Technical Information Manual

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MOD. A 1513A

6 CHANNEL FLOATING LOW VOLTAGE BOARD

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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.

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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	Monophase: 88÷264 V a.c., 48÷64 Hz; 38 A Three-phase (*on request*)
Max. number of boards per crate	16
Max. number of power supply units per crate	3
Primary power supply output (A 1531)	+/-12 V, 8 A +5 V, 20 A
Power supply unit output (A 1532)	+48 V, 15.6 A
Max. output power	2250 W
Operating temperature	From 5°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. A1513 A Low Voltage Board

2.1 Functional description

The Model A1513 A is a single width (5 TE wide) board housing 6 LV floating (reversible polarity) channels. The connector[1] output voltage range is 0÷10 V (2.7 A maximum output current) with 10 mV monitor resolution.
The board is provided with Remote Sensing Lines to compensate for the voltage drop over the connection cables.

If the output voltage differs from the programmed value by more than 3% of voltage full scale range, the channel is signalled to be either in OVERVOLTAGE or UNDERVOLTAGE condition. Moreover, for each channel, a voltage protection limit SVMAX can be fixed via software with 10 mV resolution and the output voltage can not be programmed beyond this value.

The LV RAMP-UP and RAMP-DOWN rates may be selected independently for each channel in the range 1÷ 19 V/s in 1 V/s steps. By programming this parameter at 20 V/s, the channel ramps actually at the maximum available rate.
The output current is monitored with 10 mA resolution; if a channel tries to draw a current larger than its programmed limit it is signalled to be in OVERCURRENT condition; the SY 1527 system detects this state as a fault and reacts according to the setting of the TRIP parameter, namely:

1) TRIP=infinite (= 1000 s)

   The output current is permitted to exceed the programmed limit; if the maximum output current value is reached the channel behaves like a constant current generator.

2) TRIP=finite (< 1000 s)

   The output current is permitted to exceed the limit only for programmed time interval and then is switched off.

The TRIP time (i.e. the maximum time an OVERCURRENT condition is allowed to last) can be programmed in 0.1 s steps.
The maximum output voltage (VMAX Hardware) 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 boards host also a temperature sensor located on the PCB near the LV channels: the temperature values measured by this sensor are used to signal Over Temperature condition on the SY 1527.
The boards are provided with an "EN" input that disables the channels when it is not terminated.

[1] A modest voltage drop along the connection lines, depending on the cables' length, must be expected

2.2 Channel Characteristics Table

Table 2.1 - Channel characteristics of the Mod. A 1513A LV Board

Polarity:	Floating
Output Voltage[2]:	0÷10 V (connector output)
Max. Output Current:	2.7 A
Voltage Set/Monitor Resolution:	10 mV
Current Set/Monitor Resolution:	1 mA
VMAX hardware:	0÷10 V common for all the board channels
VMAX hardware accuracy:	± 2% of FSR
VMAX software:	0÷10 V settable for each channel
VMAX software resolution:	10 m V
Ramp Up/Down:	1÷19 Volt/sec, 1 Volt/sec step
Voltage Ripple: [3]	< 5 mV pp
Voltage Monitor vs. Output Voltage Accuracy: [4]	typical: ± 0.3% ± 30 mV maximum: ± 0.3% ± 50 mV
Voltage Set vs. Output Voltage Accuracy: [4]	typical: ± 0.3% ± 30 mV maximum: ± 0.3% ± 50 mV
Current Monitor vs. Output Current Accuracy: [4]	typical: ± 2% ± 5 mA maximum: ± 2% ± 10 mA
Current Set vs. Output Current Accuracy: [4]	typical: ± 2% ± 5 mA maximum: ± 2% ± 10 mA
Load Regulation: [4]	± 0.3 % (with sense wires) ± 2 % (without sense wires/LDR ON/SENSE OFF)
Power consumption	275 W

[2] The board works properly with a Vset larger than 1.25 V and a current on the load larger than 0.1 A

[3] From 10 Hz to 15 MHz at full load; measure with the line terminated on a 10 µF capacitance and a 100 nF ceramic capacitance in parallel to the load

