USER MANUAL

SIP POWER

ION Pump Controller

saes group

Provisional

SAES Getters S.p.A. – Italy

www.saesgroup.com

The **SIP POWER** power supply is used for operating the ION element of **NEXTorr** family pumps. It is designed to be used indoor in laboratory conditions.

WARNING

After transportation, the device has to be left idle without mains voltage for at least 3 hours at the laboratory temperature.

Security provisions

ATTENTION

Inside the instrument and also in the connector and cable for the ion pump connection, a high voltage is present which is capable of causing a casualty even without any direct touch.

Manipulation of the high voltage cable and also of the grounding wire is prohibited during the supply operation.

Likewise, the supply operation without protective covers is prohibited.

Protect the device against humidity and against penetration of conductive objects and liquids into the ventilation slots.

Symbols on the Product

These symbols appear on the product:

WARNING
High voltage

Ground terminal

CAUTION
Refer to manual

INDEX

1. APPLICATION

SIP POWER is the controller unit designed for operating the ion pump of NEXTorr family.

2. INTRODUCTION

2.1. General description

SIP POWER is the power supply that controls the ion pump (**IP**) of NEXTorr family. NEXTorr pumps combine in a very compact and unique design Non Evaporable Getter (NEG) and ion pump technologies.

SIP POWER can be supplied with alphanumeric display or without display.
The controller version without display is equipped with RS485 interface and 2 status LEDs.
For both solutions, the controller case is a sub-rack 3U 14TE 230mm deep.
Both solutions can be equipped with ETHERNET (to remote control the device) and USB (to record the device parameters on a USB flash memory) data interfaces, but devices without these interfaces are also available.

The device is powered by external source of 24Vdc and provides voltage values between 600V and 6kV to the ion pump.
SIP POWER has an autoranging internal system for measuring the output current.
The current value is shown on the display (or provided through the serial communication in version without display). The current value is also provided through the ETHERNET communication in nA units. The serial communication and the ETHERNET communication can also provide the voltage output value. The current value and the voltage output value are also automatically stored in USB flash memory if it is connected in its slot.

The SIP POWER has two security signals to provide high voltage values to the ion pump:
the SAFETY connector and the INTERLOCK signal.
A SAFETY pin connector allows managing the supply of the high voltage to the ion pump in total security. The INTERLOCK contact allows to shut down the high voltage to the ion pump with an external alarm signal.

SIP POWER has 3 optional data interfaces:
* ETHERNET (to remote control the device)
* USB (to record the device parameters on a USB flash memory),
* RS485 (only available for the version without display).

The device has also a special interface with the DB15 connector compatible with NIOPS devices of NEXTorr pumps.

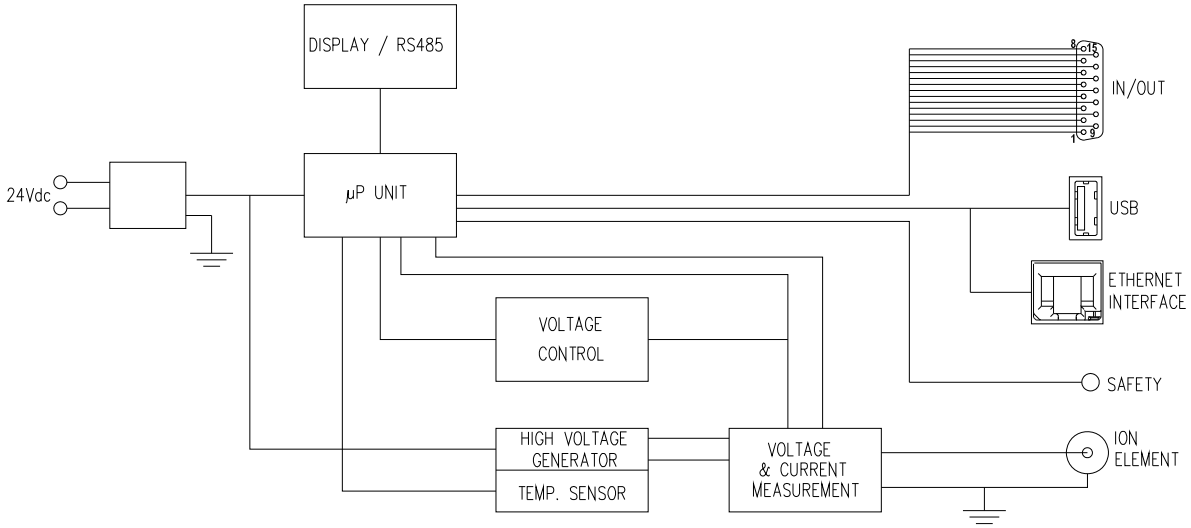
2.2. Remote and multi Control

Dedicated software is provided to remotely control the SIP POWER through the ETHERNET connection. The software allows to control several SIP POWER units at the same time.
All functions and parameters can be easily controlled through the software.
Software allows controlling a single unit or more units at the same time.
Local and remote control are possible contemporarily.
This software is available for Windows and for Linux PCs.

