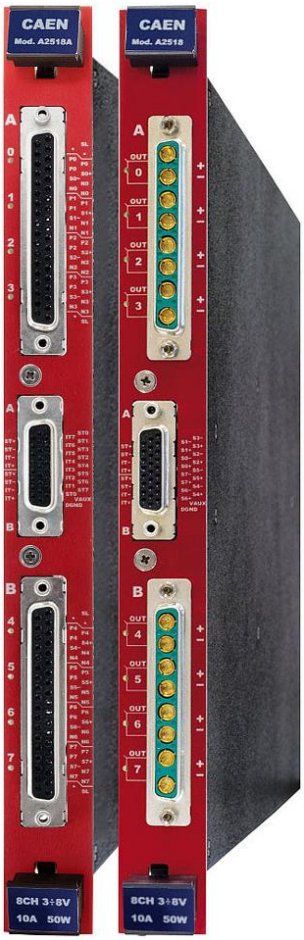
Rev. 16 - 1 August 2019

A251x Series 50W

A251x Series 50W LV Boards User Manual



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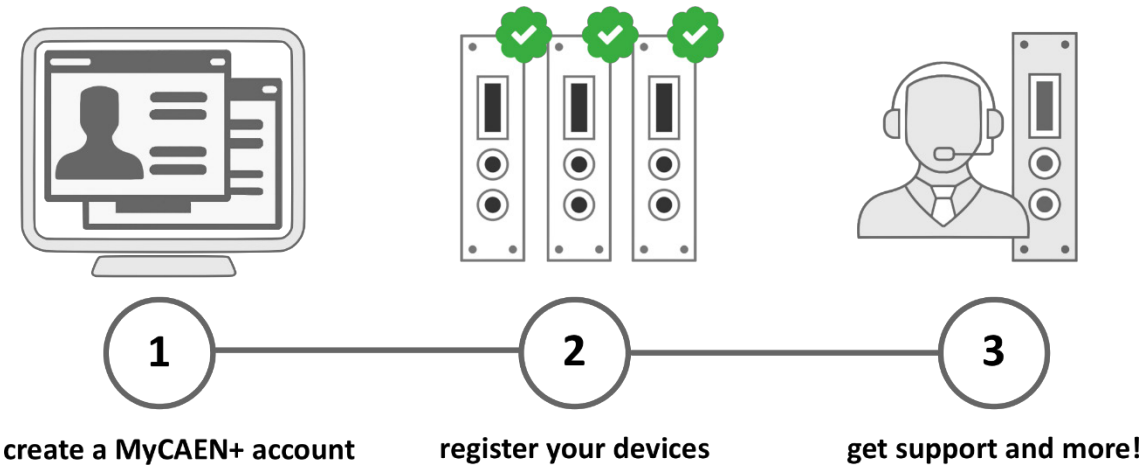

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Purpose of this Manual

This document is the A251x Series 50W LV Boards User Manual; it contains information about the installation, the configuration and the use of the boards.

Change Document Record

Date	Revision	Changes
26 May 2014	0	PRELIMINARY Release
26 June 2014	1	Updated parameters p.15
9 September 2014	2	New PID coefficient description
3 February 2015	3	RTN – GND Isolation increased to ±500V
7 September 2015	4	Output control and monitoring parameters updated
23 October 2015	5	Technical Specifications updated
20 November 2015	6	Validated version
12 February 2016	7	Technical Specifications updated
25 May 2017	8	Output control and monitoring parameters updated
25 September 2017	9	Instructions for channels in series added
1 October 2018	10	Instructions for sense lines usage and channel reset
7 December 2018	11	Technical Specifications updated
22 January 2019	12	Technical Specifications updated
14 May 2019	13	Added data for A2517BA
10 July 2019	14	Updated External connections
22 July 2019	15	Added data for A251xC
1 August 2019	16	Technical Specifications updated

Symbols, abbreviated terms and notation

N.A.

Reference Documents

Disclaimer

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. *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.*

Made In Italy : We stress the fact that all the boards are made in Italy because in this globalized world, where getting the lowest possible price for products sometimes translates into poor pay and working conditions for the people who make them, at least you know that who made your board was reasonably paid and worked in a safe environment. (this obviously applies only to the boards marked "Made in Italy", we cannot attest to the manufacturing process of "third party" boards).

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1. A251x Series Overview

The Mod. A251x series are single width (5 TE wide) boards housing 8 LV floating channels, compatible with the CAEN Universal Multichannel Power Supply System (SY1527, SY2527, SY4527, SY5527). The floating return allows on-load grounding reducing the noise level; the floating channels are insulated from each other and from Ground up to ±500 V.

Each output channel is provided with individual remote sensing lines to compensate for the voltage drop over the connection cables

The Maximum channel power (connector output) is 50 W (1.25W for A2517BA). Channels can be connected in parallel with modularity 2 or 4 to obtain higher output power (for 2/4 modularity Iset resolution is 100 mA and Imon resolution is 10 mA); this feature is not available on A2517BA and on A251xC versions.

