Computing division

ALBA Project Document No:	EDMS Document No.	Created: 18.02.2009	Page: 1
CCD-GDVC-OG-0001		Modified: xx.xx.xxxx	Rev. No.: 1.0

High Voltage Splitter Reference Guide

Abstract

The aim of this document is to summarize how to use the High Voltage Splitter developed at Alba in a correct and safe way. Everyone that uses the High Voltage Splitter unit should have read and understood these pages completely. Also detailed information about the architecture of the unit is provided.

Prepared by:	*Checked by:*	*Approved by:*
J. Jamroz	**D. Beltran (*pending*)**	**??**
O. Matilla	**R. Martin (*pending*)**	
	E. Al-Dmour (*pending*)	

Distribution List

History of Changes			
Rev. No.	*Date*	*Pages*	*Description of changes*
1.0	18.02.2009		Initial Release without Appendixes.

References

The references can be found in the *ALBA Knowledge Tree Document Management System*

[1]: Evaluation of Q-Lambda High Voltage Splitter (Alba Doc: CCD-GDVC-TR-0001)
[2]: Technical Proposal of High Voltage Splitter (Alba Doc: CCD-GDVC-TR-0002)

Table of Contents

Table of Figures

0 INTRODUCTION

The High Voltage Splitter (HVS from now) is a collaborative project between Q-Lambda Company, Vacuum Section in Engineering Division and Computing Division at CELLS. Extensive evaluations about current sensing mechanisms and performance under high voltage conditions have been done previously and are not in the scope of this document (please refer to [1] and [2] for detailed information about these points).

This manual is divided as follows: in chapter 1 an introduction about the equipment and its functionality is done. Also necessary safety considerations that must be taken into account when operating the HVS are included. In chapter 2 there is a description about controls, interfaces of HVS and also some views of the equipment. In chapter 3 a complete explanation about how to control the HVS is described. It is subdivided in three parts: 3.1 is focused in the local control, 3.2 is focused in the remote control of the unit and in the last section a typical application with HVS is described. Finally in the different appendixes detailed engineering information about schematics and part list of the unit are provided.

Any person that uses the HVS should have read and understood completely chapters 1, 2 and 3.1. Chapter 3.2 is oriented to persons interested in commanding remotely the instrument. Finally information offered in the appendixes goes beyond the “user level”.

1 HIGH VOLTAGE SPLITTER BASICS

1.1 Overview

1.1.1 Main scheme

The main function of the HVS is **to distribute +7kV power from one Ion Pump Controller up to eight Ion Pumps**. This distribution allows minimizing the total number of high voltage power supplies needed in a vacuum installation.

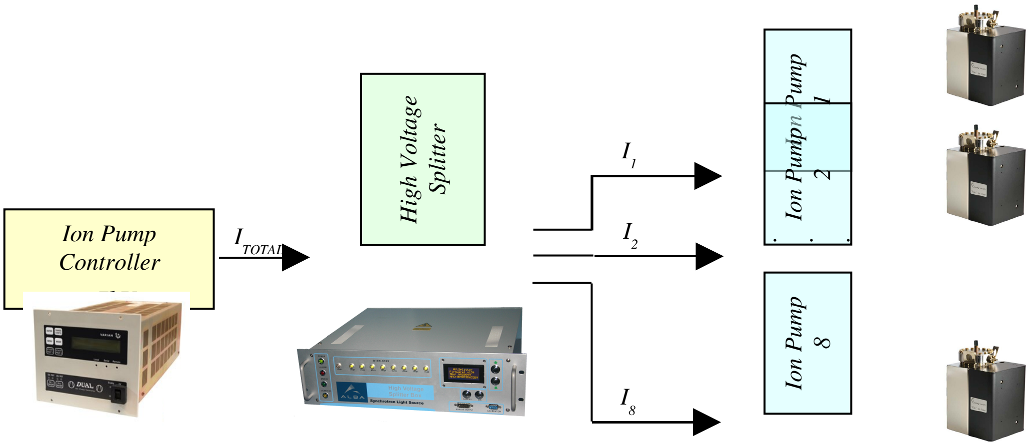

Figure 1: High Voltage Splitter basic diagram

Moreover of this power distribution, **the current drawn by each channel is measured independently inside the range from 10nA up to 10mA** with 5% accuracy. In order to achieve this precision over six orders of magnitude each splitter channel needs an independent calibration.

The design of the HVS has been done taking into account **that if there is any eventual power cut in the 220V AC input in the unit the 7kV distribution will be kept** without affecting the ion pumps performance.

Also if the current drained from the ion pump controller exceeds 10mA the HVS will not be able to measure it but the current drain will not be disturbed.

1.1.2 Calibration

The HVS integrates an **automatic calibration process** based on the *Keithley 2611 SourceMeter* working as current generator. This source is able to set a fixed current with an error lower than 0,001%. Two connections are needed between the two equipments to execute the calibration: a serial RS-232 cable has to be connected from the *Control Port* of the *Keithley 2611* to the *Calibration Port* of the HVS. And the current output of the generator has to be connected to the channel input of the splitter that wants to be calibrated. Once the calibration process is executed[1] the HVS will take remotely the control of the *Keithley* generator completing all the calibration process. For some specific ranges the HVS needs some time in order to compensate some internal thermal drifts[2]. All this process is **completely transparent to the user**. An estimated time between 3 and 4 minutes is needed to complete each channel calibration.

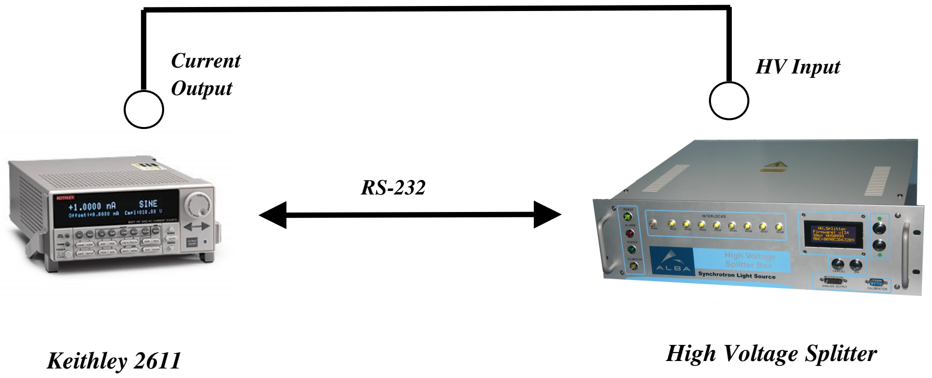

Figure 2: High Voltage Splitter calibration

The calibration process has to be executed only by experienced users. All the units have been already calibrated during the manufacture process and it is considered that **there is no need to repeat this process during the power up of the unit**. If, by mistake, one channel has not been calibrated it will appear on the display the text: *"<CAL?>"* after the channel description and also it is possible to detect this missing process remotely.

The calibration data is completely available remotely so it is possible to do easily a backup of it[3].

1.1.3 Pressure readings

Once the measure of the current is obtained the HVS calculates the **pressure** present at each ion pump using following formula provided by *Gamma Vacuum Inc*:

$$P(mbar) = \frac{0.08778 \cdot \left(\frac{5600}{Voltage(V)} \right) \cdot Cal\_Factor \cdot I(A)}{Pump\_Speed(l/s)}$$

There are four parameters that are used to obtain the pressure reading: the first one is the **voltage** that is **applied to the ion pump**. As a default the HVS is considering a value of **7kV**. The second is the **ion pump speed**. The HVS has some predefined pump sizes that can be set: **25, 75, 150, 300 and 500 l/s**[4]. The third is the **calibration factor**. This factor considers small variations between different pumps. This calibration factor, according to *Gamma Vacuum Inc*, would need to be adjusted experimentally. In the case

---

[1] *Please refer to 3.1 for further details about how to execute it.*

[2] *Please refer to [1] for detailed information about thermal drifts in the measurement.*

[3] *Please refer to 3.2 for further details.*

[4] *Please refer to chapter 3 for further details about ion pump configuration.*

of HVS the calibration factor is considered by default to 1.000 but can be changed via remote control to any value that is considered more accurate. And the last parameter is the **current reading**.

It has been decided not to limit the value that can be set in the calibration factor in order to have more flexibility under future scenarios. For example this factor could be used in an eventually scenario where the voltage provided to the ion pumps were decided to be changed from the ion pump controller side[5].

A current (and consequently pressure) **reading of each channel** is obtained **every millisecond**. In order to avoid that any vacuum disturbance affects the whole pressure measure a **moving average value** is calculated continuously. It is possible to adjust this averaging time **from 0.3s up to 3 minutes**[6] so the user can choose increasing the time response of the system or doing it more sensitive to fast vacuum changes. Anyway **up to millisecond readings are available** for any analysis **via remote commands**.

1.1.4 Pressure alarms

Once the pressure reading settings have been configured it is possible to set in the instrument **two different pressure alarms** with **two independent thresholds for each channel**. If the pressure reading exceeds the first threshold level of a channel a **warning message** will be visible in the front panel and also the Control System will be informed via Ethernet port.

The second pressure alarm activation will produce that a **dry contact** placed in the rear side will be opened (*EPS output*). The purpose of this output is to inform to the Equipment Protection System (EPS from now) about an exceptional vacuum loss situation. As the trigger of this hardware output will involve a machine shutdown it has been decided to implement in this alarm a more robust mechanism of activation. In the HVS it will be possible to set up to 8 different **EPS alarm configurations**. Every one will set a condition of alarm in the different ion pumps that will produce the EPS alarm.