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

2.3 Front Panel

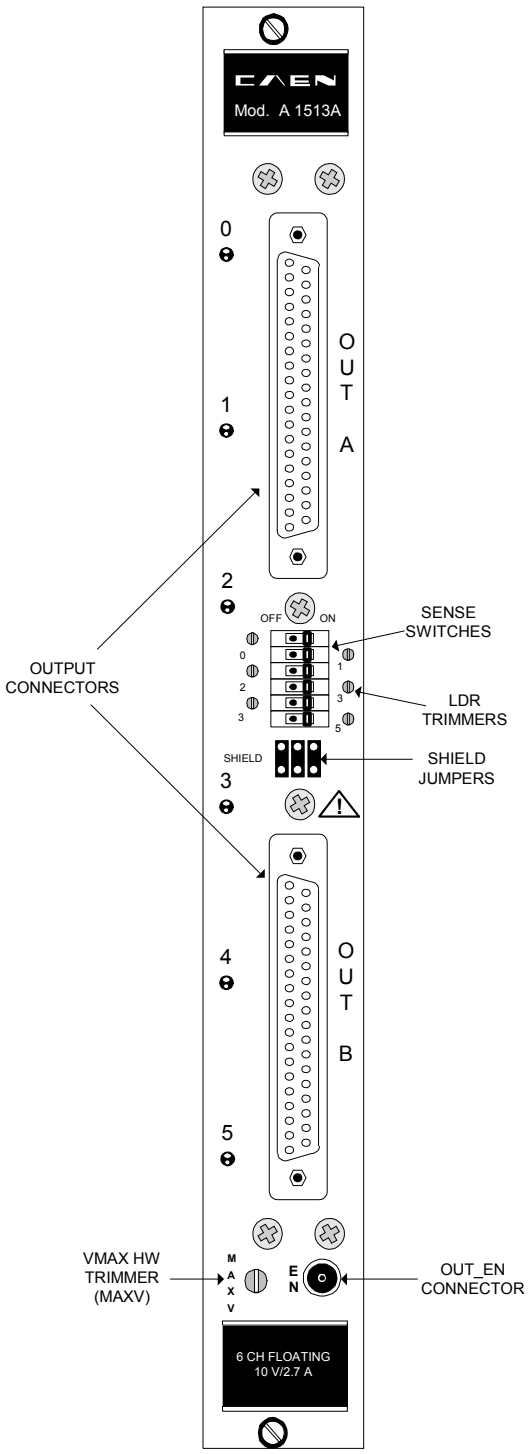

Fig. 2.1 - Mod. A 1513A front panel

2.4 Technical Specifications

2.4.1 Packaging

The Mod. A 1513A is housed in a 5TE-wide, 6U-high mechanics.

2.4.2 External connections

The location of all components of the front panel is shown in Fig. 2.1, p. 8. The function and electro-mechanical specifications of the external connectors are listed in the following subsections.

OUT A, OUT B CONNECTORS:

Mechanical specifications:
two DB37 type female connectors
Electrical specifications; LV outputs according to specifications given in Table 2.1, p.9 and Sense wires.

EN CONNECTOR:

Mechanical specifications:
00-type LEMO connector.
Electrical specifications: board ENABLE input, if it is connected to ground, the channels are enabled. Refer to § 4.4.1 for further details.

2.4.3 Displays

0…5 LEDs:

Function: they light up as the relevant channel is on.

2.4.4 Switches

SENSE 0…5

Function **:** they allow to enable/disable the automatic Line Drop Recovery system

2.4.5 Front Panel Jumpers

JP1, JP2, JP3 :

Type: two pin jumpers
Function: grounding of the front panel connectors' shield (see also § 4.5)

2.4.6 Other components

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

LDR trimmers: *Function:* 6 calibration trimmers for the automatic Line Drop Recovery system

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 boards. 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 apply a voltage to a load that is outside the range specified for that load.

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 there is damage to this product, 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

ATTENTION

Refer to Manual

3.3 Installation

The Mod. A 1513A is a single-width (5 TE wide) board which can be inserted in any slot of the SY 1527 crate. 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 1513A 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.