The available versions are the following:

Version	A2517	A2517BA	A2518	A2518A	A2519	A2519A
Output Voltage	1÷5 V	1÷5 V	3÷8 V	3÷8 V	5÷15 V	5÷15 V
Max. Output Current	15 A	250mA	10 A	10 A	5 A	5 A
Output Connector	DSub8	DB37	DSub8	DB37	DSub8	DB37

The Output Voltage RAMP-UP and RAMP-DOWN Times may be selected independently for each channel in the 1 ÷ 200 ms range (1 ms step).

Safety features include:

OVERVOLTAGE: if a channel monitored voltage goes above the programmed Overvoltage threshold value (OVVThr), it is signalled to be in "overvoltage" and is switched off.

UNDERVOLTAGE: when the monitored voltage goes below the programmed undervoltage threshold (UNVThr), the channel is switched off

OVERCURRENT: if a channel tries to draw a current larger than its programmed limit, it is signalled to be in "overcurrent" and is switched off. In the A2517BA and A251xC versions, when overcurrent is detected, 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 module to work as current generator.

FAST RAMP DOWN (A251xC): a faster ramp-down speed could be needed to better drive loads, such as DC-DC converters, that otherwise would remain ON longer or enter ON-OFF cycles as the power supply ramps down. The standard A251x's are capable of ramping-down from full power to zero their channels between 20 and 200 ms (less only with certain loads) while the A251xC's can reach 1 V in 100 µs and switch-off completely the channel in 1 ms in all conditions.

The output channels can be enabled according to the interlock logic (see Interlock operation)

A global enable/disable connector allows to disable the channels and it is also possible, via front panel logic signals, to enable individually each channel (only for DB 37 versions).

Channels are organized into groups, and the turning on/off of the channels within one group can be delayed up to 900ms (User programmable) between each other.

Channels feature a PID (proportional integrative-derivative) digital controller, whose parameters are User programmable; in this way, the control loop can be optimized to any load (see also the **Application Note A251X Board Family PID Digital Regulation System**, that can be downloaded from the A251x page at www.caen.it web site).

2. Channel Characteristic Table

Characteristics of A2517BA, A2517, A2518, A2519

Version		A2517BA	A2517	A2518	A2519
Packaging		1 unit (5 TE) wide, 6U-high mechanics			
No. of Channels		8 (Individual Floating)			
Polarity		Floating			
Output Voltage		1÷5 V (connector output)		3÷8 V (connector output)	5÷15 V (connector output)
Voltage Ripple	Typical	< 5 mVpp		< 10 mVpp	
	Maximum	< 10 mVpp		< 20 mVpp	
Max. Output Current		250mA	15 A	10 A	5 A
Max. Ch. Output Power		1.25 W	50 W (firmware limited)		
Minimum Load		0 A			
Voltage Set Resolution		1 mV			
Vset Accuracy		< ±0.5%			
Voltage Monitor Resolution		0.2mV	1 mV (connector and status)		
Current Set Resolution		100µA	10 mA; 100 mA (2/4 modularity)		
Current Monitor Resolution		10µA	1 mA ; 10 mA (2/4 modularity)		
Over/Under voltage thr.		0÷6 V settable for each channel		2÷9 V settable for each ch.	4÷16 V settable for each ch.
Over/Under voltage thr. Res.		10 mV			
Accuracy		Typical	Maximum	Typical	Maximum
Vset vs Vout		<± 0.1% ± 10mV	<± 0.2% ± 20mV	<± 0.1% ± 5mV	<± 0.2% ± 10mV
Vmon vs Vout		<± 0.1% ± 10mV	<± 0.2% ± 20mV	<± 0.1% ± 5mV	<± 0.2% ± 10mV
Imon vs Iout		<±0.2% ± 250µA	<±0.5% ± 500µA	<±1% ± 10mA	<±2% ± 20mA
Iset vs Iout		<±1% ± 1mA	<±2% ± 2mA	N.A.	
Hardware OVV Protection		7.50V		9.75V	17.50V
Short Circuit Protection		Available			
Trip		Max. time an "overcurrent" can last (seconds). A channel in "overcurrent" works as current generator; output voltage varies to keep the output current at the programmed value (if Vout > 0.7V). "Overcurrent" lasting more than set value (1 to 9999) causes the channel to "trip". Output voltage will drop to zero either at the 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	Not Available		
Ramp Up/Down Time		1÷200 ms ; 1 ms step			
Turn on/off delay		0 ÷ 900ms			
Transient response		Adjustable via PID controller			
RTN – GND Isolation		±500V			
Sense cable input impedance		1 kOhm			
Enable inputs		Available			
Status outputs		Available			
Temperature range		0 ÷ 45 °C			