	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8
EPS Configuration x		X	X					X

Figure 3: EPS Alarm Configuration

For example in Figure 3 case the EPS alarm will be activated only if the pressure readings in the ion pumps connected to the channels 2, 3 and 8 is exceeded. It has to be noticed that also independent channel pressure thresholds can be set[7].

The HVS incorporates an ***External Interlock*** input connector with a two pin contact. The purpose of this input is being able to combine the interlock produced by the EPS alarm with any other external interlock. The internal cable diagram in the HVS is as follows:

---

[5] *For example: a calibration factor of 1,4 would lead to a correct pressure reading under 5kV supply conditions.*

[6] *Please refer to chapter 3 for further details.*

[7] *Please refer to 3.1 and 3.2 for further details about the configuration of the EPS alarms.*

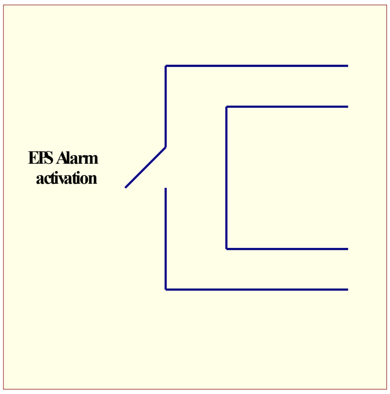

Figure 4: EPS and External Interlock cable diagram

As it can be noticed if the external interlock is not going to be used an external shortcut has to be inserted in the contacts in order to enable the EPS functionality[8].

1.1.5 Cable interlock

In order to increase the security in the operation of the instrument a **cable interlock security system** has been implemented. In the case of *Alba* synchrotron a *Varian Dual* Ion Pump Controller will be used. This controller uses a cable interlock security mechanism which consists in producing a 5V high impedance output that is sent using an interlock cable that is inserted into the high voltage cable. When the cable is connected to the Ion Pump a shortcut is produced between this pin and a second one. Finally a shortcut between the second interlock pin and ground is produced on the controller side. In this way the controller senses the voltage of the first interlock pin. If a low level is detected, it involves that the high voltage cable has been accordingly connected and the controller has enabled the high voltage output.

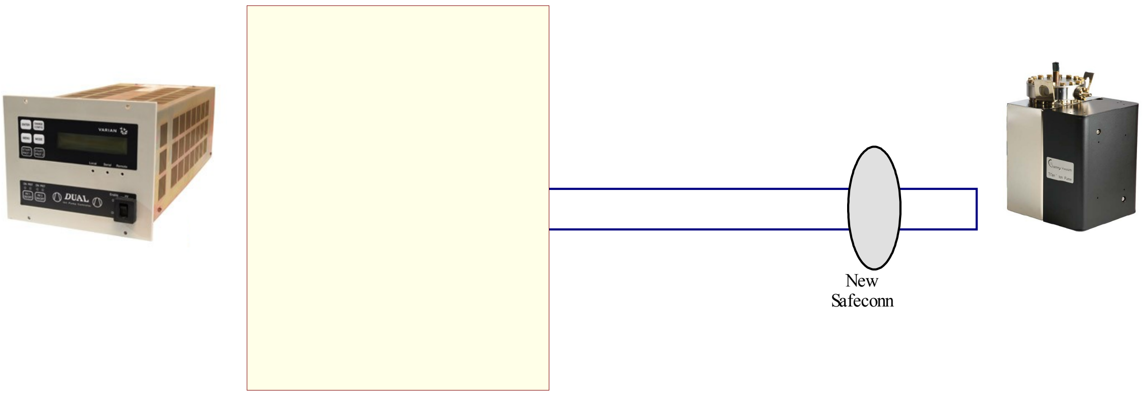

Figure 5: Cable Interlock diagram for one controller and one Ion Pump

[8] *An internally shortcut connector is provided together with every HVS unit for this purpose.*

In the case of the HVS a cable interlock management system has been designed to preserve this security protection. Internally all the interlock signals are connected as a chain. Doing in this way **all the high voltage cables will be needed to be correctly connected before the high voltage power is enabled by the controller**. In order to ease operation of the unit the HVS also **detects** which is the **cable** that is **unconnected and informs via the display and remotely** about any unplug condition in any channel that could happen.

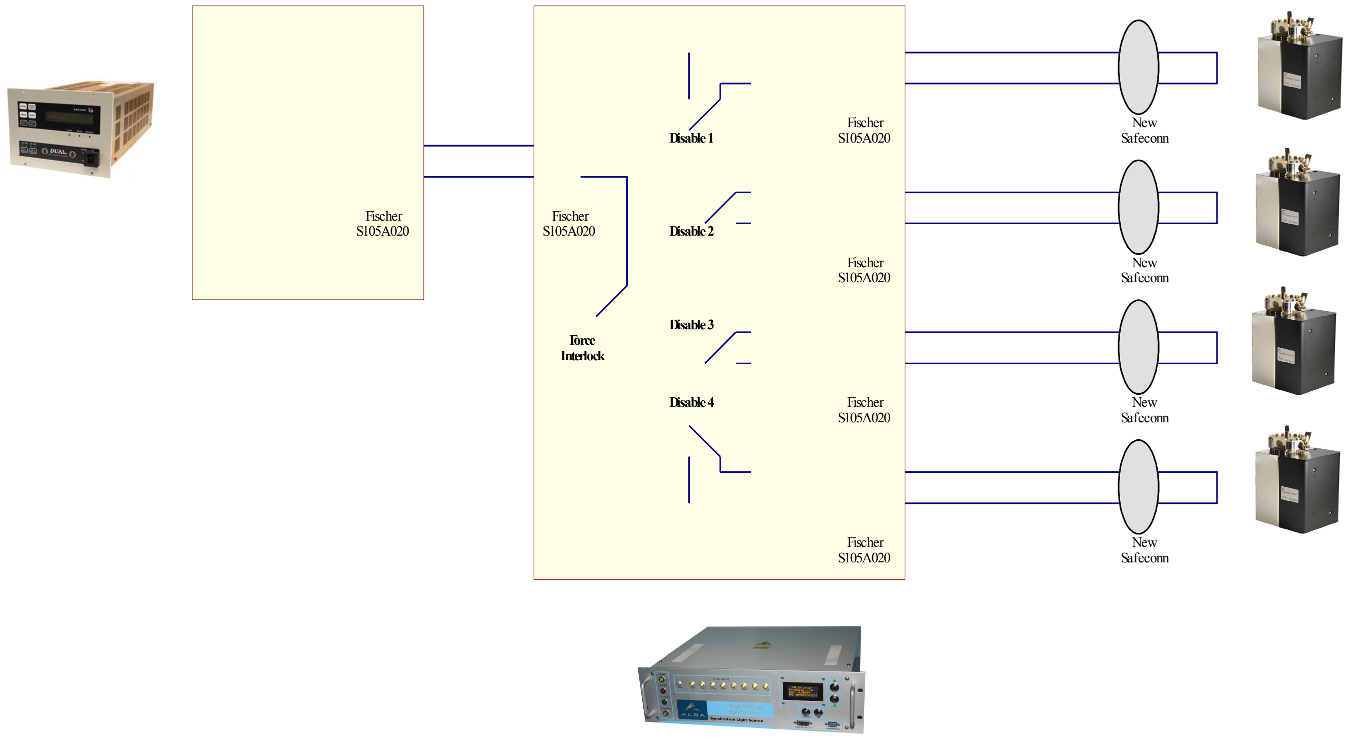

Figure 6: Cable Interlock diagram for one controller, HVS and four Ion Pumps

It could happen that during the use of the HVS not all the outputs available are needed. For these cases the unit has a mechanism to **disable the cable interlock of any specific channel**. This disable is done via an internal switch following the schema of Figure 6. As this disable could affect the security of the working condition of the unit the user is informed continuously via front leds about the disable state of each channel[9]. It has to be taken especially into account that **disabling the interlock of one channel is not involving that the high voltage is not being supplied to this channel but that the interlock of this channel is not taken into account to stop the Ion Pump Controller**. Also it has been implemented an internal switch to force the interlock manually.

[9] *Please refer to 2.2.5 for detailed information about led color information.*

1.1.6 Remote control

The equipment integrates a **10/100 Base-T Ethernet Port** in the rear panel. From this port the equipment can be fully configured and all the data are available remotely.

The HVS Ethernet port uses **DHCP protocol**[10]. All the remote communication is done via Telnet protocol. In order to access to the unit it will be requested a password. As a **default** the **password is 1243** and can only be changed via remote commands for security reasons.

When the Ethernet link is correctly set and the telnet port has been already opened the front panel led *Status* will be switched on. Also some blinking will be noticeable in this led when network activity occurs.

1.1.7 Operational Modes

The HVS has **two operation modes**: commissioning mode and secure mode. In **commissioning mode** a user has **unrestricted access** to the HVS configuration using menu navigation. In **secure mode** the access to the **configuration** settings are limited **only via Ethernet commands**. To change from one mode to another can be done only via Ethernet[11].

It is strongly recommended that in final conditions the HVS will be set to work into secure mode. Doing in this way it can be assured that there will be no accidental local action via front button pressing that would produce any alarm in the machine.

