MOD. A 1535 BOARD REQUIRE

SY 1527 FIRMWARE VERSION 2.00.01 OR LATER

4.1 Output control and monitoring

For each output channel, it is possible, through the SY 1527 system, to perform the following operations:

- Assign to channel a symbolic name
- Set output voltage (VSET)
- Set max. output current (ISET)
- Set output voltage software limit (SVMAX)
- Set voltage ramp-up rate (RAMP-UP)
- Set voltage ramp-down rate (RAMP-DOWN)
- Set TRIP parameter
- Enable/disable POWER ON option
- Switch channel ON/OFF
- Monitor output voltage (VMON)
- Monitor output current (IMON)
- Monitor channel status

If the POWER ON option is enabled, the channel, at POWER ON, is restored in 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 SY 1527 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)[5]
- EXTTRIP (channel OFF due to external TRIP line signal)
- INTTRIP (channel OFF due to internal OVERCURRENT condition)
- EXT_DIS (channel disabled by board INTERLOCK protection)

Moreover it is possible to monitor board temperature and to check board status; the following messages may be returned by the SY 1527 when monitoring the board status:

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

4.2 Output Enable

In order to enable the HV output channels, first of all it is necessary that pin 9 and 10 on the output connector are short circuited (see § 2.4.2.1).
Then the enable procedure is completed in one of the following ways:

– terminating the PASSIVE INTERLOCK (see § 2.4.2) connector on 50 Ohm.
– supplying the SIGNAL INTERLOCK (see § 2.4.2) connector with a +5 V (3-4mA) differential 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.

4.3 Grounding specifications

The Mod. A1535 channels share a common floating return (FAGND, see § 2.4.2), available on the front panel multipin connector, insulated from the crate ground (AGND, see § 2.4.2), which is available as front panel 2mm socket connector. 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 the environment requirements.

[5] UNV is also reported when Hvmax limit is reached, it is up to the User to verify that VMON value does not exceed HVMAX.