Characteristics of A2517C, A2518C, A2519C

Version	A2517C	A2518C	A2519C
Packaging	1 unit (5 TE) wide, 6U-high mechanics		
No. of Channels	8 (Individual Floating)		
Polarity	Floating		
Output Voltage	1÷5 V (connector output)	3÷8 V (connector output)	5÷15 V (connector output)
Voltage Ripple Typical	< 5 mVpp	< 10 mVpp	
Voltage Ripple Maximum	< 10 mVpp	< 20 mVpp	
Max. Output Current	15 A	10 A	5 A
Max. Ch. Output Power	50 W (firmware limited)		
Minimum Load	0 A		
Voltage Set Resolution	1 mV		
Vset Accuracy	< ±0.5%		
Voltage Monitor Resolution	1 mV (connector and status)		
Current Set Resolution	10 mA		
Current Monitor Resolution	1 mA		
Over/Under voltage thr.	0÷6 V settable for each channel	2÷9 V settable for each ch.	4÷16 V settable for each ch.
Over/Under voltage thr. Res.	10 mV		
Accuracy	Typical	Maximum	
Vset vs Vout	<± 0.1% ± 5mV	<± 0.2% ± 10mV	
Vmon vs Vout	<± 0.1% ± 5mV	<± 0.2% ± 10mV	
Imon vs Iout	<±1% ± 10mA	<±2% ± 20mA	
Iset vs Iout	N.A.		
Hardware OVV Protection	7.50V	9.75V	17.50V
Short Circuit Protection	Available		
Trip	Max. time an "overcurrent" can last (seconds). A channel in "overcurrent" works as current generator; output voltage varies to keep the output current at the programmed value (if Vout < Vset min, the correct operation is not guaranteed). "Overcurrent" lasting more than set value (1 to 9999) causes the channel to "trip". Output voltage will drop to zero either at the 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		
Ramp Up/Down Time	1÷200 ms ; 1 ms step. If Ramp Down is set to 0 (fast ramp down mode), the channel output will decrease to 1 V in 100µs and turn off completely in 1ms		
Turn on/off delay	0 ÷ 900ms		
Transient response	Adjustable via PID controller		
RTN – GND Isolation	±500V		
Sense cable input impedance	1 kOhm		
Enable inputs	Available		
Status outputs	Available		
Temperature range	0 ÷ 45 °C		

3. Technical description

Front Panel

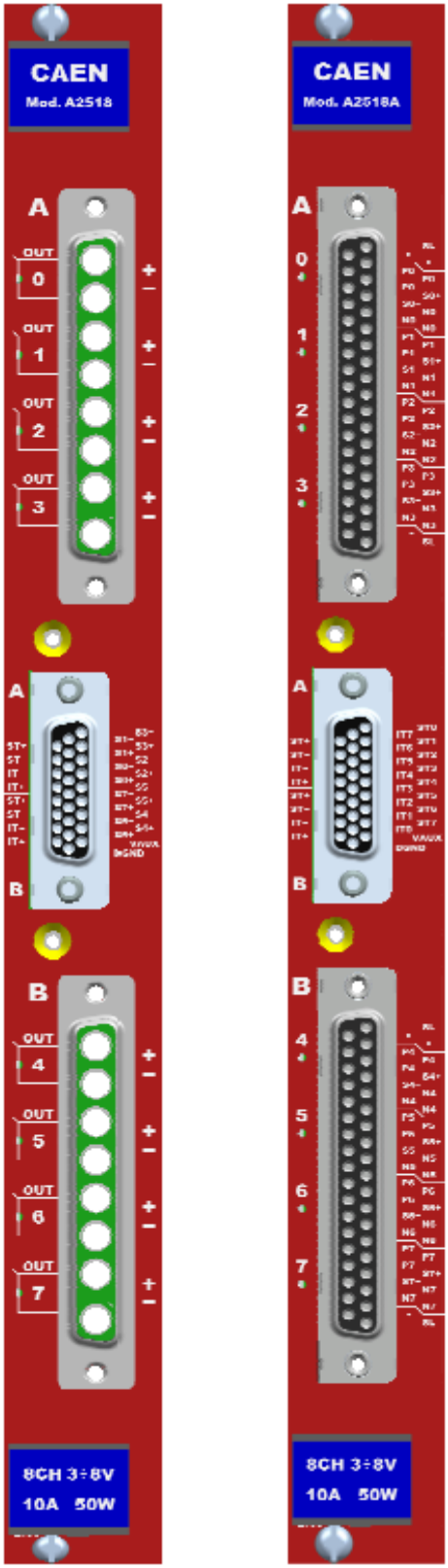


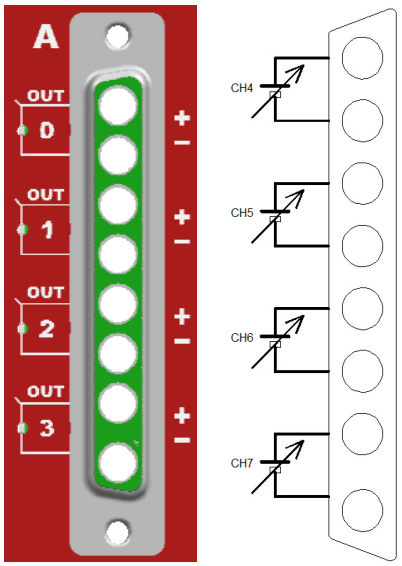
Fig. 1 – A251x series front panel (8 pin & db 37 version)

External connections

Output connectors

WARNING! Despite Low Voltage, the risk of electric shock still exists; never connect or disconnect the Output connector with the SYx527 power ON/OFF switch ON; always switch SYx527 power OFF and wait at least 30s before connecting or disconnecting output cables.