After switching on the unit it is set to **commissioning mode by default**. This decision has been taken in order to avoid having a complete "hanged" system in case of Ethernet signal loss when working under secure mode[12]. So the control system will need to set the mode to secure every time the unit is switched on.

1.2 Block Diagram

The internal block diagram of the HVS is presented in this section as reference.

---

[10] *The MAC address of each unit can be easily found via menu navigation. Please check 3.1 for further details.*

[11] *Please refer 3.2 to for detailed information.*

[12] *Even if we set remotely the mode to secure and we send the command to save the actual configuration to Flash. After switching off the HVS will return to commissioning mode.*

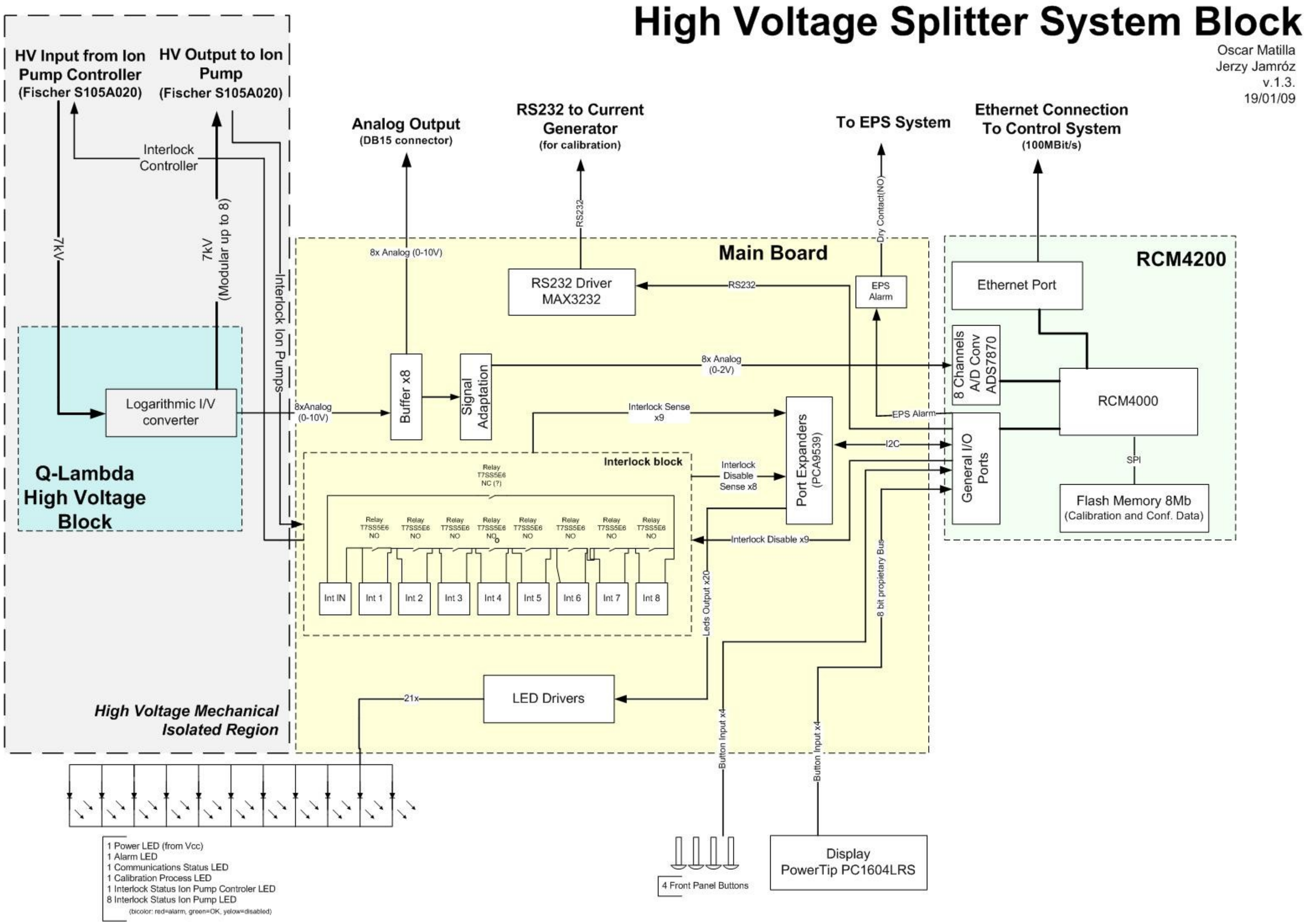

Figure 7: High Voltage Splitter System Block

1.3 Features

In this section the features of the HVS are summarized:

- 19'' rackable unit of 3Us height (according DIN 41494 and IEC 60297-2). Total weight 10Kg.
- AC Input: 100-240V (47-63Hz). Maximum power consumption: xxxW
- Distribution of 7kV up to 8 ion pumps[13].
- Individual channel current consumption measurement from 10nA up to 10mA with 5% accuracy.
- Automatic calibration process using Keithley 2611 generator.
- Direct chamber pressure reading in the display and remotely. Averaging time configurable from 0.3 seconds up to 3 minutes.
- Independent channel programmable pressure warning.
- Programmable Equipment Protection System hardware output under exceptional pressure loss scenario. Additional external interlock port available.
- Secure cables interlock management system.
- Fully remote operation via 10/100 Base-T Ethernet Port. DHCP protocol implemented.
- Possibility to limit the local and remote access available.

[13] *Depending on the model.*

1.4 Important safety considerations

In this section some safety considerations are summarized. **All following points shall be fully understood by any user that operates the HVS**:

As in any equipment that works with high voltage, **ground connection should always be connected**. The unit is using AC plug earth pin but also offers a **central ground point connection**[14]. It is considered that the normal working condition is that **this ground terminal should be connected** in order to avoid that an occasional unplug of the AC cable or any problem with the AC installation would involve that the unit works without proper ground reference.

Cable interlock disabling of a specific channel does not involve that high voltage is not provided to the output. **No cable should be connected in the outputs that are disabled**. It is strongly recommended to work with the interlock security system enabled from the Ion Pump Controller and to disable only the channels that are not going to be used.

Cable interlock unplug security system can be disabled from the Ion Pump Controller side. If this system is disabled the unplug of one high voltage cable will not produce the automatic switch off of the power. **It is strongly recommended to check controller status before operating with high voltage cables and is considered mandatory to disable HV output from the controller side before any manipulation of them.**

Switching off of the HVS unit not involves that the high voltage is no longer provided. It could cause this effect depending on the configuration of the interlock cable in the Ion Pump controller. **Switch off of the high voltage is mandatory to be done from the Ion Pump Controller side**.

[14] *Please refer to 2.1 for detailed information about central ground connector.*

2 UNIT DESCRIPTION

In this chapter a complete description of the controls and interfaces of the HVS will be done.

The HVS form is a standard 19'' rackable unit of 3Us height (according DIN 41494 and IEC 60297-2). The total weight of the unit is 10Kg. Due to its weight two handles have been placed in the front of the unit to ease the handling.

The unit distribution has been designed so the connectors are placed in the rear side[15] and the user interfaces are placed in the front side[16]. The exceptions to this general rule are the two DB connectors for calibration and analogue output. Anyway both connectors are considered to be rarely used during normal unit operation.

2.1 Rear Panel

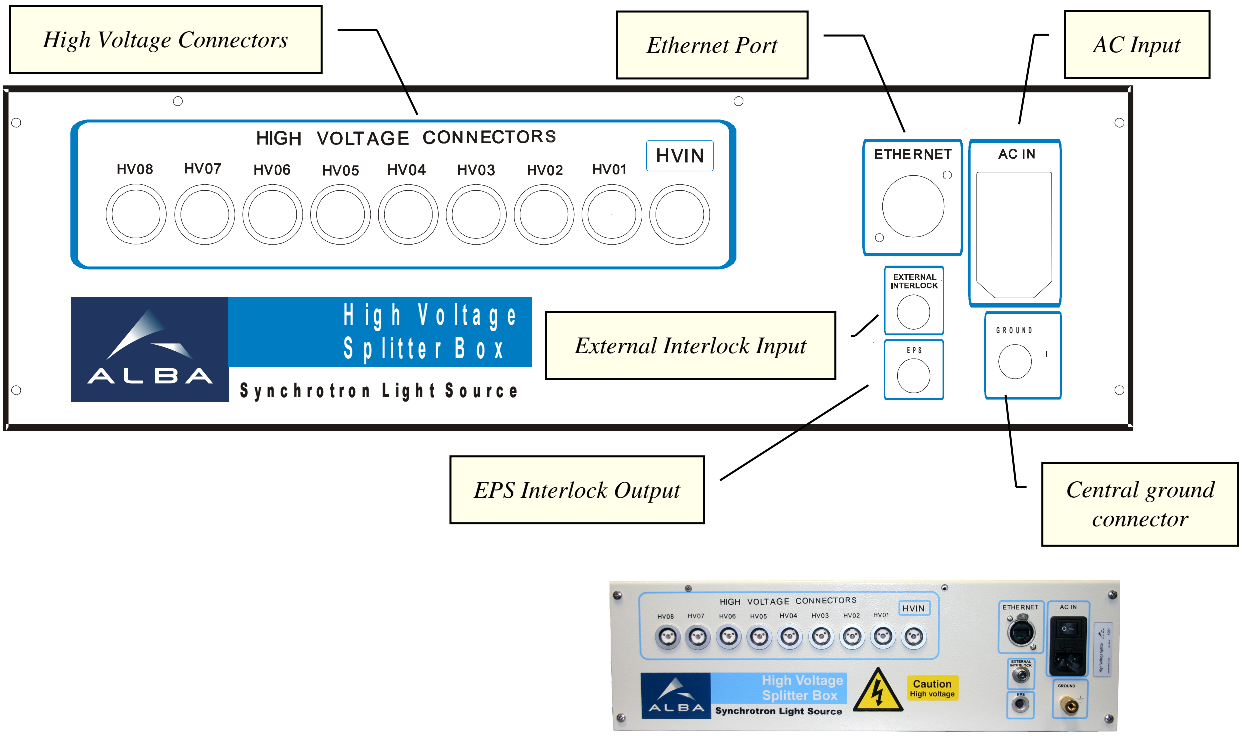

Figure 8: Rear Panel Description

[15] *Please refer to Figure 8.*

[16] *Please refer to Figure 9.*

2.1.1 AC input

The AC input **plug** is a standard **IEC** 60320. The voltage input range is **100-240V @47-63Hz**. The unit incorporates a 5A slow blow fuse that is accessible from the exterior of the unit[17]. The **maximum power consumption** of the unit is **40W**.