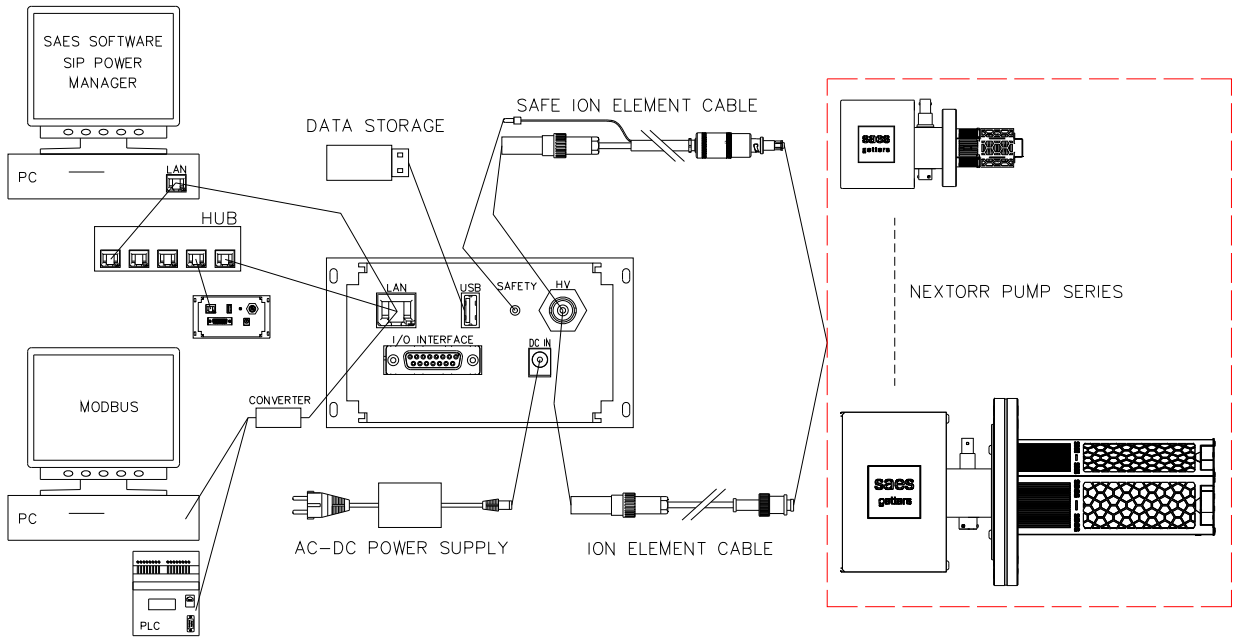
For SIP POWER equipped with RS485 interface a different dedicated software is available (just for one unit at a time). Serial communication protocol via RS485 is MODBUS RTU (for more details

see the dedicated paragraph).

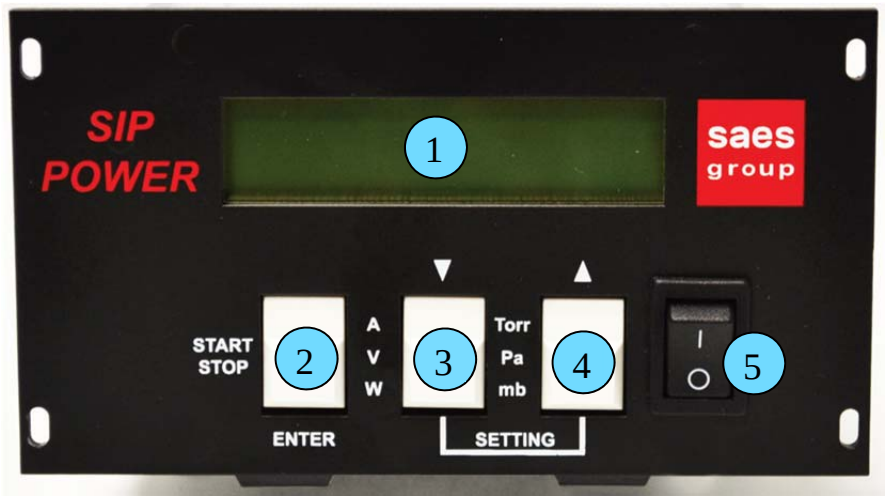
2.3. Simplified block scheme



2.4. Scheme of the instrument connection

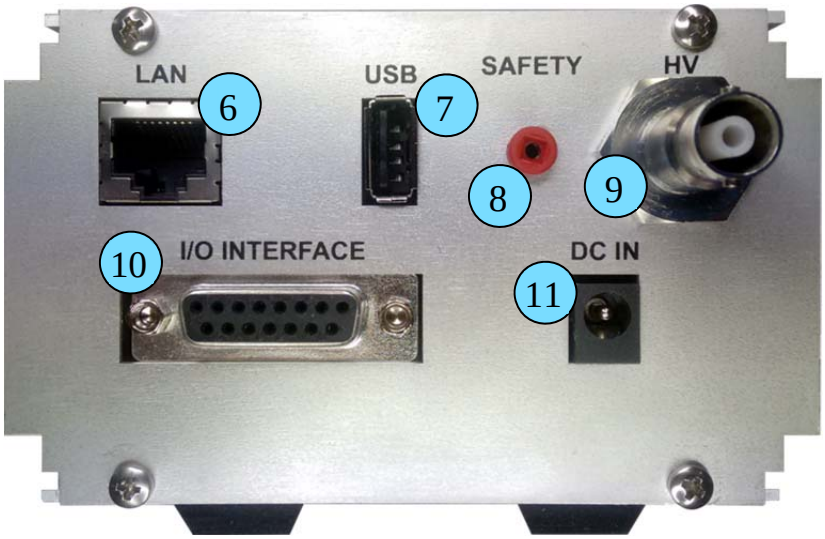


2.5. The front panel of the unit



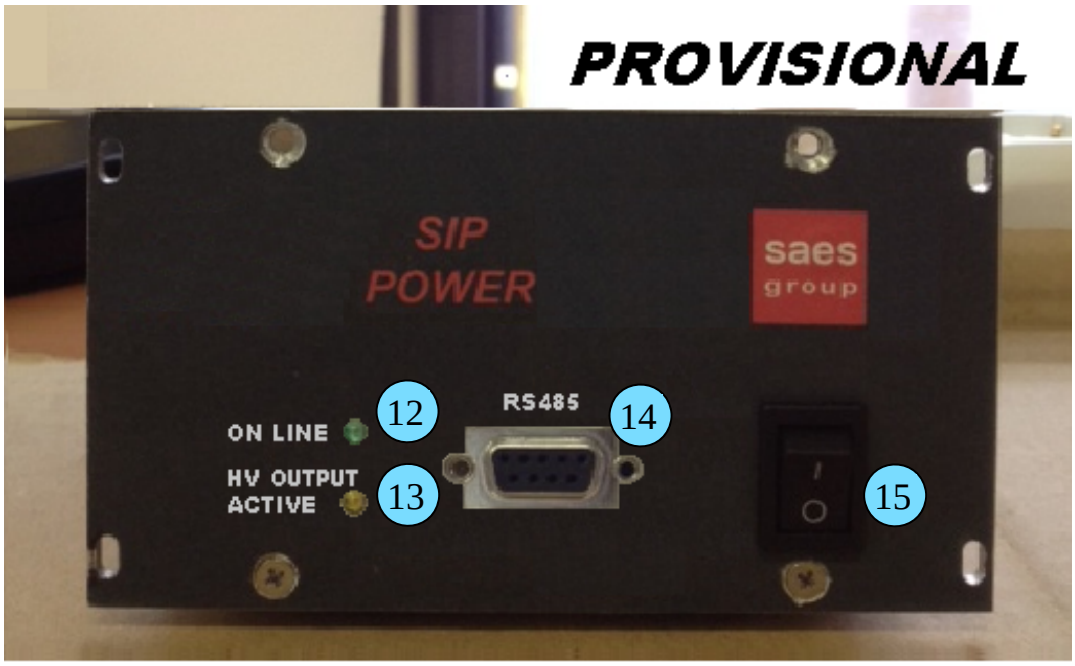
1. Alphanumeric display
2. START/STOP button to switch on/off the output
3. A/V/W button to change the parameter shown on display; current, voltage or power alternately
4. Torr/Pa/mb button to change the unit of pressure between Torr, Pascal or mbar respectively
5. ON/OFF instrument power switch