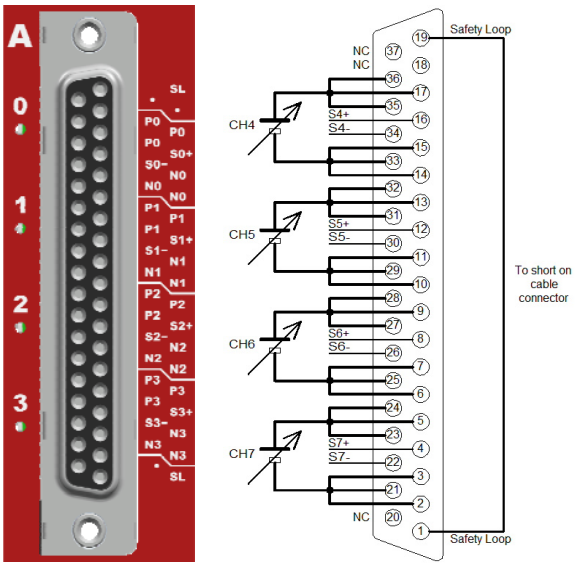
A251x



DC8W8SA00LF D-Sub 8W8; cable connector: Amphenol FCI DC8W8PA00LF; available pin: PIN 10A Amphenol FCI 8638PPS1005LF; PIN 15A Amphenol FCI 8638PPS1505LF; PIN 20A Amphenol FCI 8638PPS2005LF

Out Channels (0÷3; 4÷7); Positive, Negative

A251xA

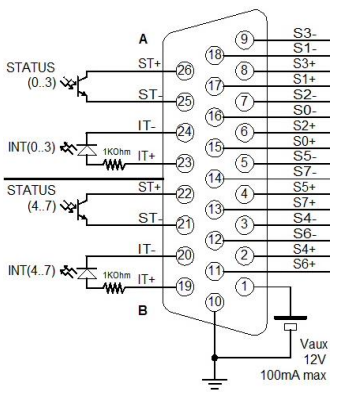


FCI DCPV37S300GT DB37; cable connector: Amphenol FCI DC37P064TXLF

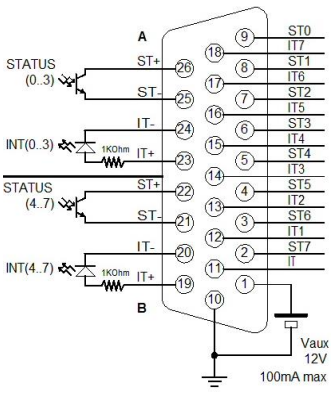
Out Channels (0÷3; 4÷7) Positive, Negative; Sense± (0÷3; 4÷7)

Service connector

A251x



A251xA



Type: FCI ICD26S13E4GV00LF D-Sub SKT 26 POS 2.28mm; cable connector: Amphenol FCI 10090769-P264ALF

Group Interlock (insulated); Group Status (insulated); Sense± (0…3; 4…7); VAUX, DGND

Group Interlock (insulated); Group Status (insulated); Individual Interlock (GND); Individual Status (GND); VAUX, DGND

Interlock operation

A251x

One Group (channels 0..3 and 4..7) can be ENABLED in one of the following ways:

- Short circuit IT- with DGND and IT+ with VAUX pins on service connector
- Send signal 4÷6V, ~5mA current between IT- and IT+

A251xA

One Group (channels 0..3 and 4..7) can be ENABLED in one of the following ways:

- Short circuit IT- with DGND and IT+ with VAUX pins on service connector
- Send signal 4÷6V, ~5mA current between IT- and IT+

One channel can be ENABLED in one of the following ways:

- Short circuit IT# with VAUX pins on service connector
- Send signal 4÷6V, ~5mA current between IT# and DGND

N.B.: interlock setting is ignored if Intck A and Intck B board parameters (see p. 15) are set to “disabled”.

Status operation

A251x

- Contact closed between ST+ and ST- when no FAIL is present on one Group channel (0..3 and 4..7)
- Contact open between ST+ and ST- when FAIL is present on one Group channel (0..3 and 4..7)

A251xA

- Contact closed between ST+ and ST- when no FAIL is present on one Group channel (0..3 and 4..7)
- Contact open between ST+ and ST- when FAIL is present on one Group channel (0..3 and 4..7)
- Level high on ST# when no FAIL is present
- Square wave (TTL grounded) on ST# when FAIL is present

Sense Lines

Output channels have Sense Lines (see p.8) to compensate for the voltage drop over the cable. Voltage is monitored directly at the load by a high input impedance differential amplifier through the sense wires.

When the sense wires are connected to the load, the Vset value equals the voltage on the load; if the sense wires are not used, they must be left not connected, and Vset will equal the voltage on the connector.