ATTENTION

THE MOD. A 1513A BOARD REQUIRE

SY 1527 FIRMWARE VERSION 1.09.04 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 speed (RAMP-UP)
- Set voltage ramp-down speed (RAMP-DOWN)
- Set TRIP parameter
- Enable/disable POWER ON option
- Switch channel ON/OFF
- Monitor output voltage (VMON) [measured on the load by the sense wires, see § 4.3.1]
- 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)

- 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 Pin assignment

The following figure shows the pin assignment of the front panel connectors:

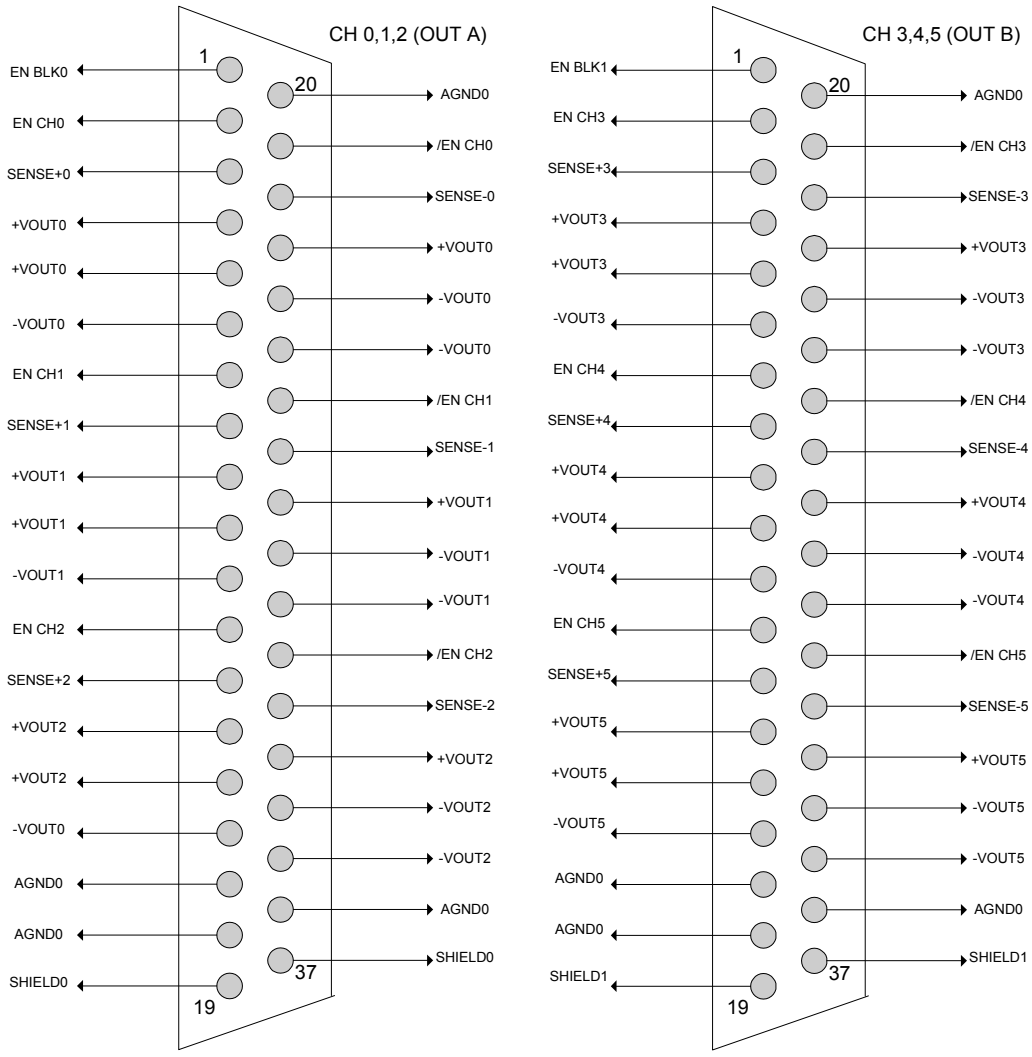

Fig. 4.1 - Mod. A 1513A Pin assignment

4.2.1 Front panel connectors pin assignment description

- +*VOUTx* and -*VOUTx* : they are the x channel's LV outputs (x ranging from 0 to 5)
- *SENSE±x* : they are the sensing lines to be connected to the load in order to compensate the voltage drop (see § 4.3.1)
- *ENCHx* and */ENCHx* : ENMODE0: short circuiting these pins, x channel is disabled (default); ENMODE1: x channel is enabled when a +5 V d.c. voltage difference is applied between *ENCHx* and */ENCHx* pins (see § 4.4.2)
- *ENBLK0/1* : grounding these pins channels 0, 1, 2 (ENBLK0) and 3, 4, 5 (ENBLK1) are enabled
- *AGND0* : these pins are connected to the crate ground
- *SHIELD0/1* : these pins are connected to the connector's external shield

4.3 Voltage drop compensation

The voltage drop along the cables can be recovered in the two following ways:

4.3.1 Voltage sensing

All output channels have a Remote Sensing Line to compensate for the voltage drop over the cable. Voltage is monitored directly at the load by an high input impedance differential amplifier through the sense wires; the voltage sensing circuit is schematically illustrated in the figure below.

