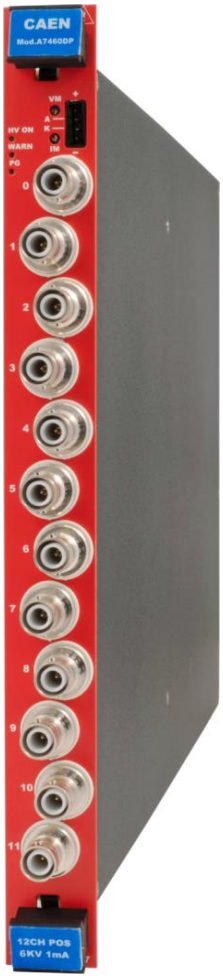
Rev. 0 - 19 May 2020

A7460

12 Channel 6 kV, 1mA/100µA
Common Floating Return Dual Range Board



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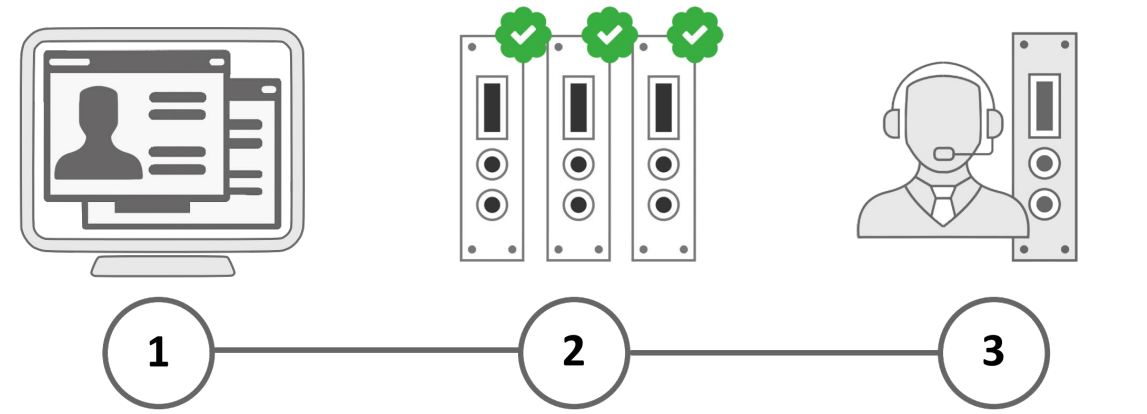

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Purpose of this Manual

This document is the A7460 12 Channel 6 kV, 1mA/100µA Common Floating Return Dual Range Board user manual; it contains information about the installation, the configuration and the use of the board.

Change Document Record

Date	Revision	Changes
19 May 2020	0	PRELIMINARY Release

Symbols, abbreviated terms and notation

N.A.

Reference Documents

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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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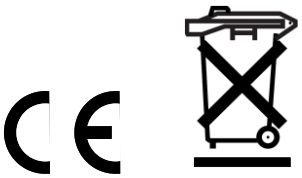

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1. Overview

Functional description

The Mod. A7460 is a 12 channel HV board, available with either positive or negative polarity, compatible with the CAEN Universal Multichannel Power Supply System[1] (SY1527, SY2527, SY4527, SY5527).

The A7460 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.

The output voltage range is 0 ÷ 6 kV, with 1mA/100µA dual range maximum output current and 10mV set and monitor resolution.

The boards are provided with both current and voltage protections.

Two output current limits are foreseen:

- ISet; software limit, individually set for each channel; if exceeded, the relevant channel is signalled in Overcurrent
- IMax; hardware limit, common to all channels, set via front panel trimmer and monitored via software; if exceeded 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 particular feature allows the module to work as current generator.

The maximum output voltage can be fixed, through a trimmer 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 have also the safety board interlock (see p. 10).

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).

[1] Please verify that the SYx527 system is running the latest firmware release

Channel Characteristic Table

Table 1 – Channel characteristics of the Mod. A7460 HV Board

Polarity			Positive / Negative depending on purchased version
Output Voltage			0 ÷ 6 kV
Max. Output Current[2]		**High range**	1mA
		Low range	100µA
VSet Resolution			10 mV
VMon Resolution			10 mV
Current Set Resolution			5 nA
Current Monitor Resolution		**High range**	2 nA
		Low range	200 pA
IMAX hardware			0÷1 mA
IMAX hardware resolution			1 µA
IMAX hardware accuracy			<±1% of FSR
VMAX hardware			0 ÷ 6 kV common for all the board channels
VMAX hardware resolution			1 V
VMAX hardware accuracy			<± 1% of FSR
VMAX software			0 ÷ 6 kV settable for each channel
VMAX software resolution			1 V
Ramp Up / Ramp Down			1÷ 500 Volt/sec, 1 Volt/sec step
Trip			Max. time an “overcurrent" can last (seconds). A channel in "overcurrent" works as a current generator; output voltage varies to keep the output current lower than the programmed value. "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
Voltage Ripple [3]	**20 ÷ 1000 Hz**		<15 mV typical; 20mV max
	1000 Hz ÷ 20 MHz		<5 mV typical; 10mV max
Accuracy [4,5]	**VMon vs. VOut**		typical: ± 0.3% ± 0.5 V max: ± 0.3% ± 2 V
	VSet vs. VOut		typical: ± 0.3% ± 0.5 V max: ± 0.3% ± 2 V
	IMon vs. IOut	**High range**	typical: ± 1% ± 100 nA max: ± 1% ± 1 µA
		Low range	typical: ± 1% ± 50 nA max: ± 1% ± 500 nA
	ISet vs. IOut	**High range**	typical: ± 1% ± 100 nA max: ± 1% ± 1 µA
		Low range	typical: ± 1% ± 50 nA max: ± 1% ± 500 nA
Maximum output power			6 W (per channel)
Power consumption @ full power			120 W max