Channels in parallel

N.B.: this feature is not available for Mod. A2517BA and A251xC

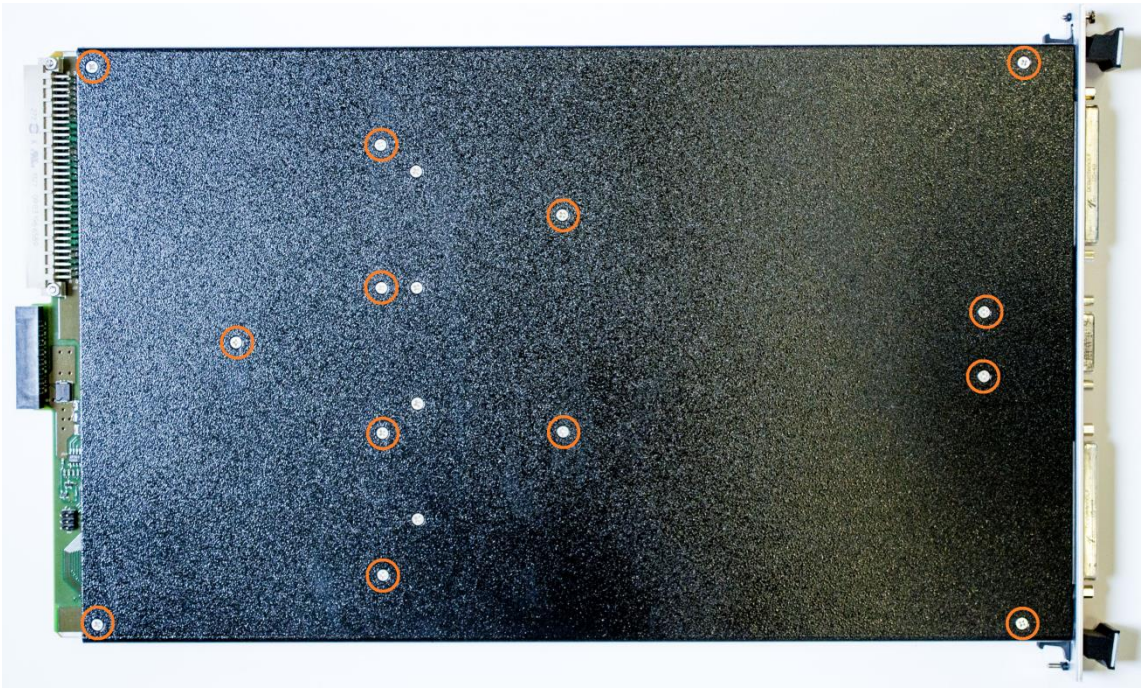
The A251x boards are provided with six Connection Keys (four X keys and two Z keys), that allow to connect the channels in parallel.

The X key allows to parallel two channels, the Z key allows to parallel four channels.

As two or four channels are paralleled, the system automatically recognizes the actual number of channels: two or four paralleled channels are seen by the control software as one channel with double or quadruple output current and power.

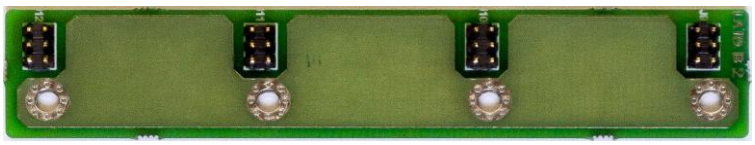
In order to connect the channels in parallel, follow these steps:

- Remove ONLY the screws as indicated (orange circles)



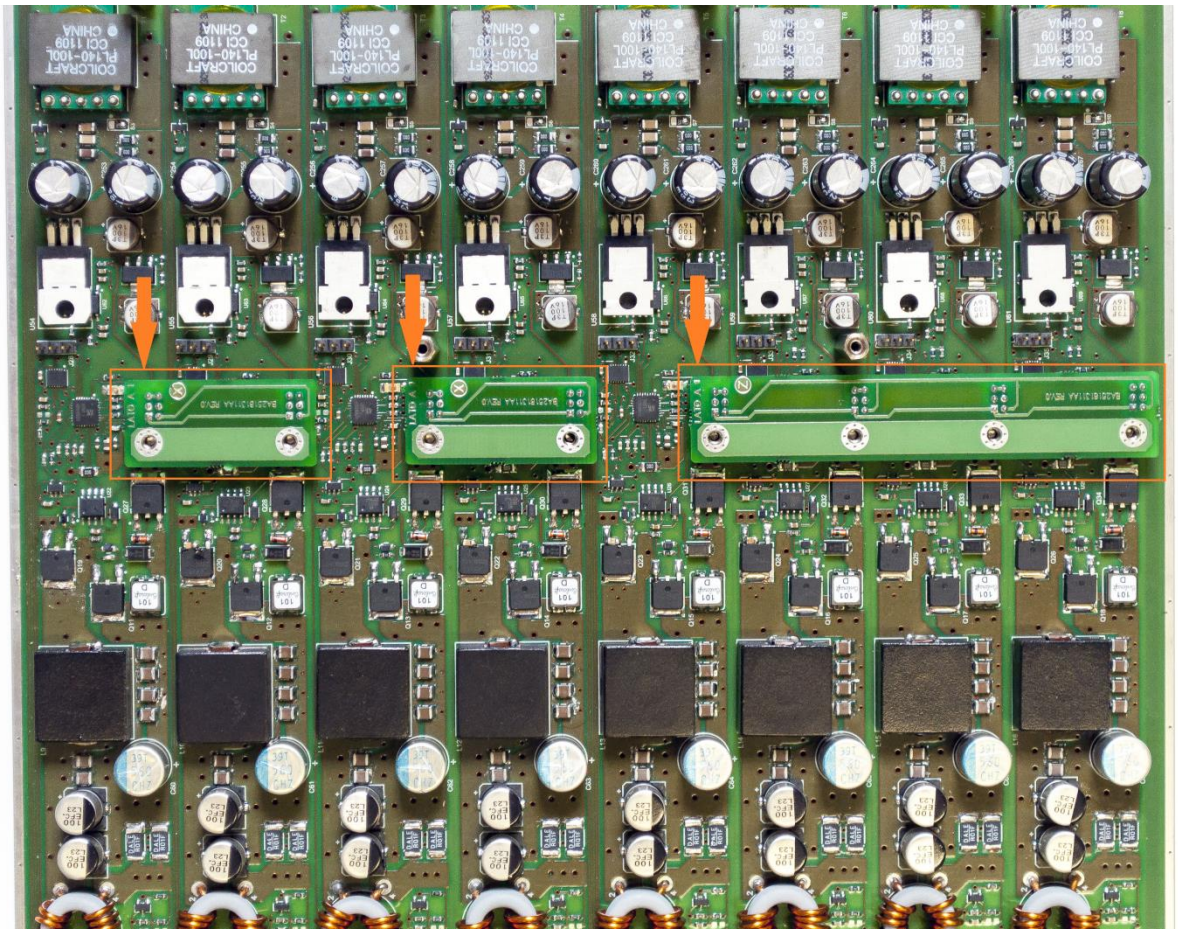
- Remove carefully the shield
- Insert the Connection Keys between the channels to be paralleled
    - Each connection key is provided with 2x3 pin male strips (two for X keys and four for Z keys)