2.6. The rear panel of the unit



6. ETHERNET connector (to remote control the device)
7. USB connector (to record the device parameters on a USB flash memory)
8. SAFETY connector
9. OUTPUT pump connector
10. IN/OUT interface connector with INTERLOCK
11. instrument’s MAININPUT plug

2.7. The front panel of the unit with LEDs and RS485 interface



12. “ON LINE” Status LED: if it is on it means that the instrument is on
13. “HV OUTPUT ACTIVE” Status LED is on when power is issued to the pump
14. RS485 connector
15. ON/OFF instrument power switch

2.8. Supplied accessories

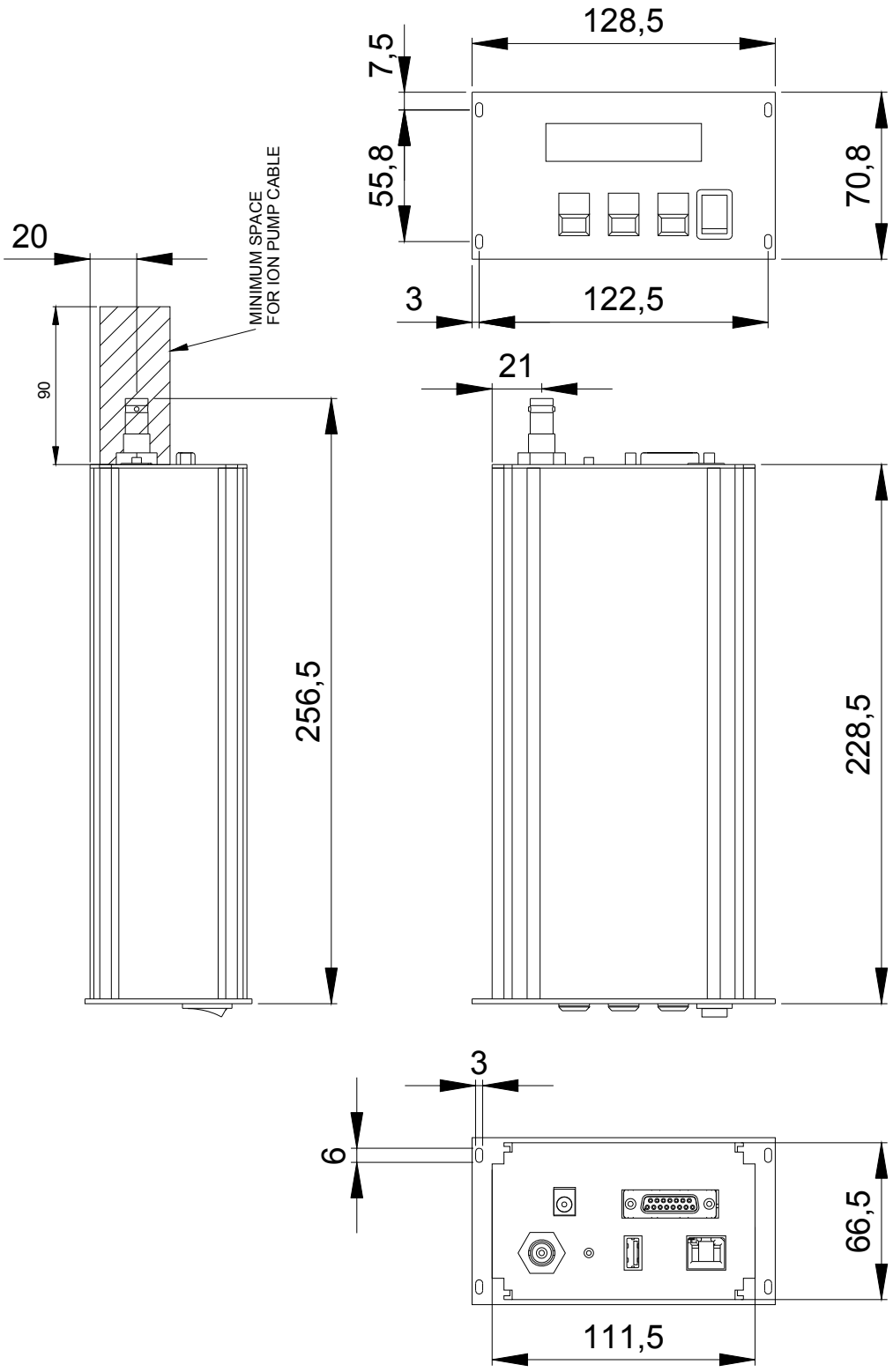
The following accessories are provided with SIP POWER (version 3B0506):

- Power supply 220V – 24 Vdc with shuko wall plug cable
- DB15 plug with PIN to bypass Interlock and Safety connections
- Saes Group USB stick with
    - User manual
    - SIP power manager: software for remote control via LAN
    - SIP power controller: software for remote control of one unit via RS485
    - SAES product brochures

2.9. Instrument Dimensions and Weight

SIP POWER dimensions (all configurations)	Subrack 3U 14 TE
SIP POWER weight (all configurations)	about 1 kg

220V to 24Vdc power supply unit weighs about 300g and its dimensions are about 12x5x3 cm.