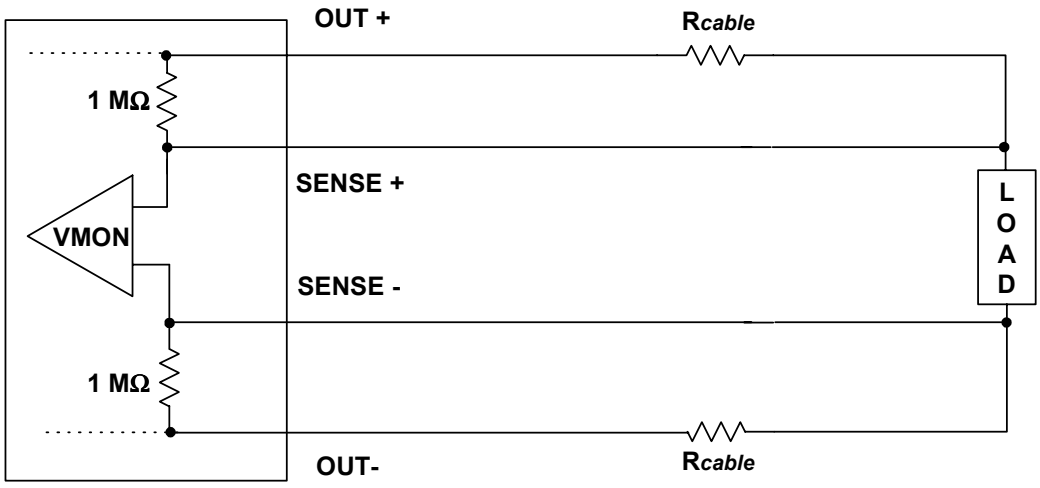

Fig. 4.2 - Remote voltage sensing scheme

When the sense switches (see Fig. 2.1) are set ON and the sense wires are connected to the load, the Vset value equals the voltage on the load; if the sense wires are not connected (to the load), Vset will equal the voltage on the connector.

4.3.2 *Line Drop Recovery (LDR) system*

The Mod. A 1513A also features a Line Drop Recovery system which can compensate for the voltage drop over the connection cables. If the User wishes to employ the LDR system a short calibration procedure is required:

- Set the sense switch (see Fig. 2.1) on the OFF position
- Set the output voltage (Vset) so that the voltage drop over the cable is near to the maximum drop expected during operation
- Measure the voltage over the load by a voltmeter (the measured value will be, in general, different from the Vset value)
- Turn the relevant LDR trimmer (see Fig. 2.1) so that the measured voltage equals Vset.

N.B. The LDR system works properly with a Vset larger than 1.25 V and a current on the load larger than 0.1 A.

A third way consists of using the sense wires over the first cable segment (point A and A', sense switches = OFF); then, the remaining loss (voltage drop over r_{cable}) can be compensated with the LDR, as illustrated in the following scheme:

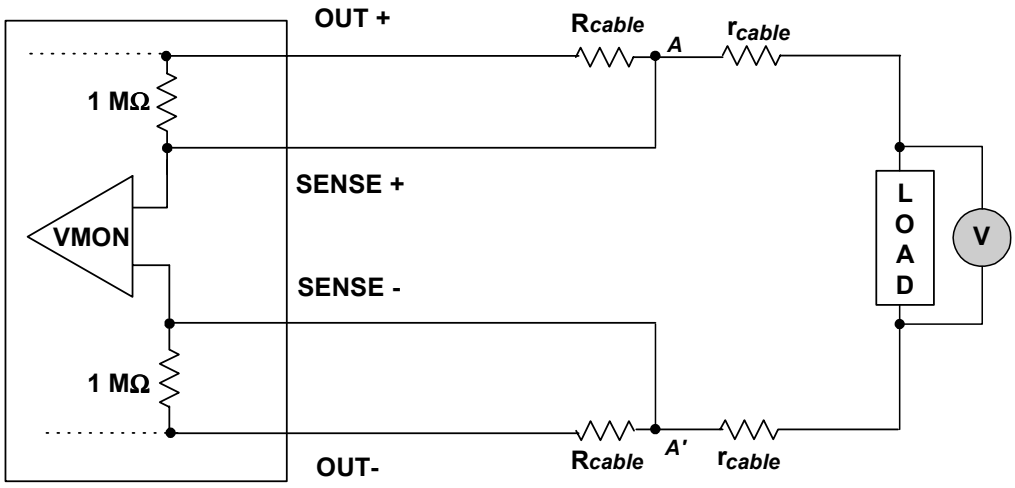

Fig. 4.3 – LDR system + remote voltage sensing scheme

4.4 Output Enable

It is possible to enable the board's channels in the following ways.

4.4.1 *Board Enable*

The board is provided with an "EN" input that enables the channels when it is connected to ground. When the channels are disabled the voltage outputs drop to zero at the maximum rate available; when the output disable cause is removed, i.e. the "EN"

connector is connected to ground, the channels remain OFF until the User turns them ON via software.

4.4.2 Channel Enable

Each channel can be either enabled or disabled singularly. This operation can be performed in two ways, according to the mode, selected via jumpers (see § 4.4.2):

- *ENMODE0*: if ENCHx and /ENCHx front connector pins (see § 4.2.1) are not connected, x channel is enabled; if ENCHx and /ENCHx pins are short circuited, channel x is disabled
- *ENMODE1*: a +5 V d.c. voltage difference between ENCHx and /ENCHx pins must be applied in order to enable x channel

ENMODE0 is the default setting. Mode selection is shown in the following figure:

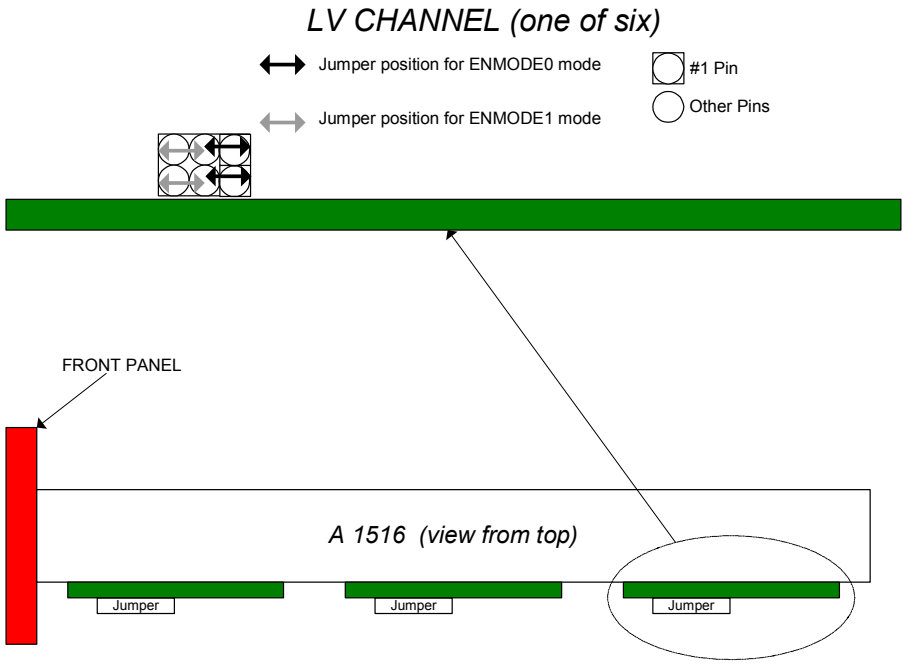

Fig. 4.4 - Enable mode jumpers setting

4.5 Front panel jumpers

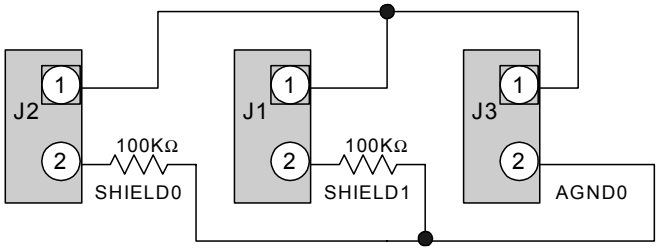

Fig. 4.5 - Front panel jumpers

The front panel jumpers J1, J2 and J3 allow to connect the two DB37 connectors shields (SHIELD0 and SHIELD1) with the ground reference of the crate (AGND0).