X key

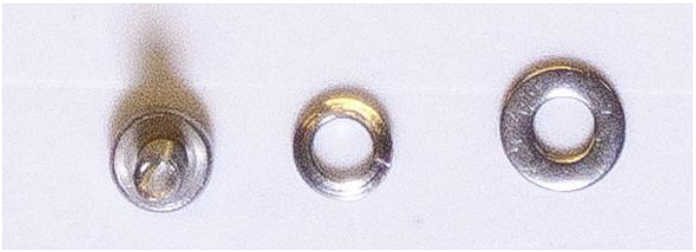


Z key

    - The 2x3 strips must be plugged into the relevant sockets on A251x (named J20÷J27, see figure)



- Secure the Connection Keys with the provided screws, grover washers, flat washers



All adjacent channels can be paralleled, with the exception of Channel 3 and 4. The pictured configuration shows:

- Channels 0-1 paralleled
- Channels 2-3 paralleled
- Channel 4-5-6-7 paralleled

With this configuration the SYx527 system detects 3 channels (0, 2, 4); the lower channel index is assigned to the paralleled channels.

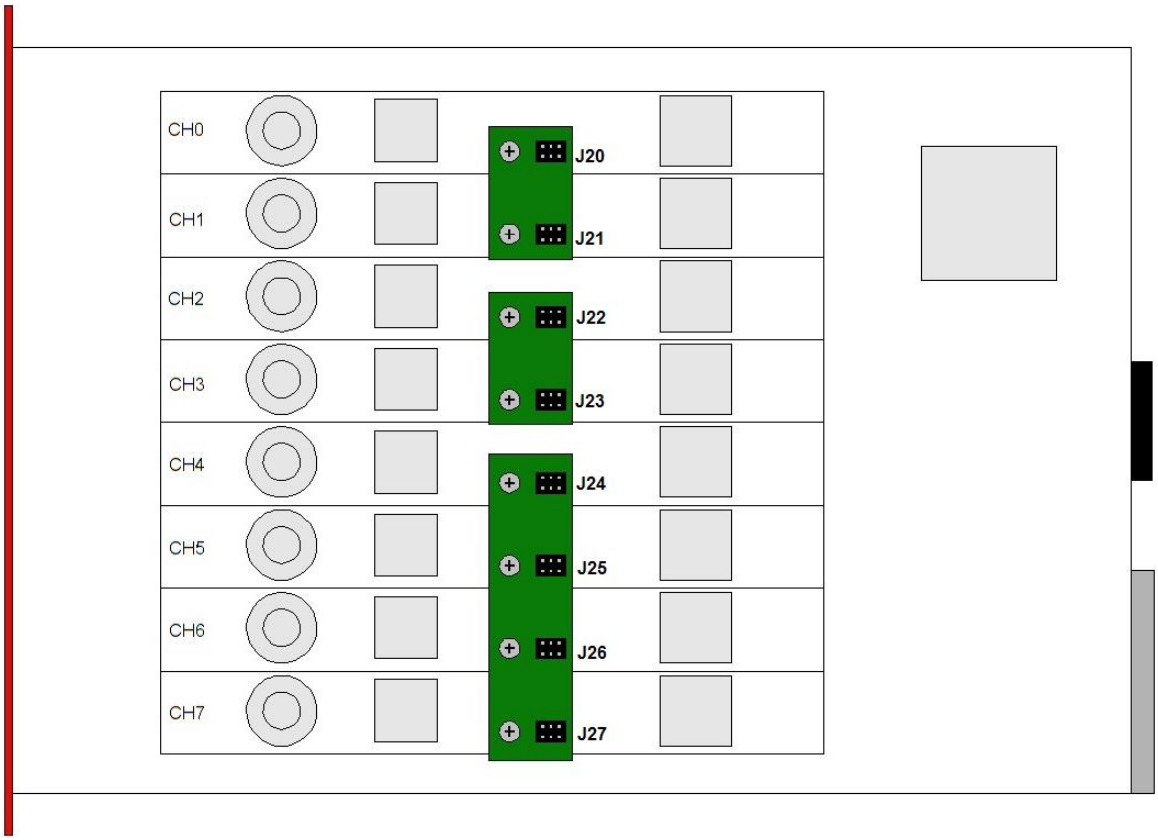


Fig. 2 – A251x with paralleled channels

Once the Connection Keys are secured, it is possible to put the shield in place.