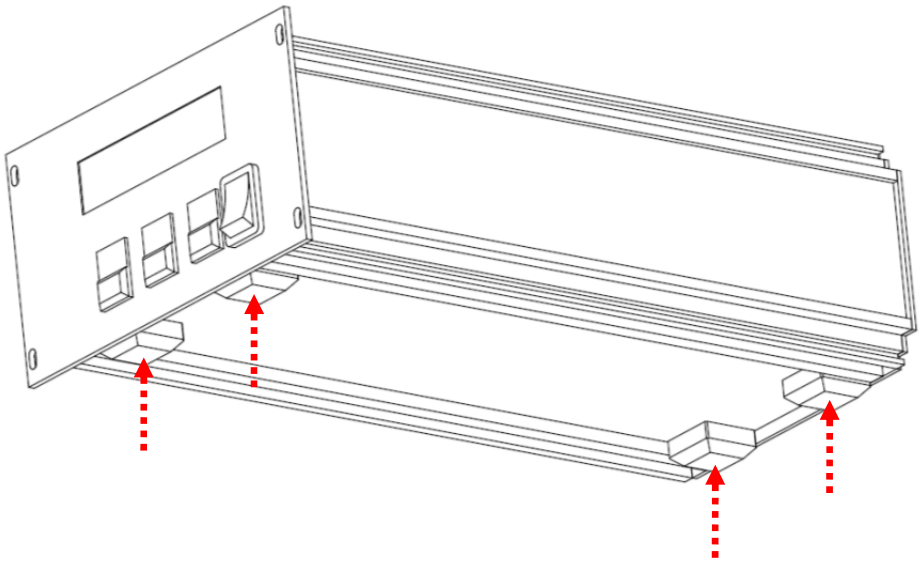


3. INSTALLATION

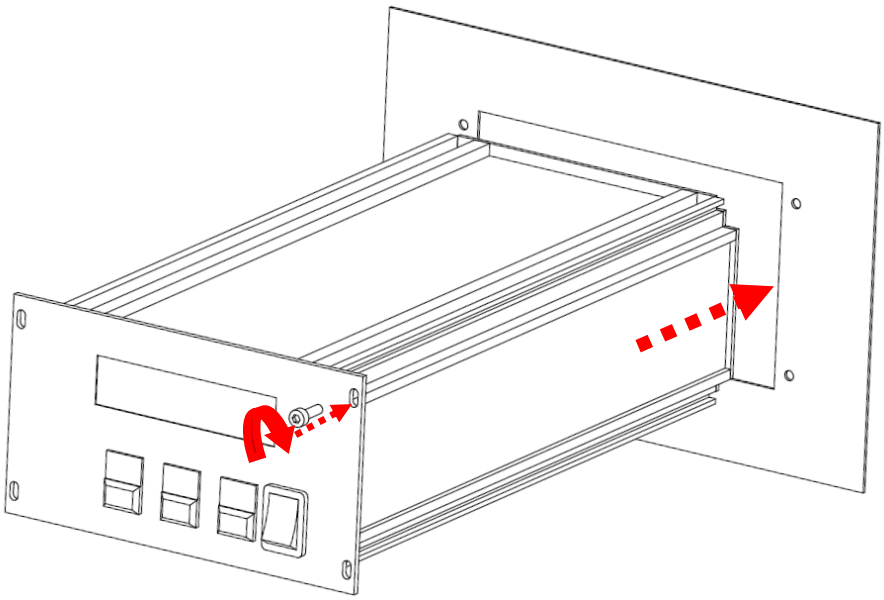
3.1. Mounting operation

Construction design enables the unit to operate either as a stand-alone version (to be laid on a table) or as a system version which can be mounted in a rack (rack 3U 19" installation with M3 screws). According to the desired version it is possible to mount/remove four rubber feet.

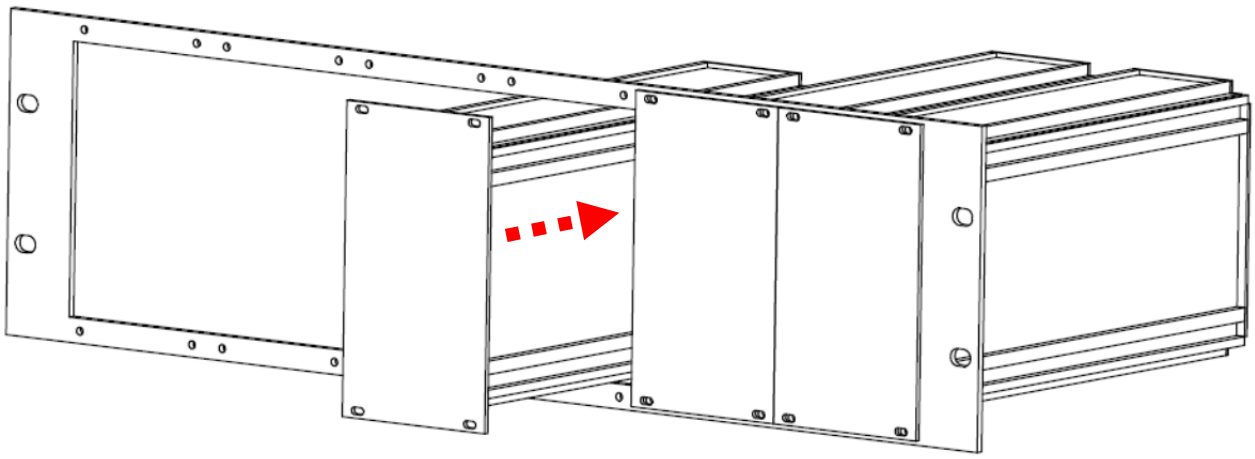
Stand-alone version



Mounting on panel



Mounting in a rack 3U 19"



Warning

The circulation of cooling air on the upper/bottom left/right side and behind the device must not be significantly limited when the unit is inserted in a rack or laid on a table.

3.2. Electrical connections

The device can be powered by external source of 24 Vdc with appropriate isolation from main line via connector Jack pin P1J with central positive contact (maximum current 2A).

It is made available:

- 220V -24 Vcd power supply (provided with version 3B0506)
- battery pack (can be ordered separately)

The **IP** is connected to the power supply by means of the provided high voltage cable. The appropriate cable terminal is inserted into the high voltage connector labeled **HV**. The cable is locked by rotating the ring against spontaneous disengagement. The same operation must be done for the opposite end of the cable on the pump side.

Safety pin of safe cable (2 mm plug) must be inserted into the Safety connector.