Internally the system uses a commercial power supply with MTBF higher than 250.000h.

2.1.2 HV Connectors

There are up to 9 high voltage connectors. As can be easily understood the HV_IN should be connected to the Ion Pump Controller and the HV0x should be connected to the different ion pumps.

The high voltage panel connectors used in the unit are **Fischer D105A020**.

2.1.3 Ground connector

A central ground connector is offered in the right side of the panel. It is **strongly recommended to connect this terminal to the ground of the installation during the normal operation**. Doing in this way the ground connection of the unit will be assured. **Using as the only ground connection the AC plug earth or high voltage cable shields is considered to be a potential risk**.

2.1.4 External Interlock Input

A male two pin **Binder 702** series connector is used for the External Interlock input (Ref. 09-0403-00-02).

2.1.5 EPS Output

A female two pin **Binder 702** series connector is used for the Equipment Protection System interlock output (Ref. 09-0404-00-02).

2.1.6 Ethernet connector

An **RJ45** connector 10/100 Base-T Ethernet Port is used for remote controlling.

---

[17] *A spare unit is placed also inside the IEC plug.*

2.2 Front Panel

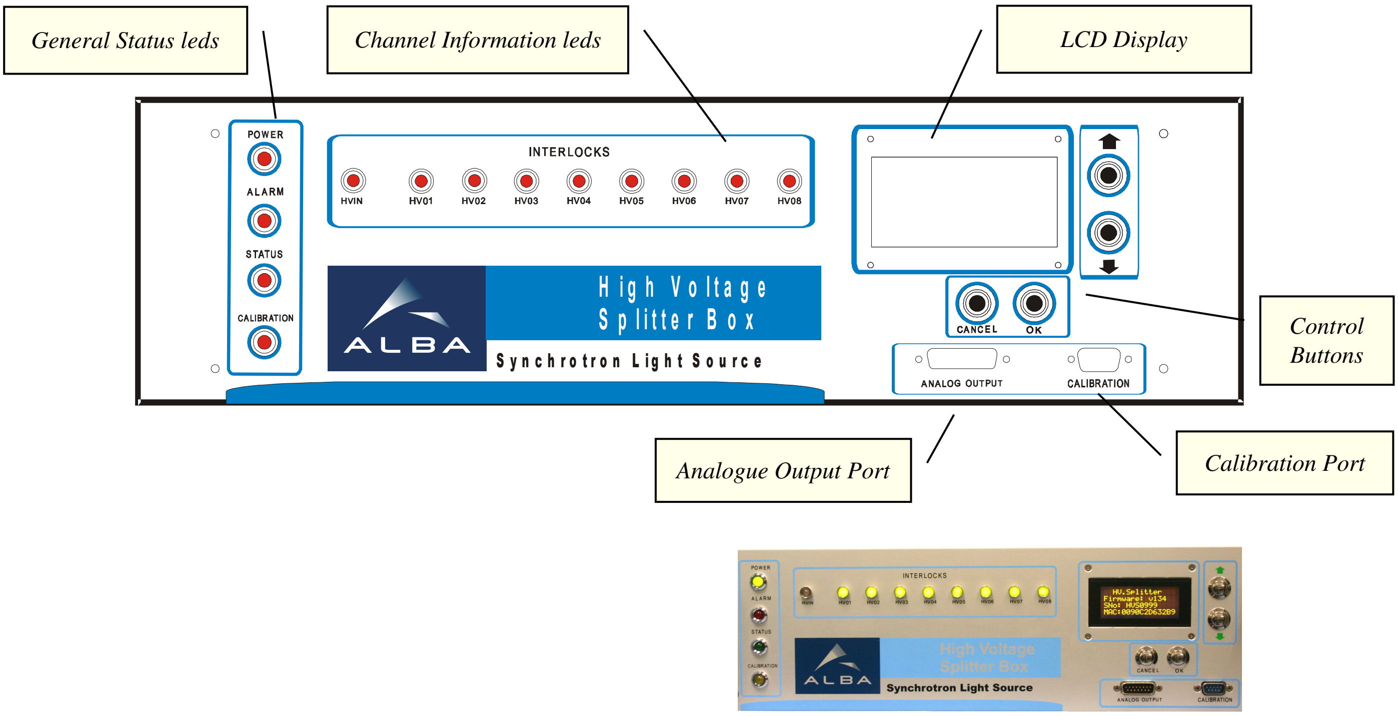

Figure 9: Front Panel description

2.2.1 Power led

This led inform about the internal power supply status. If the unit has **input power** the led will be on.

2.2.2 Alarm led

This led **informs if there is any alarm detected in the HVS**. In order to detect the source of the alarm the interlock leds or the display should be consulted.

2.2.3 Status led

This led shows the **status of the remote port link**. If it is switched on it means that a correct DHCP identification process has been done and the telnet remote port link has been established. It also shows communication activity through its blinking.

2.2.4 Calibration led

The led will inform when the HVS is executing the calibration process. **This calibration is executed using the "Service Menu" and should be done only by experienced users**.

2.2.5 Interlock leds

A lot of information is offered through the channel interlock leds. In fact **it is possible to know the actual status of the HVS interlock and alarms just by a quick look at them**. The colour configuration of the leds is listed in the figures 10 and 11:

HV In LED		
Fixed LED		
		Normal state.
		Interlock signal detected in the input from the controller[18].
Blinking LED		
		Manual EPS has been switched ON.

Figure 10: HV Input led color configuration

HV 0x LED		
Fixed LED		
		All the functionality of this output is disabled as the HVS has been configured to work with less than 8 outputs.
		Normal state.
		Cable interlock has been disabled in this channel.
		Cable unplugged detected in this channel.
Blinking LED		
		Pressure warning threshold has been exceeded in this channel.
		EPS pressure threshold has been exceeded producing that one alarm configuration activates the EPS interlock.
		Cable interlock has been forced in the HVS.

Figure 11: HV channel led color

[18] *If the interlock cable detection has not been disabled from the controller side the HV should have been switched off.*

2.2.6 Display

A 4x16 character display is used to display HVS readings and navigate through the menu. Please refer to 3.1 for detailed information about its contents.

2.2.7 Buttons

The interface has been done using four buttons. Please refer to 3.1 for detailed information about their functionality.

2.2.8 Calibration Port

The calibration port is a serial DB9 male connector that is used to connect to *Keithley 2611* current generator in order to execute the calibration process.

2.2.9 Analog Output Port

This DB15 connector **outputs a voltage from 0 to 10V proportional to the logarithm of the measured current**[19]**. This voltage output is not calibrated but follows the approximate equation**.

$$V(V) = 11.4 + 1.3 \cdot \log I(A)$$

The pin diagram is as shows next figure:

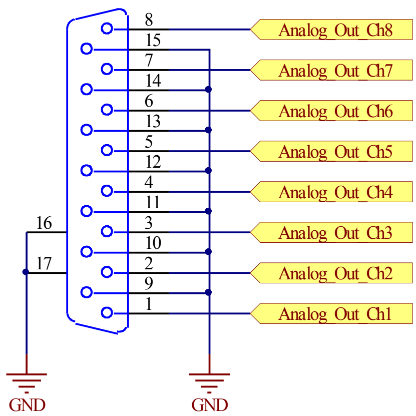

Figure 12: Analog Output pin diagram

---

[19] *Inside the measurement range from 10nA to 10mA.*

2.3 Equipment Views

Figure 13: HVS General View

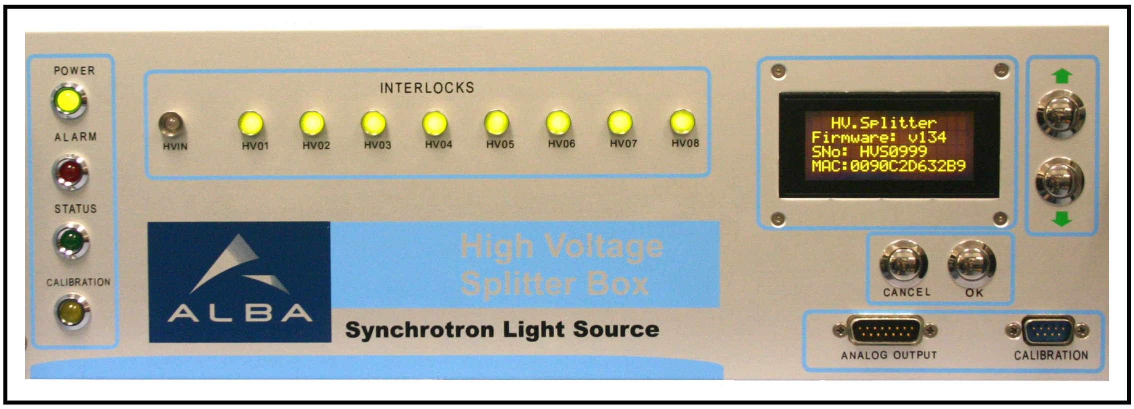

Figure 14: HVS front view

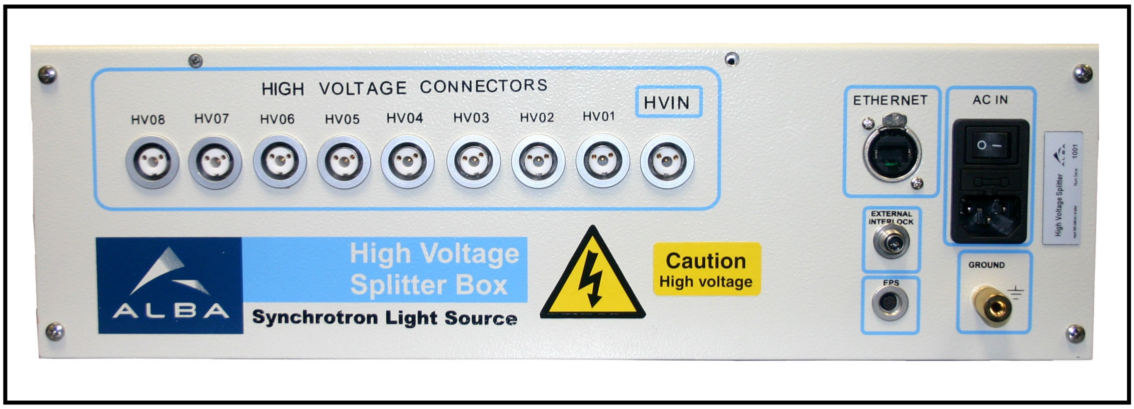

Figure 15: HVS Rear view

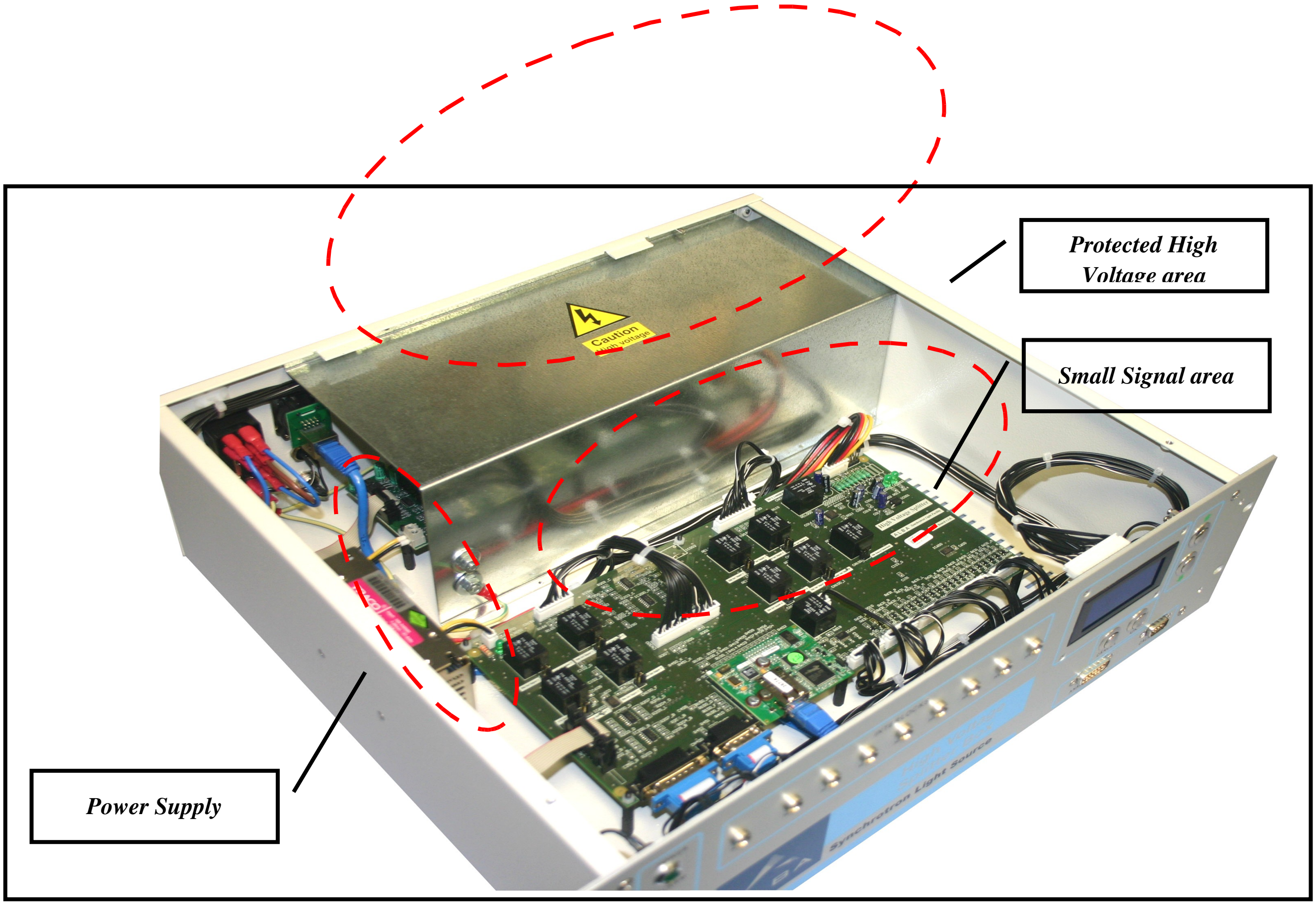

Figure 16: HVS Insight View 1

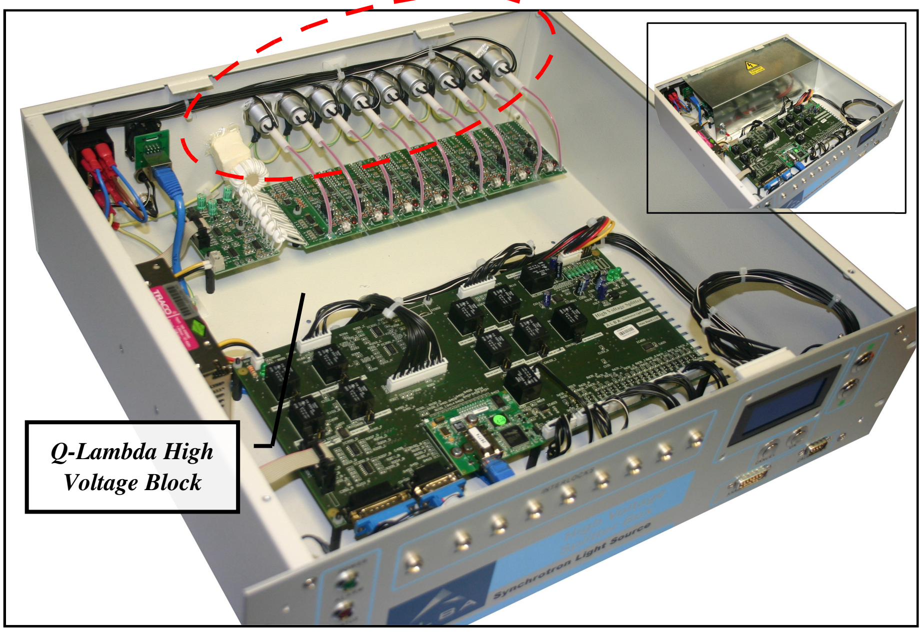

Figure 17: HVS Insight View 2

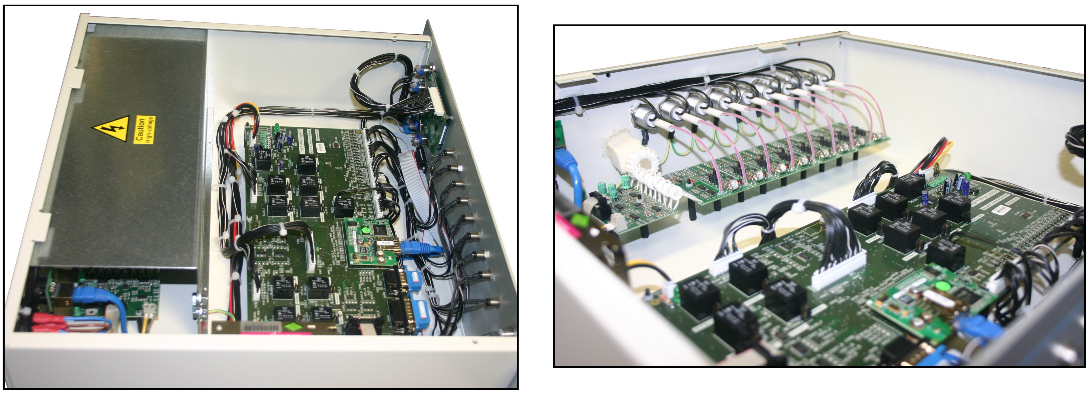

Figure 18: HVS Insight View 3

3 HOW TO CONTROL THE UNIT

3.1 Local Control

The local control is based on a keypad which contains **four buttons**. Each button has a label which describes its function: *Up*, *Down*, *OK* and *Cancel*. Using these controls it is possible to navigate through the menu to read measurements and to change the HVS configuration.