Remember that, at this point, it is necessary to short circuit the paralleled channels output; these connections must be made as close as possible to the connectors, for both positive and negative voltages.

The same procedure is necessary for the Sense terminals.

Channel in series

It is possible to connect two channels in series; the control software will still manage them as separate channels. The best performance is achieved setting the same VSET value on both channels (for example, 12V, to provide a 24V output); it is very important that ISET is smaller than 2A, on both channels.

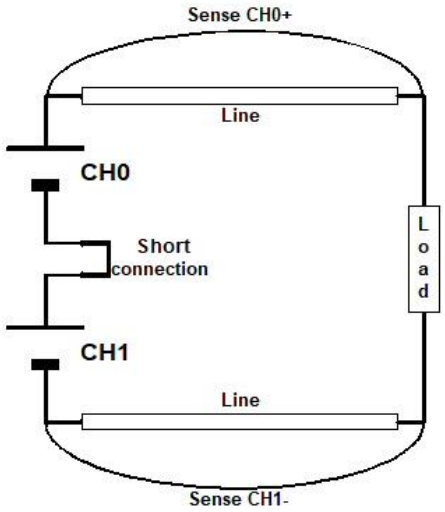


Fig. 3 – Schematic view of A251x channels in series

The figure above shows how to connect Ch0 with Ch1; the short connection must take place as close as possible to the board output connector. The sense terminals Ch1+ and Ch0- are not used. If necessary, the User can connect to the load the Ch0+ and Ch1- sense terminals.

It is very important to turn ON and OFF the channel in series at the same time; to do this, after assigning the same index of “ChToGroup” parameter to both channels, the User can use the "OnGroup" and “OffGroup" board parameters to turn them ON and OFF.

4. 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 A251x are single-width 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.

5. Operating modes

The A251x boards can be controlled, either locally or remotely, through the SYx527 System software interface. For board installation and 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

The following board parameters are available:

Parameter	Descritpion
BdStatus (monitor)	bit 0: PowerFail; if 1, failure in the channels local power supply bit 1: Firwmare Checksum Error; if 1, error in the board firmware checksum bit 2: HVMax Calibration Error; if 1, the board HVMax parameter (if present) is not calibrated bit 3: Temperature Calibration Error; if 1, the board temperature sensor (if present) is not calibrated bit 4: Under Temperature; if 1, the board temperature sensor (if present) signals a board temperature < 5 °C bit 5: Over Temperature; if 1, the board temperature sensor (if present) signals a board temperature > 65 °C bits 6..31: Reserved
OnGroup (settable)	Turn ON channel associated to the selected group
OffGroup (settable)	Turn OFF channel associated to the selected group
Intck A (settable)	Enable /disable operation of IT+/IT- signals of section A
Intck B (settable)	Enable /disable operation of IT+/IT- signals of section B

For each output channel, the following parameters are available:

Parameter	Descritpion
CHANNEL NAME (settable)	Descriptive name for the relevant channel
V0SET (settable)	Output voltage programmable value (make sure it is between UNVTHR and OVVTHR)
I0SET (settable)	Current limit programmable value
UNVTHR (settable)	Set output under voltage threshold
OVVTHR (settable)	Set output over voltage threshold
RUpTime (settable)	Set voltage ramp-up time
RDWnTime (settable)	Set voltage ramp-down time. A251xC: 0 = FAST MODE
TRIP (settable):	Set TRIP parameter value, i.e. the maximum time an Over Current condition can last. **(A2517BA, A251xC)**
VMON (monitor)	Monitored voltage value
VCON (monitor)	Monitored connector voltage value
IMON (monitor)	Monitored current value
STATUS (monitor)	Displays the channel status
PW (ON/OFF)	Power parameter shows the ON/OFF channel status; when set to ON, the channel is switched on (if the INTERLOCK is not active and if the channel is enabled either locally or remotely)
TripInt (settable)	2N-bit word (Dec. 0÷2^2N-1) max 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. 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)
ONGRDEL (settable)	Set ON delay between channel in the same group
OFFGRDEL (settable)	Set OFF delay between channel in the same group
CHTOGROUP (settable)	Number of group to associate the channel
TEMP (monitor)	Monitored channel temperature
Intck	Enable/Disable operation of channel interlock signals (only A251xA versions)

All parameters can be changed when the channel is off. When the channel is switched on, only a variation of VSET in a range of ± 5% is allowed, for adjustment purposes.