An enable signal called INTERLOCK must be provided to SIP POWER via IN/OUT interface connector with a closed contact between pins 6-9 and 1-14 (see plot at Sec. 8.1).

If these safety supports are not available (INTERLOCK and SAFE CONNECTOR) it is possible to bypass these signals using the provided DB15 plug.

The enclosed DB15 plug (Interlock by shorted pins 6-9 and 1-14) with SAFE pin (shorted to ground) should be inserted to connector IN/OUT and to connector SAFETY on the rear panel.

Warning

Negative wire of power supply is grounded.
The ground terminal and the outer electrode of the high voltage connector are mutually galvanically interconnected.

Warning

Connection and disconnection of the high voltage cable are possible only with the power supply switched off.

4. OPERATIONS

4.1. Start operations

The supply is switched on by pressing the **I-O** switch into position **I**. The connection is signaled by the display turned ON or by the green light of the Status Led **ON LINE** for version with RS485.

The **IP** is not electrically powered when the supply is switched on: the word **Stop** shows on the display (for more details see the display section).

Some ticks are heard during the starting of the power supply belonging to the automatic initialization settings.

SIP POWER switches on very rapidly (3-5 seconds) and is immediately ready to locally operate.

Remote communication (Ethernet plus USB module) is available after 30 seconds from the switch on of the SIP POWER.

During device initialization, the outer electrical circuit is tested. If the interlock plug is not inserted or some other signal (defined *alarm*) is present, the display will show the message about the detected alarm/alarms. Name of alarm/alarms appear and blink on the display. In case of more than one alarm, their names are shown sequentially.

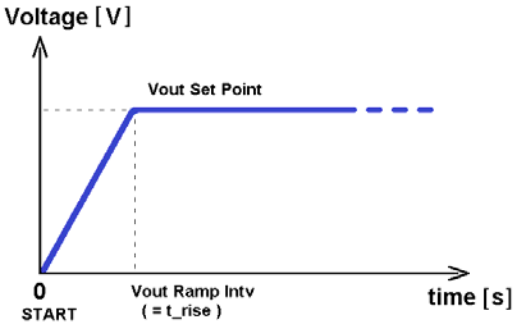
Even if alarm root is removed (example: interlock sensor is inserted again) the message will stay visible till the operator intervention. In order to delete the alarm message from display and memory, the right key (up arrow) must be pressed for 5 seconds.

For more details see chapter 5 “display and multiple functions of keys”.

4.2. Operating IP supply

The **IP** supply can be switched on by pressing the pushbutton **START/STOP** on the front panel. The unit must be switched on only at the recommended starting pressure (see pumps *Operating Instruction Manual* for details). The working state of the supply is indicated by the word **Active** on the first line of the display (for more details see display section).

When the START button is pressed, the voltage is gradually provided to the pump with a linear ramp and some ticks related to internal automatic settings can be heard. Those ticks can be heard also during normal operation.



The current flowing through the pump is shown on the display. Pump voltage, pump current and output power can be alternatively displayed by pushing the **A/V/W** button.

Pressure inside the ion pump is roughly estimated from the current value and is shown on the display (pushing the button **Torr/Pa/mb** changes the unit of measurement).

The relationship between the values of current and pressure depends on the type and size of used pump and on the instantaneous pump voltage. To set the parameters of this relationship see SETTINGS chapter at Sec. 6.

The value ***<1e-11 Torr*** shows up when IP current reaches 0 nA (IP current is below the measurable limit).

Warning

In the case the HV cable is disconnected, the current will be 0nA and the value ***<1e-11 Torr*** will show up as well.

4.3. Comparators with simple threshold or hysteresis

Single Threshold SWITCH 1 comparator.

The device is equipped with an automatic overcurrent protection which switches off the **IP** supply after the pump current exceeds the safety value protection adjusted under **SW1**.

This condition is indicated by an alarm message on the display

After 3÷5 seconds the supply automatically switches on again. If the overcurrent protection level is exceeded once again, the device switches off repeatedly. After 3 unsuccessful attempts to switch the supply on automatically, the supply switches off permanently.

After the cause of excessive current is removed (e.g. getting a better vacuum or removing a short circuit) it is possible to switch on the unit again. To switch on the **IP** supply unit, it is necessary to remove the alarm condition (keep right ▲ button pressed for 5 seconds) and only after that, press the START/STOP button.

These functions protect the supply against an excessive load but also protect your pump against an uncontrolled operation, which could damage it or shorten its lifetime.

On the IN/OUT INTERFACE connector a proper signal that reports current status of the SWITCH is reported. The same status is shown on the display with the symbol of open/close electric switch (more details in the display paragraph).

The pin layout of the output connector is described in the *Sec. 8.1.*

Single Threshold or Hysteresis SWITCHES 2 and 3 comparators

The supply is equipped with other two comparators-switches of the pump current/pressure. These other two switches, **SW2** and **SW3**, can be used to directly connect the SIP POWER with other electronic equipment. Their outputs are led to the **IN/OUT INTERFACE** output connector. As for **SW1**, also for **SW2** and **SW3** the status is shown on the display first line with the symbol of open/close electric switch (more details in the display paragraph).

Comparator-switch **SW1** can works only in **Simple** working mode.

Comparators-switches **SW2** and **SW3** can work in **Simple** working mode or in **Window** working mode.

To change working mode see SETTINGS chapter (Sec. 6).

Simple working mode

If the current/pressure is smaller than preset *threshold*, the indicator on the display and the output switch of related comparator opens contact on output connector and will stay unchanged until current/pressure value does not go over *threshold* value.

If the current/pressure is bigger than preset *threshold*, the state of the indicator on the display and the output switch of related comparator closes contact on output connector and will stay unchanged until current/pressure value exceeds *threshold* value.

Window working mode

In this working mode we have two thresholds: *min threshold* and *max threshold*.

If the current/pressure is between preset *min threshold* and *max threshold* values, the state of the indicator and output switch of related comparator on output connector are closed contacts and will stay unchanged until current/pressure value exceeds *max threshold* value or until current/pressure value goes under preset *min threshold* value.

The hysteresis switching on / off is given by adjusted values *min threshold* and *max threshold*.

To change *min* and *max thresholds* see SETTINGS chapter.

The pin layout of the output connector is described in the *Sec.8.1*.