The menu flow possesses two main submenus:

1) ***Measurement Menu*** which shows the actual **measurements** recorded by HVS (P[mbar] and I[A]).
2) ***Settings Menu*** which contains the **configuration** of HVS.

A user can toggle between those two menus by the button *Cancel* when the unit is in Commissioning Mode. In the case the HVS has been set to **Secure Mode** remotely[20] a user will not be allowed to enter into the Settings Menu, and a message will appear in the display informing about this fact.

3.1.1 Measurement Menu

In this menu a user is able to read the current and pressure level of each channel.

Pressing *OK* button a user toggles between current and pressure measurements. Using buttons *Up/Down* allows the user to select a high voltage channel. The complete menu tree is presented in Figure 19.

[20] *Please refer to 1.1.7 for further details about HVS operation modes.*

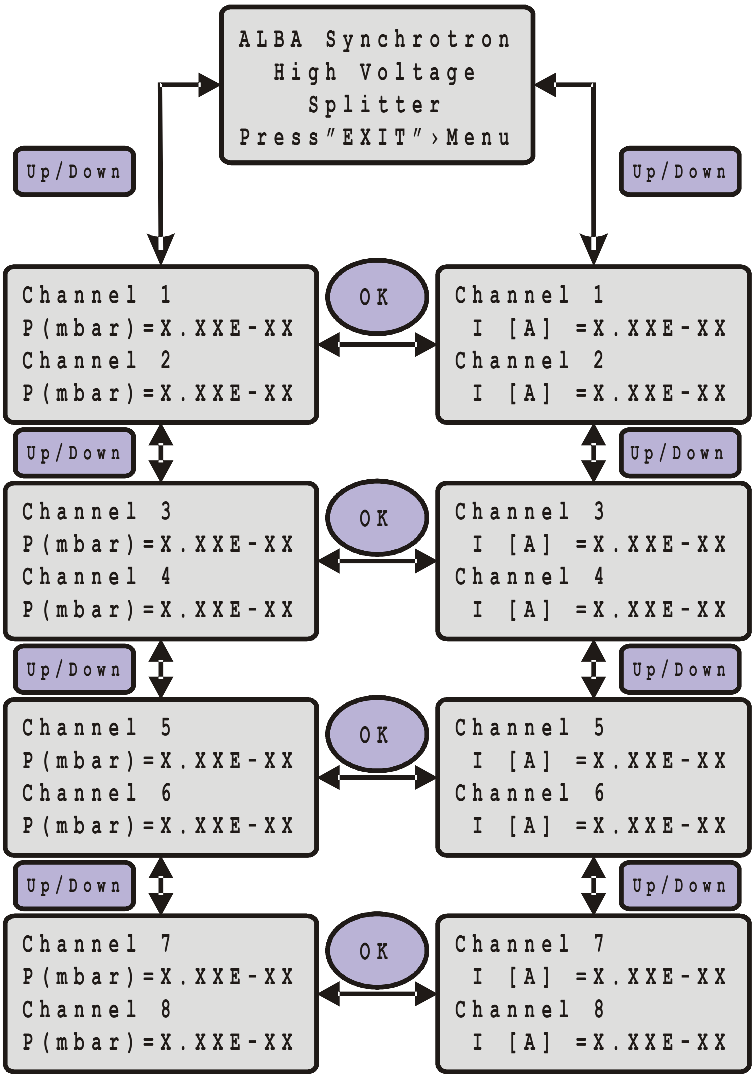

Figure 19: Measuring menu – tree

3.1.2 Settings Menu

Using Settings Menu the user can change the HVS configuration, save it into the Flash or load previous configuration and execute different unit tests.

Figure 20 shows a menu tree of all controls and configurations which allow a user to set proper work conditions. Moreover the HVS contains a default configuration which restore standard work conditions that can be recalled at any time.

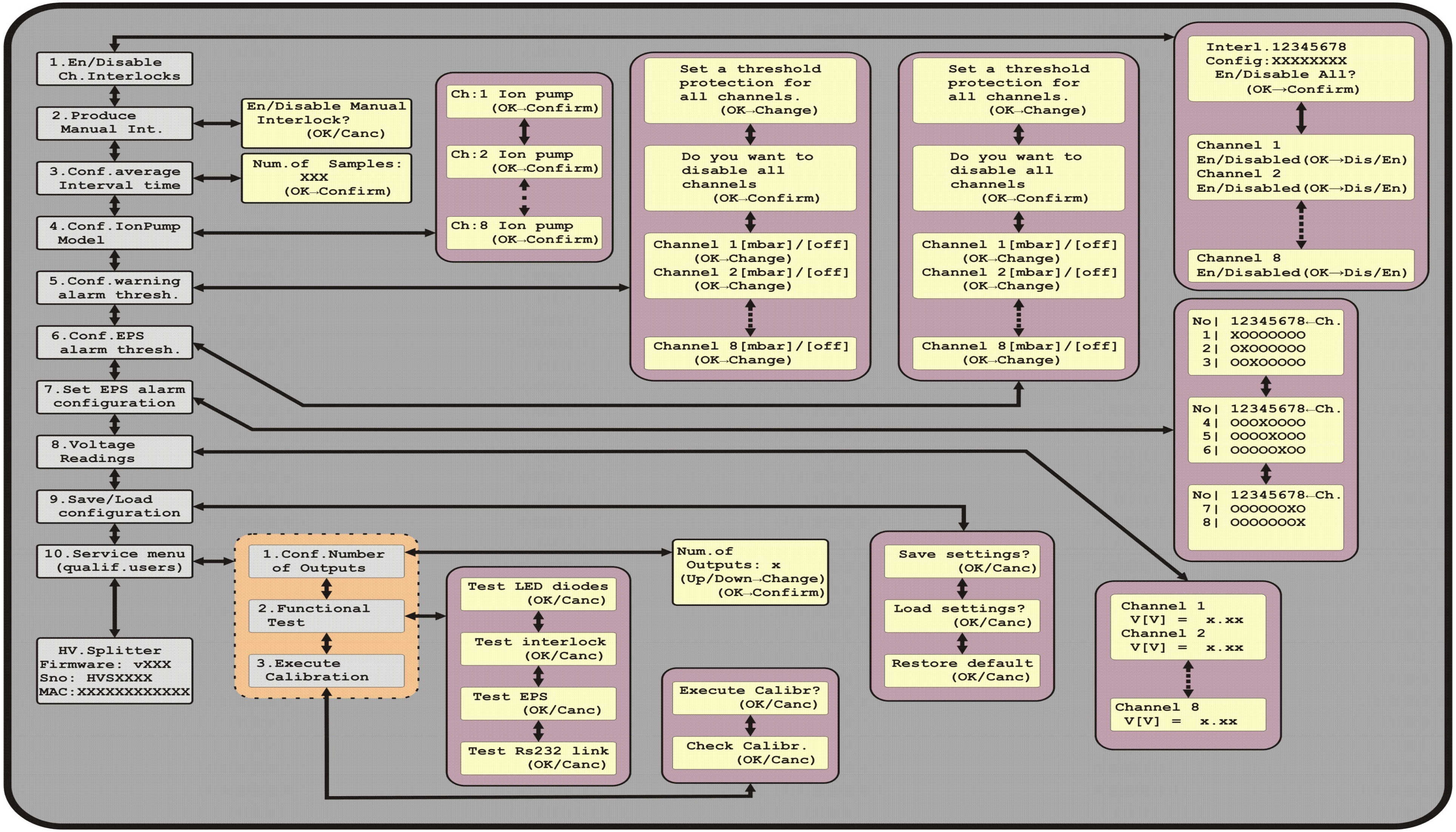

Figure 20: Setting menu – tree

A description of the menu options is as follows:

1. ***En/Dis Ch. Interlocks*** – It allows enabling or disabling the cable interlock protection of individual channels[21].

2. ***Produce manual int*** – It forces the cable interlock internally from the HVS.

3. ***Conf. average interval time*** – It configures the amount of samples that will be used to calculate the moving average. Based on them, the final pressure/current is calculated. The number of samples range possible to be selected goes from 1 up to 256. Each sample requires approximately 320ms[22] to finish the pre-process and includes 256 measurements[23].

4. ***Conf. Ion Pump Model*** – It sets an ion pump model. Possibilities: [25, 75, 150, 300, 500] [l/s].

5. ***Conf. warning alarm thresh*** – It sets pressure thresholds which generate warnings if the threshold is exceeded. The thresholds can be applied to each channel independently. Pressure interval ∈[9E-9, 9E-5][mbar].

6. ***Conf. EPS alarm threshold*** – It sets pressure thresholds which generate EPS activation[24]. Pressure interval ∈[9E-9, 9E-5][mbar].

7. ***Set EPS alarm configuration*** – It sets an EPS configuration which will produce the EPS output to be active. Otherwise the hardware EPS will not occur, even if the thresholds are exceeded.[25]

8. ***Voltage Readings*** – It provides the voltage measurements that are outputted to the *Analog Output* port. That information is essential during the test of measuring instruments.