[2] Set via channel parameter ImRange; see p. 9
[3] Ripple may exceed such limits whenever OVC and >VMAX occur (see Output control and monitoring)
[4] From 10% to 90% of Full Scale Range
[5] Vmon and Imon accuracy specifications can not be guaranteed in OVC or VMAX conditions.

Front Panel

Fig. 1 – A7460 front panel

Component Specifications

Packaging

Single width (5 TE) SYx527 board. Height is 6U.

Displays

HV ON LED	lights up as at least one channel is on; *r*ed: positive polarity*;* yellow: negative polarity.
POWER GOOD	Board correctly powered
WARNING	Warning status detected (over current, over/under voltage, trip, external disable)

Trimmers

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

Output Channels: 	HV coaxial connectors Radiall SHVR317580 WARNING! These connectors produce extremely hazardous high voltages at a potentially lethal current level; never connect or disconnect the HV OUT connector with the power ON/OFF switch ON; always switch power OFF and wait at least 30s before connecting or disconnecting HV cables
INTERLOCK (see p. 10):	AMP 280371-2

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 Unit is a SYx527 board. 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.

3. Operating modes

The A7460 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:

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
ImRange (High/Low):	Sets current range (high or low)
Status (monitor):	it displays the channel status (ramp, trip etc.).
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).

Channel STATUS Flag

The following messages may be returned by the SYSTEM 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
I-TRIPPED	channel OFF due to internal OVERCURRENT condition
EXT_DIS	channel disabled by board INTERLOCK protection

After a E-TRIPPED, I-TRIPPED, EXT_DIS notification, it is necessary to perform a CLEAR ALARM cycle, before turning the channel ON.

Moreover, it is possible to monitor board parameters:

Temperature	Measured Temperature
HVMax	Hadware maximum voltage, set via trimmer
HIMax	Hadware maximum current, set via trimmer

The following messages may be returned by the POWER SUPPLY SYSTEM when monitoring the board status:

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

Board Clear Alarm “Clr Alarm” set command is also available: it removes alarm status present on the board.

Interlock protection

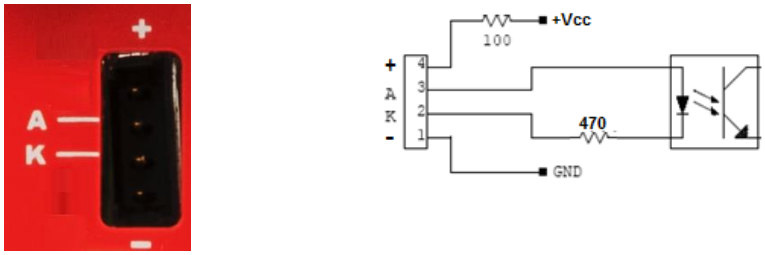


Fig. 2 – INTERLOCK electrical scheme

To enable the HV output channels, it is necessary to configure the Interlock connector as follows:

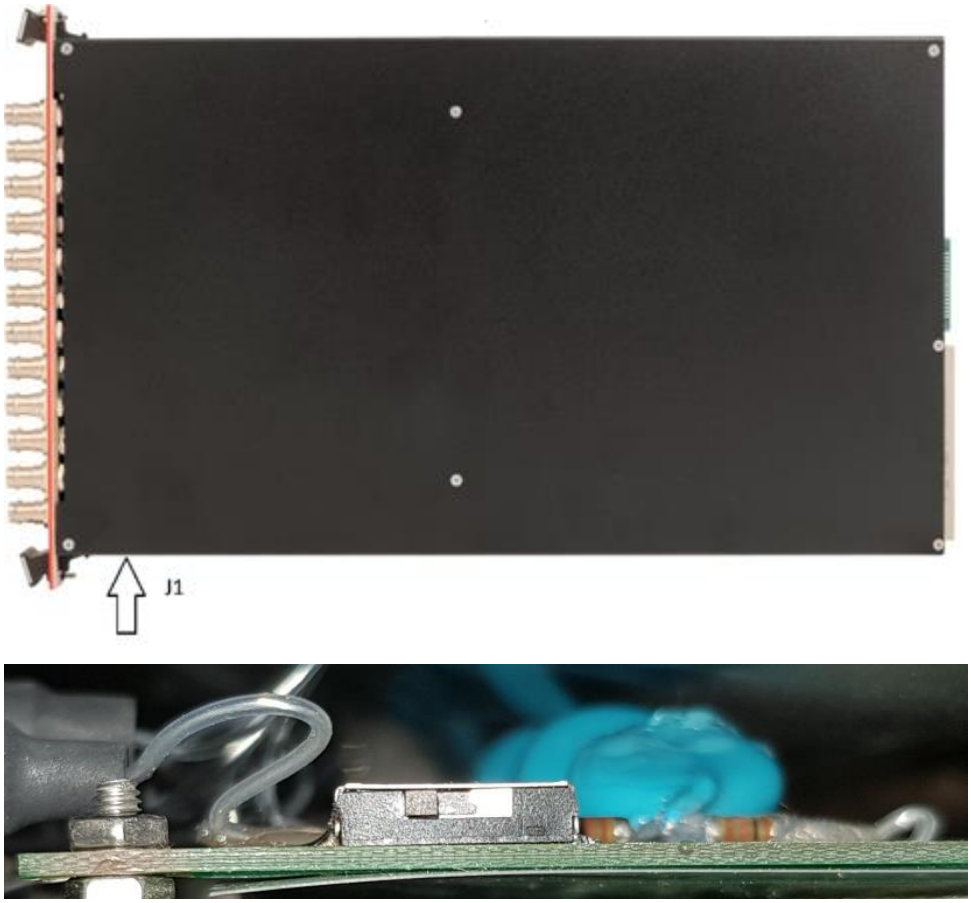
contact open	INTERLOCK
TTL Low on A-K	INTERLOCK
short circuit + with A, and - with pin K	ENABLED
TTL High on A-K	ENABLED

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 Warning 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.

Grounding specifications

The Mod. A7460 channels share a common floating return (HVGND), insulated from the crate ground (DGND). This feature allows on-detector grounding, thus avoiding loops which may increase noise level. HVGND and DGND may be connected, via J1 switch on the motherboard (see figure below).



J1: left = HVGND to DGND (EARTH); center/right = HVGND floating

Fig. 3 – J1 switch location

Safety Earth connection

The connection of return to Earth is fundamental for User safety. The connection must always be at the level of detector or power supply system. Return connection even if not present or performed incorrectly, due to protection circuits implemented on the A7460 are bound to Earth; in this case the voltage difference between return and Earth (System), 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 return and of DGND (Earth). The best configuration must be determined by the user upon application, the optimal connection depends on many characteristics of the related experiment.

The following diagrams show two examples of configuration, namely:

The “closed loop” Earth configuration (J1 contacts closed = left position)

The “open loop” Earth configuration (J1 contacts open = center/right position)

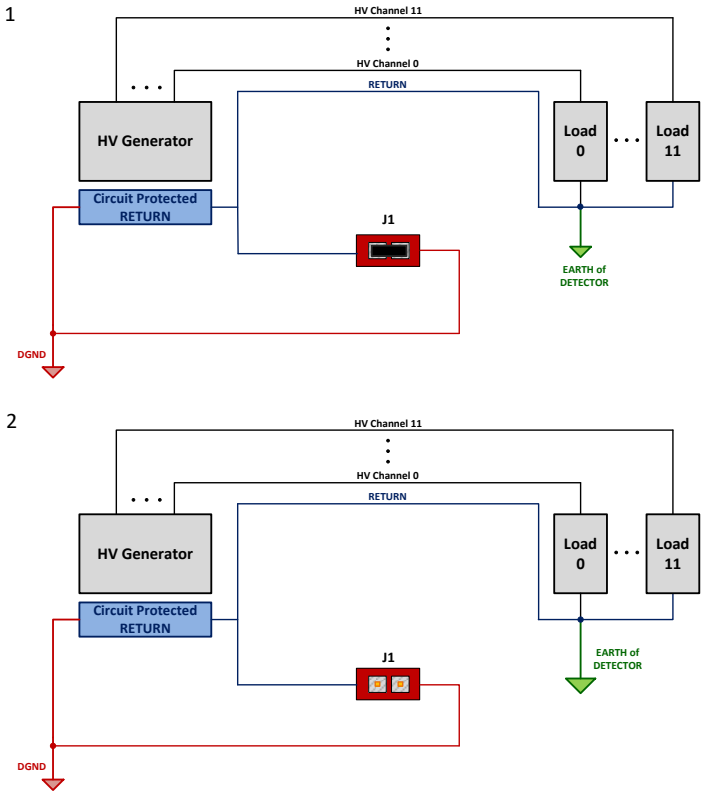


Fig. 4 – Earth configuration connection examples

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