4.4. Operating IP in case of main line interruption

In case of interruption of line voltage, the SIP POWER restarts in the conditions indicated in section 3.1.

For security reasons it is not possible to activate automatic restarts.

In case of line interruption any alarm indication is cleared.

5. DISPLAY AND MULTIPLE FUNCTIONS OF KEYS

5.1. Display information

Frontal panel has 16 character x 2 row alphanumeric display (model 3B0506).

Display is organized with different positions: three on the first row and two on the second.

IP operational status	current and switch status	supply time
current value of electrical supply variables	current estimation of pump pressure	

In case of abnormal situation or alarm, in order to highlight the occurrence (still active or happened in the past) an identification word shows in the first row of the display (complete detail in the section “alarm and abnormal situation indications”).

On the first row the following will be shown alternatively: three pieces of information on the working situation, alarm or alarms indications. In order to state to SIP POWER that the indication has been understood and then hide it, press the right key for 5 seconds.

In the SETTING menu the parameter name is shown in the first row, while on the second the current value is shown.

For details please refer to the SETTINGS chapter.

Ion Pump (IP) operational status

Three status values are possible:

- Stop: high voltage is switched off
- Active: high voltage is supplied
- Restart: equivalent to “Stop” status; in this case some alarms are detected and the user has to acknowledge them before activating the supply again.

Note: alarms are automatically cleared if the power supply is switched off. The instrument is in the Stop status if it is switched on again (no supply).

Current and switch status

This field is 4 characters long. The first character on the left represents the supplied current. The other 3 characters represent the setting and the current status of switches **SW1**, **SW2** and **SW3** respectively.

First character: supplied current trend

During Active pump status, down and up arrows (↓ or ↑) may appear on the display indicating a systematic trend (calculated on the last 3 seconds operation) in the pump current variation – decreasing or increasing. If the current value is stable, the symbol ≅ is shown.

The same symbol (≅) is shown in “Stop” status.

Second character: setting and status of **SW1** switch

In Stop status the displayed character indicates the selected setting.

A white space means **SW1** is OFF, while “S” means **SW1** is ON.

In Active status the symbol indicates the current status of the switch (as set on the connector IN/OUT INTEFACE of back panel, see wiring diagram for details):

╱ = open switch and ╎ = closed switch

Third character: setting and status of **SW2** switch

In Stop status the displayed character indicates the selected setting.

A white space means **SW2** is OFF, while “S” means that **SW2** is ON and set to Simple working mode and “W” means that **SW2** is on and set to Window working mode.

In Active status the symbol indicates the current status of the switch (as set on the connector IN/OUT INTEFACE of back panel, see wiring diagram for details):

╱ = open switch and ╎ = closed switch

Fourth character: setting and status of **SW3** switch

In Stop status the displayed character indicates the selected setting.

A white space means **SW3** is OFF, while “S” means that **SW3** is ON and set to Simple working mode and “W” means that **SW3** is on and set to Window working mode.

In Active status the symbol indicates the current status of the switch (as set on the connector IN/OUT INTEFACE of back panel, see wiring diagram for details):

╱ = open switch and ╎ = closed switch

Supply time

This field refers to the IP working time since the high voltage supply starts. For short times (less than 1 hour) the value is shown in minutes (“m”), for longer times in hours (“h”).

Current value of electrical variables

On the second row the operating values are shown.

The current flowing through the ion pump is shown on the left side of the display. The pump voltage, output power and pump current can be alternatively displayed by pushing the pushbutton **A / V / W**.

The pump voltage is shown in V (Volt), current measurement automatically sets to nA - uA - mA (nano (10^{-9}) - micro (10^{-6}) - milli (10^{-3}) - Ampère) with a resolution of about 10nA, power range is in mW or W (milli Watt (10^{-3} W) or Watt)

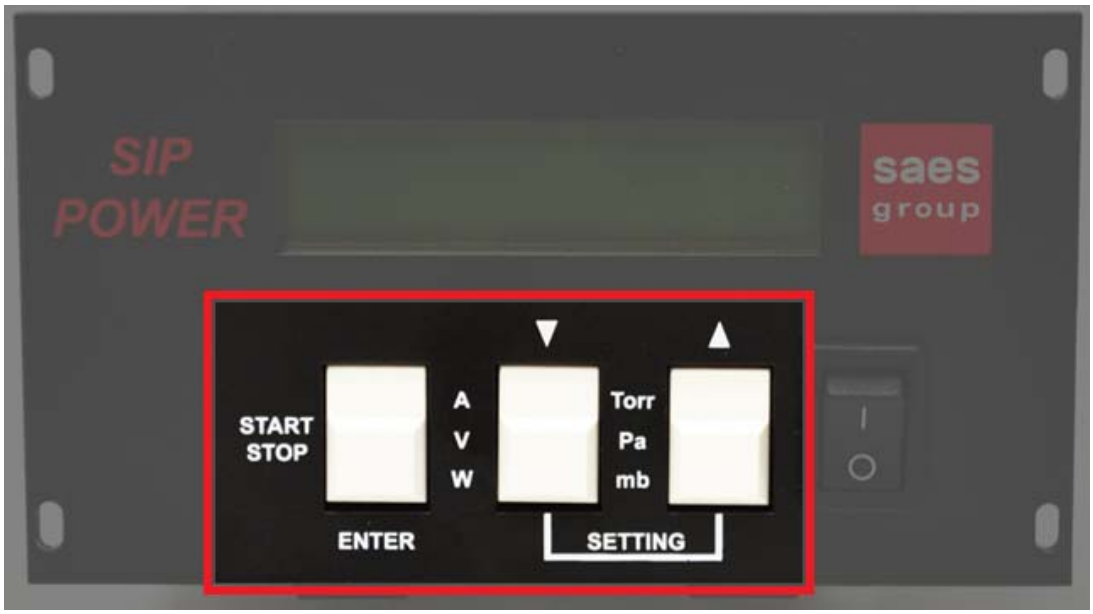
Note: the voltage here reported is the actual value measured on the output in real time, without any average, and without any processing. So it is possible that it changes slightly instantly.

Current value of estimated pump pressure

A rough indication of the local pressure can be estimated from the measurement of the ion current. The pressure indication is shown on the right side, in the second line of the display and can be expressed in Torr, Pa or mbar. The pressure units can be alternatively selected by pushing the pushbutton **Torr / Pa / mb**.