To ensure that two or more channels are turned on / off with delays programmed by user, these channels must be assigned the same value of the ChToGroup parameter and the desired time must be entered in

the OnGrDel and OffGrDel parameters (0 = no delay). The switching on and off are performed by entering the ChToGroup parameter value in the field OnGroup / OffGroup, (available as parameters of the board).

The following messages may be returned by the SYSTEM when monitoring the channel status:

OFF	(channel turned OFF)
OVC	(channel in OVERCURRENT condition)
OVV	(channel in OVERVOLTAGE condition)
UNV	(channel in UNDERVOLTAGE condition)
EXTTRIP	(channel OFF due to external TRIP line signal)[1]
INTTRIP	(channel OFF due to internal OVERCURRENT condition)
EXT_DIS	(channel disabled by board INTERLOCK protection)
PWR_FAIL	(channel OFF due to a Power failure)
OVV_PROT	(channel with connector over voltage detected)
TEMP_ERR	(channel over >85°C / under <5°C temperature)

After an ALARM notification, it is necessary to perform a CLEAR ALARM cycle, before turning the channel ON. If, after the CLEAR ALARM cycle, voltage and/or current monitored values still exceed the channel range by more than 10%, then it is necessary to perform a Power Cycle over the board.

Proportional–integral–derivative (PID) controller

The channels implement a digital type PID controller, a feedback control loop algorithm that involves three separate parameters; the Proportional, the Integral and Derivative values.

The Proportional value determines the reaction to the current error, the Integral determines the reaction based on the sum of recent errors and the Derivative determines the reaction to the rate at which the error has been changing.

The weighted sum of these three actions is used to adjust the process via the control loop. By tuning the three constants in the PID controller algorithm, the control action is provided; the general PID formula is the following:

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau)d\tau + K_d \frac{\mathrm{d}}{\mathrm{d}t} e(t)$$

The user has the possibility to change the loop parameters (Kp, Ki and Kd). These operations are not allowed by CAENGECO2020 Control Software, but they can be done only in transparent mode (see SY4527 manual). By typing P from the main menu, it is possible to open the interface to modify the PID coefficients of the channels. All changes of the coefficients are saved by typing S (see figure below):

[1] EXTTRIP and INTTRIP parameters are expressed in Hexadecimal format

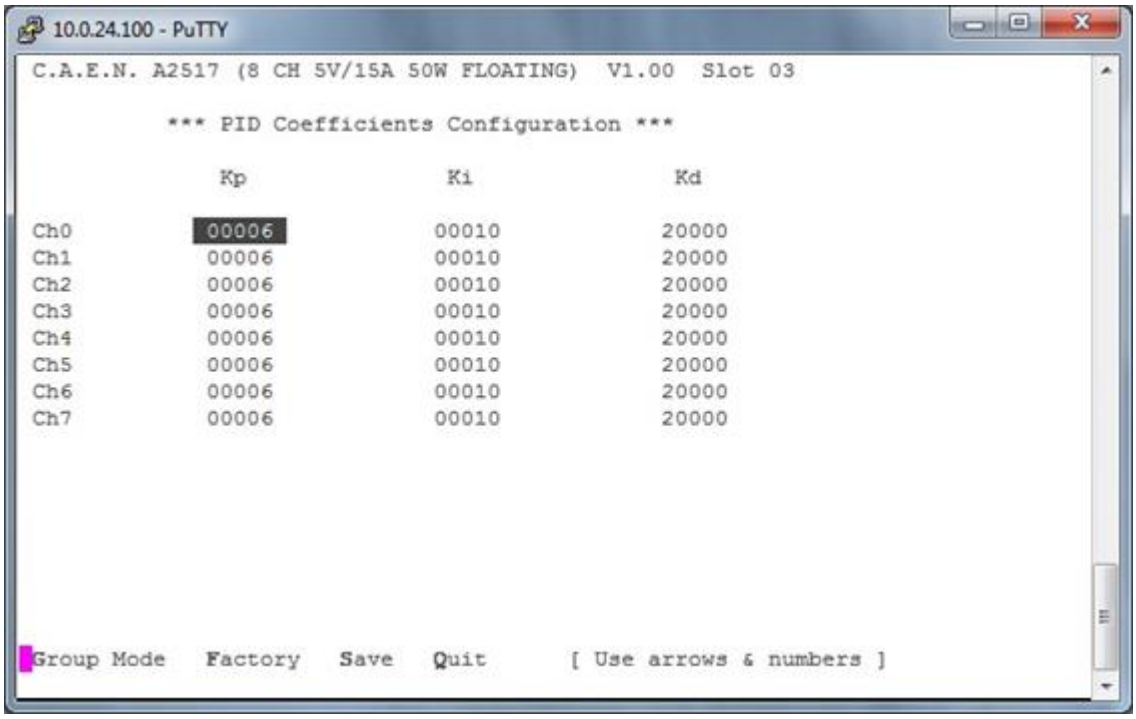


Fig. 4 – PID coefficients setting

N.B. The PID coefficients can be modified when the channels are switched off. In case of change of the coefficients with the channels on, a confirmation message asks authorization to turn off the channel and change the coefficients.

Examples of how to set the PID Digital Regulation System, in order to adapt to load changes, are thoroughly explained in the **Application Note A251X Board Family PID Digital Regulation System**, that can be downloaded from the A251x page at www.caen.it web site.

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