9. ***Save/Load configuration*** – This menu has to be executed each time a user wants to save settings in a flash memory or restore previous settings configuration. Without saving them the settings of the HVS will not be kept after reset of HVS.

10. ***Service menu*** – It allows to change the number of outputs, to perform a functional test of LED diodes, interlocks, EPS output, RS232 link, and to calibrate measurements of each channel. This menu part is **restricted only for qualified personnel**.

---

[21] *Please refer to 1.1.5 for detailed information about cable interlock protection system.*

[22] *Please refer to 3.2.1.2 for detailed information about how to get the exact averaging time.*

[23] *The number of samples used to calculate the moving average goes from 256 up to 65536 samples.*

[24] *Please refer to 1.1.4 for detailed information about EPS pressure alarms.*

[25] *Please refer to 1.1.4 for detailed information about EPS pressure alarms.*

3.2 Remote control

HV Splitter contains one Ethernet port which provides the remote communication. There is implemented a **DHCP client**, so HV splitter acquires an IP address automatically after the MAC address is provided to the DHCP server. Each unit has its unique MAC of its Ethernet adapter, password and serial number. HV Splitter runs **a telnet server** which pre-processes string orders sent by a user. The **default telnet password is 1243**. The connection with HV Splitter can be established by any telnet client (port 23), so there is an easy way to collect information and to get an access to the HV Splitter configuration.

Figure 21 depicts a block diagram which presents a graphical implementation of the telnet communication provided by HVS.

The implementation contains:

a) ***Log in*** – a system which checks user passwords, if the password is wrong, it closes the communication at once.

b) ***Task 2 (Alarm handler)*** **–** this task cooperates together with "Data acquisition engine", this engine pre-processes all measurements and updates a system status of the splitter continuously. **If the engine detects any alarms**, the adequate information is sent to the task 2, so **a proper message is sent to a client**.

c) ***Task 3 (Watchdog handler)*** **–** when the communication is established **a user must request any activity to reset a watchdog counter**, if not, the watchdog closes the communication automatically. **It protects HVS against any network blocks, cable unplugs or other communication errors.** There are methods implemented[26] which allow adjusting watchdog parameters to requirements.

---

[26] *Please refer to see 3.2.1 for detailed information.*

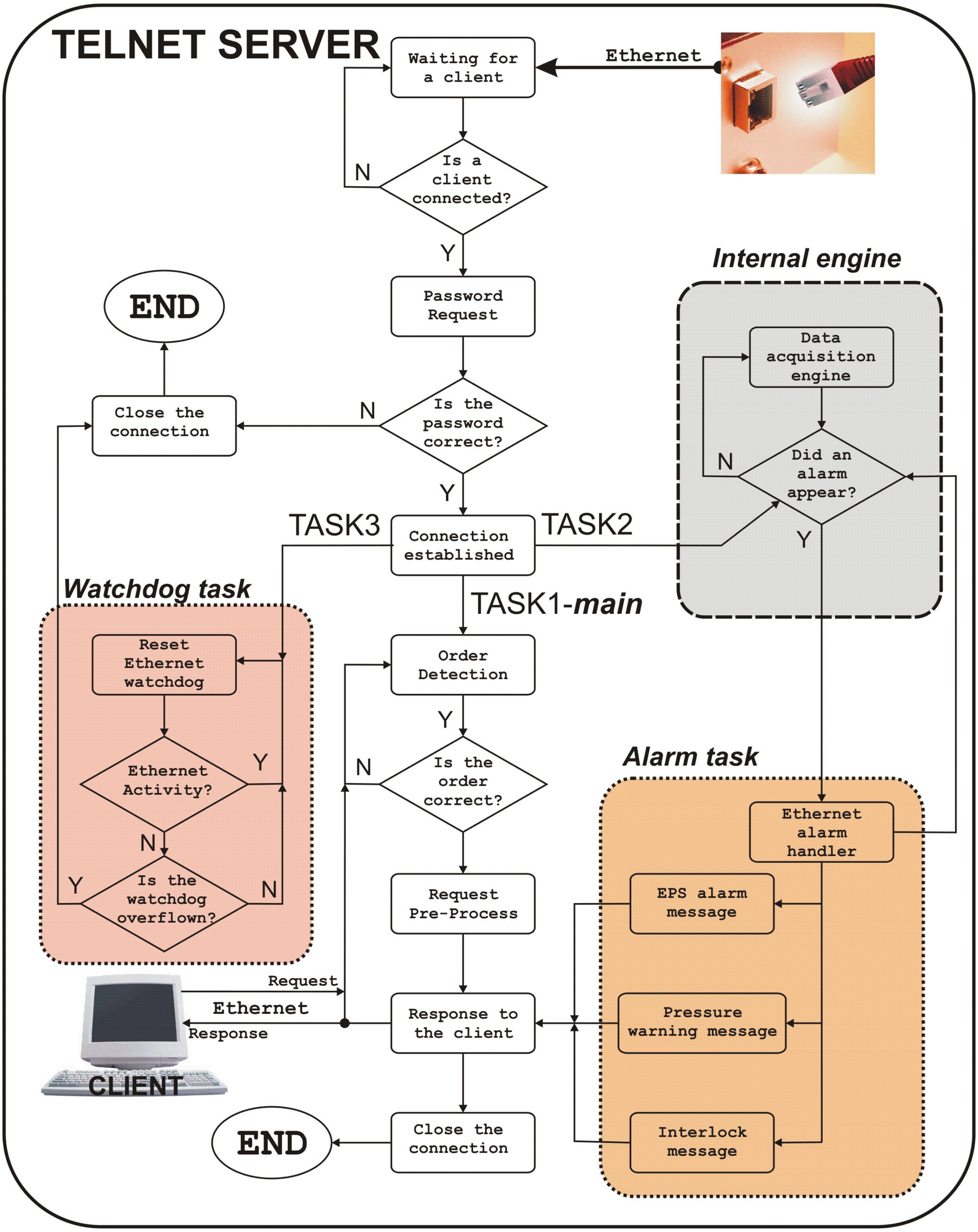

Figure 21: Telnet server – block diagram

3.2.1 Telnet commands

Once the telnet communication port has been opened the user can communicate with the HVS using different commands. A description of them is presented next:

3.2.1.1 General Commands

1) `“help”` – displays all available orders.
2) `“exit”` – closes the connection (HVS – Client).
3) `“mode=set,<no>”` – sets the HVS operation mode. There are two possibilities, 1- *Commissioning Mode*, or 2- *Secure Mode*. The *Commissioning Mode* permits the local control and remote one working in parallel. The *Secure Mode* blocks the local control entirely, it protects against accidental local settings change.
4) `“mode=get”` – returns the actual mode reference.

3.2.1.2 Data acquisition commands

5) `“acquisition_time_get”` – returns the time necessary for data pre-processing. It is a real time measurement of how long it takes to calculate the pressure and current mean.
6) `“voltage=get,ch,<ch_no>”` – returns an actual voltage reading of the selected channel.
7) `“voltage=get,buffer1,<ch_no>”` – returns the whole voltage buffer– 256 samples/320ms.
8) `“voltage=get,buffer2,<ch_no>”` – returns the buffer which contains values considered for the final voltage calculations.
9) `“voltage=get_all”` – returns the actual voltage measurements of all the channels.
10) `“current=get,ch,<ch_no>”` – returns an actual current reading of the selected channel.
11) `“current=get,buffer1,<ch_no>”` – returns the whole current buffer– 256 samples/320ms.
12) `“current=get,buffer2,<ch_no>”` – returns the buffer which contains values considered for the final current calculations.
13) `“current=get_all”` – returns the actual current measurements of all the channels.
14) `“pressure=get,ch,<ch_no>”` – returns the actual pressure of the selected channel.
15) `“pressure=get,buffer1,<ch_no>”` – returns the whole pressure buffer–256 samples/320ms.
16) `“pressure=get,buffer2,<ch_no>”` – returns the buffer which contains values considered for the final pressure calculations.
17) `“pressure=get_all”` – returns the actual pressure measurements of all the channels.

3.2.1.3 Ion Pump configuration commands

18) `“ion_pump=set,<ch_no>,<model>”` – sets an ion pump model for a chosen channel.
19) `“ion_pump=get,<ch_no>”` – returns an ion pump model of a chosen channel.
20) `“ion_pump=show”` – shows all possible ion pump models.
21) `“ion_pump=get_all”` – returns the configuration of ion pumps.

3.2.1.4 Preprocess configuration commands

22) `“mean_preprocess=set,divider,<div_no>”` – sets the sample divider of the buffer2, it has an influence on the pre-process timings.
23) `“mean_preprocess=get,divider”` – returns an actual divider value.
24) `“mean_preprocess=help”` – provides all possible configurations for different dividers.

3.2.1.5 EPS configuration commands

25) `“eps=open”` – activates the EPS output of HVS generating an EPS hardware alarm.
26) `“eps=disable”` – disables the EPS output of HVS.
27) `“eps=enable”` – enables the EPS output.
28) `“eps=status”` – shows the actual status of the EPS output.
29) `“eps_mask=get”` – returns the EPS configuration masks which must be satisfied[27].
30) `“eps_mask=set,<mask_no>,<1/0 mask_str>”` – sets the adequate configuration mask, 1- means channel marked, 0- channel not considered[28].