5.2. Multifunctional keys

On the front panel there are three multifunctional keys (model 3B0506).

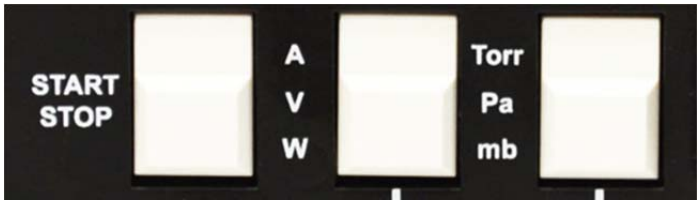


Labels on the left of each key indicate their function during normal operation of the power supply.

Labels on top and below each key indicate their function in the setting mode.

Pressing the keys for shorter or longer period of time corresponds to different functions of the key in various menus. This helps avoiding errors due to accidental pressures.

Main working page

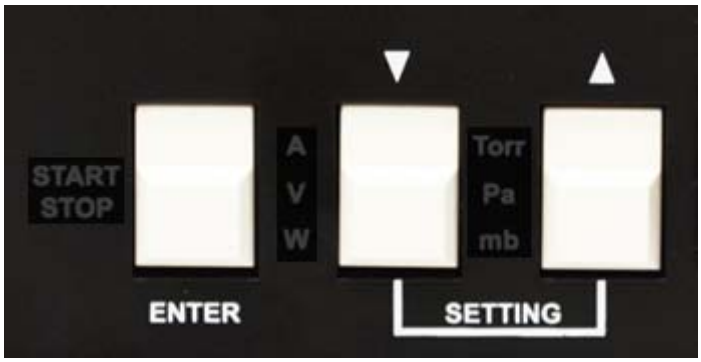


The function of each key is visible on the side of each key (see above image):

- START / STOP key switches on and off the high voltage supply to the pump

- A / V / W key can select among current / voltage / power values
- Torr / Pa / mb key converts the pressure unit of measurement to Torr / Pascal / mbar; moreover pressing this latter key for a long period deletes all the notifications on display.

SETTING page



The functions of each key are shown above and below them.

- To enter and exit SETTING menu press at the same time central and right keys for 5 seconds
- Use the keys ▲ or ▼ to run through the menu
- To modify a parameter press ENTER; a blinking cursor will indicate the parameter change mode. In order to modify the parameter act on keys▲ or ▼.
  A short pressure increments/decrements the value by 1 unit, a long pressure will make the values change quickly, the longer the pressure, the faster the change.
  Press ENTER to save and make a value active.

  For multifield parameters ENTER will switch from one field to the next and saving will only happen when all field will be modified.
- In order to leave SETTING menu, press at the same time central and right keys for 5 seconds

For details on all setting see SETTINGS chapter.

6. SETTINGS and SERVICE MODE MENU

By pressing at the same time right and central keys, user can enter the SETTINGS and SERVICE MODE, called briefly SETTINGS, where it is possible to change some of the working parameters and obtain useful information about the operation of the device.

Note: All pre-set values are stored even if the device is switched off.

Here in the following all the items and their description.

Vout Set Point

This is the working voltage of the IP. This parameter can be adjusted by the user according to his needs.

The factory default value is 5kV. To change this value, enter in SETTINGS menu by pressing the two buttons together for 5 seconds, press the ENTER key and then just press key ▲ or ▼. The range of adjustment is 1÷6 kV with a precision within 1%. Save the new value by pressing the ENTER key. Exit to SETTING menu by pressing the two buttons together for 5 seconds.

Then the output voltage keeps this value with accuracy ±50 V providing that the output power does not overcome maximum possible value of the source.

Vout Ramp Intv

This is the ramp time, that is the time that is required to linearly increase the high voltage from 0 V to Vout Set Point. The Vout Ramp Time value is adjustable by the user according to his needs in the range 1÷60 seconds.

Conversion Rate

Magnitude of the converting constant used to estimate the local pressure from the value of current. It is possible to change this constant in the range 1 to 200 A/Torr. Resulting readings of pressure in different units will be influenced as well. The factory default value is 65 A/Torr. This value is valid for standard operation at 5kV of NEXTorr D100-5, D200-5, D300-5 and D500-5 pumps. In case of NEXTorr D1000-10 and D2000-10 this parameter must be set at 150 A/Torr.

SW1 Mode and SW1 Thr.

The comparison level for the overcurrent protection circuits (**SW1**) and the additional two comparators (**SW2** and **SW3**) have been introduced in Sec. 4.3.

SW1 Mode allows to switch on and off **SW1**: possible values ON / OFF default OFF.

SW1 Thr. is the threshold value for **SW1** comparator: can be changed from 0nA to 99mA.

SW2 Mode and SW2 Min Thr. and SW2 Max Thr.

SW2 Mode allows to switch on and off **SW2**: possible values SIMPLE / WINDOW / OFF

SW2 Min Thr. is the threshold used by SIMPLE mode and lower hysteresis value in case of WINDOW mode. Can be changed from 0nA to 99mA

SW2 Max Thr. is the upper hysteresis value in WINDOW mode. Can be changed from 0nA to 99mA (ignored in SIMPLE mode).

SW3 Mode and SW3 Min Thr. and SW3 Max Thr.

SW3 is the same as **SW2.**

SW3 Mode is the mode (SIMPLE / WINDOW / OFF)

SW3 Min Thr. and SW3 Max Thr. are the thresholds.

IP Address, IP Netmask and MAC Address

IP Address (Internet Protocol Address), IP Netmask e MAC Address will show up in the menu only if the instrument is equipped with the ETHERNET-USB card.

IP address can be changed according to user needs. It is a multifield parameter that allows to set the 4 different bytes of an IP address.

IP Netmask field allow you to change Sip Power IP Netmask which is represented in CIDR notation. For example the class 255.255.255.0 = 8+8+8+0 is indicated as 24

MAC Address of ETHERNET-USB card cannot be modified.

Keepalive

This parameter is a watch-dog on the remote communication. The parameter is the time (in milliseconds) and indicates within how much time the instrument expects a communication from remote connection.

It can be OFF (by setting it below 1 second), which means no control is performed. All other values from 1000 to 900000 ms activate the watchdog after the START. This watchdog is related to the communication channel through which the START has been received.