3.2.1.6 Interlock configuration commands

31) `“interlock=status”` – presents the actual interlock status.
32) `“interlock=generate,on”` – forces a cable interlock alarm.
33) `“interlock=generate,off”` – switches off the manual interlock cable generation.
34) `“interlock=en/dis,<ch_no>”` – enables/disables the interlock cable protection of a chosen channel.

---

[27] *Please refer to 1.1.4 for detailed information about EPS pressure alarm configuration.*

[28] *Please refer to 1.1.4 for detailed information about EPS pressure alarm configuration.*

3.2.1.7 System configuration commands

35) “`config=get,software_version`” – returns the firmware version.
36) “`config=get,serial_number`” – returns the serial number.
37) “`config=get,mac`” – returns the MAC address.
38) “`config=save`” – saves new configurations to the flash memory. It means that after reset, HV Splitter will recover the current settings.
39) “`config=load`” – load the previous saved configuration from the flash memory.
40) “`config=load_default`” – loads default configurations implemented by the manufacturer.
41) “`config=set,outputs,<amount>`” – sets the number of active channels which will be considered in all calculations and data acquisition.
42) “`config=get,outputs_no`” – returns amount of active channels.

3.2.1.8 Alarm threshold configuration commands

43) “`Pth_warning=set,<ch_no>,<xe-x>`” – sets the pressure threshold of a chosen channel, when the pressure alarm warning will occur.
44) “`Pth_warning=get,<ch_no>`” – returns the pressure warning threshold value of a chosen channel.
45) “`Pth_warning=mode_set,<mode_bool>`” – disables(1)/enables(0) threshold warnings.
46) “`Pth_warning=mode_get`” – returns which threshold warning mode is set: enabled/disabled
47) “`Pth_warning=get_all`” – returns all threshold warnings.
48) “`Pth_eps=set,<ch_no>,<xe-x>`” – sets a EPS pressure threshold of a chosen channel[29].
49) “`Pth_eps=get,<ch_no>`” – returns the EPS pressure threshold value of a chosen channel.
50) “`Pth_eps=mode_set,<mode_bool>`” – disables(1) or Enables(0) the EPS threshold protection.
51) “`Pth_eps=mode_get`” – returns if the EPS threshold protection is enabled or disabled
52) “`Pth_eps=get_all`” – returns all the configured EPS pressure threshold values.

3.2.1.9 Calibration commands

53) “`cal_data_get=<ch_no>`” – returns calibration data of an selected channel.
54) “`cal_data_set=<ch_no>,<data_no>,<raw_data>`” – sets new calibration raw data of a selected channel and current identifier. “`data_no`”∈<1,22>, it is adequate to <10nA,20mA> - the step is logarithmical. “`raw_data`” – is a value between 100 and 2000. **This method is restricted only for qualified users** because can affect all the measurements.
55) “`cal_data_get=status`” – returns all the calibration details.
56) “`cal_data=save`” – saves a new set of the calibration raw data to the flash memory. Necessary if a user wants to change calibration conditions permanently.
57) “`cal_data=load`” – restores all calibration raw data from the flash memory.

---

[29] *Please refer to 1.1.4 for detailed information about EPS pressure alarms.*

3.2.1.10 User commands

58) “activity” – returns the MAC address and serial number. The method can be used to request continuously if a user wants to be sure that the communication is being established.
59) “raw_data=read,<ch_no>” – returns an actual current measurement raw data read.
60) “password=<old>,<new>” – sets a new password for the telnet server of HV Splitter.

3.2.1.11 Factor commands

61) “pressure_factor=set,<ch>,<float_factor>” – sets a new calibration pressure factor for the chosen channel.[30] By default: Pfactor=1.
62) “pressure_factor=get,<ch_no>” – returns the actual calibration pressure factor of a requested channel.
63) “pressure_factor=get_all” – returns all calibration pressure factors of all the channels in one string.

3.2.1.12 Alarm functions – Task 2 configuration commands

This messages which occur independently. There is no need to request any information as they will appear also when any alarms occur.

64) “alarm=status,get” – returns the actual status of alarms pressure readings. It can be requested continuously giving full information about ion pump statuses.
65) “alarm=period_set,<secs>” – sets an alarm occurrence period. The time between repeating the alarm message.
66) “alarm=period_get” – returns the alarm occurrence period [10, 65000][ms].
67) “alarm=eps,get” – returns the channels where the EPS alarm has occurred on.
68) “alarm=warning,get” – returns the channels where the warning alarm has occurred on.
69) “alarm=interlock,get” – return the channel where the interlock occurred.
70) “alarm=alert,enable/disable” – enables/disables the Ethernet alarm message box.

3.2.1.13 Watchdog commands

71) “telnet_timer=set,<long_seconds>” – sets the Ethernet watchdog timer. If there is no Ethernet activity until the timer elapses the watchdog closes the connection.
72) “telnet_timer=get” – returns current configured Ethernet watchdog timer.

---

[30] *Please refer to 1.1.3 for detailed information about current to pressure conversión used in HVS.*

73) “telnet_timer=disable” – disables the Ethernet watchdog timer.

3.3 Typical application

In this section a **typical system implementation** with the HVS is presented. The standard arrows show the Ethernet data flow, where a client records pressure measurements each 1s. The big arrows depict the high voltage connections between the high voltage power supply and ion pumps. The checked arrows provide a solution for a client, which stores time related data.

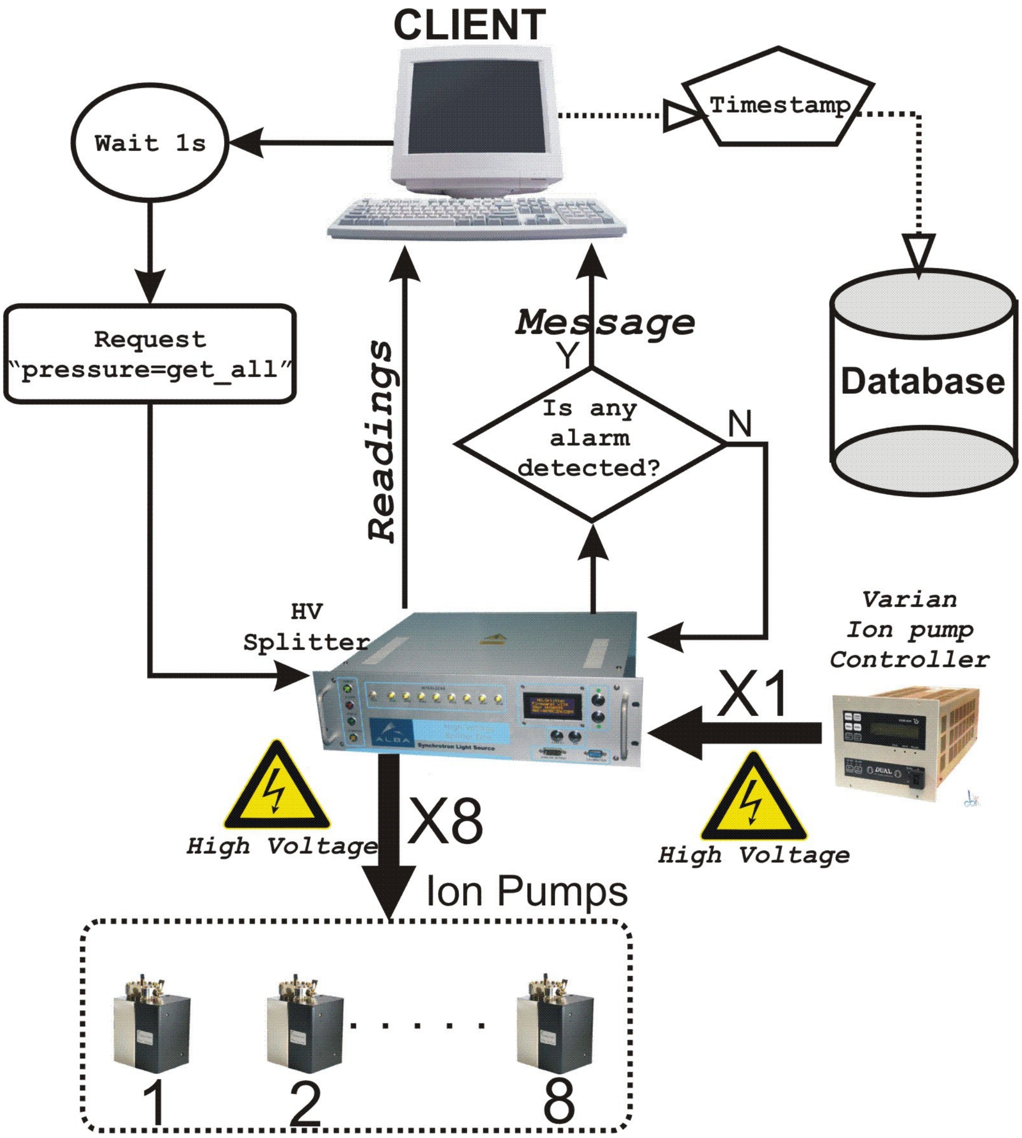

Figure 22: Typical workflow

APPENDIX A – INFORMATION PROVIDED IN PROJECT FOLDER

<Pending to be added>

APPENDIX B – SCHEMATICS

<Pending to be added>

APPENDIX C – PARTS LIST

<Pending to be added>