When there is no communication, the instrument resets to a security status: interrupts high voltage emission and raises the “Communication” alarm.

Backlight Sleep

After these time duration the display back light is switched off to save energy. It can be modified from 5 to 600 seconds or put to off so the backlight is always on.

Active Time

It indicates how long the SIP POWER supplied high voltage during its whole life.

Int. Temperature

Read-only internal temperature of SIP POWER.

Card Type

Readonly parameter that indicates which boards are installed in the instrument:
0 = base board with RS485
1 = base board with RS485 and Ethernet communication
2 = user interface with display and keys
3 = complete version with both user interface and Ethernet

Hw. Rev. and Sw. Ver.

Read only parameter reporting Hardware and Software version of the instrument.

Serial Number

Read only parameter reporting serial number of the instrument.

7. ABNORMAL SITUATION AND ALARM NOTIFICATION

In case of abnormal situations and/or alarms SIP POWER states the situation with a significant word on the first line of the display.

At the beginning of the line a bell will be shown 🔔 if one notification is present, or two bells 🔔🔔 if multiple notifications are present.

In order to delete notifications from display it is necessary to press right key (▲) for 5 seconds (all notifications are deleted in one shot).

Interlock

This alarm is shown when interlock input signal is missing. Check IN/OUT INTERFACE connector.

If contact is opened when the pump is already working, SIP POWER switches off immediately the voltage supply which resumes when the contact is closed back. On the contrary if Interlock is open in Stop status it is not possible to start supply.

Safe

This alarm is shown when safety input signal is missing.

If contact is opened when the pump is already working, SIP POWER switches off immediately the voltage supply which resumes when the contact is closed back. On the contrary if Safety signal is not present in Stop status it is not possible to start supply.

Arcing

During particular working conditions (for example the first pump switching on, or unexpected pressure bursts), arcing may occur. Such events are characterized by direct current flow through the ionized gas between anode and cathode. Such condition is detrimental for the pump since it may accelerate the normal degradation process of the cathode surface.

SIP POWER electronic circuit is designed so that this phenomenon is automatically stopped. If arcing is particularly strong or long SIP POWER switches off the voltage supply to the pump for one or two seconds and raises an event. If arcing happens at least three times in less than 45 seconds the supply to the pump is stopped completely.

SIP POWER stores how many arcing events have happened since Start or since last deleting of notifications. On the display, near the word Arcing, a # will be shown followed by the value of this counter.

Over current

This alarm is shown when the power supply detects an output over-current event: if switch SW1 mode is set to ON and the output current increases over SW1 threshold. (See 4.3)

SIP POWER performs three retries of automatic restart: if Over Current happens three times in 45 seconds the supply to the pump is stopped completely and the corresponding Switch1 contacts on IN/OUT INTERFACE connector present a closed contact permanently.

Over temperature

This alarm is shown when the power supply internal temperature increases over 80°C.

In case of Over Temperature the voltage supply is interrupted and restart automatically when the

internal temperature is reduced.

It is important to check that the lateral grids for air flow are clear and air flow is possible.

Input voltage

Nominal voltage is 24VDC. This alarm is shown when the power supply detects an input over/under-voltage of 25% the rated input voltage. The voltage supplied to the pump is interrupted and restarts automatically when the alarm is cleared.

This notification can be useful with the battery pack. It is recommended to switch SIP POWER off immediately when this message is shown.

Output over-voltage

This alarm is shown when the power supply detects an output voltage 5% over the given set-point. The voltage supplied to the pump is interrupted and restarts automatically when the alarm is cleared.

Communication

This message can be shown when the instrument is commanded via one of the remote interfaces (Ethernet or RS485 Modbus) and the communication watchdog is active (see 5.1)

When the device master who sent Start enable to the power supply does not send any request for KEEPALIVE ms consecutively, supply is interrupted and this alarm is shown on the display.

8. THE OUTPUT CONNECTOR FUNCTION

The output connectors can be used for a possible connection of a device designed for monitoring or controlling the supply activity.

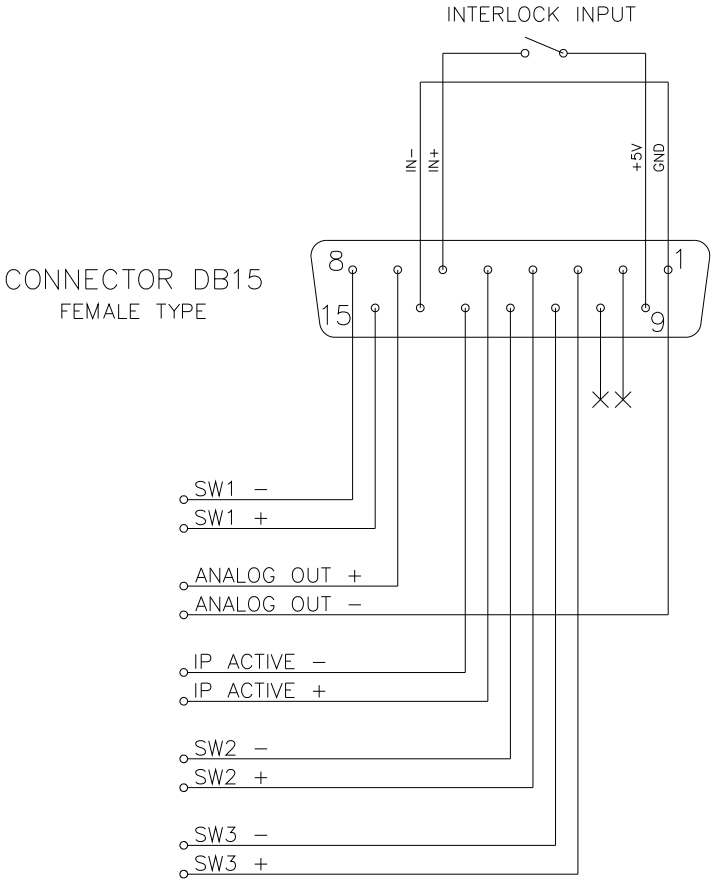
The **IN/OUT INTERFACE** is intended for connection to protective hardware systems;

the **LAN** connector can be utilized for communication purposes via ETHERNET interface

the **USB** connector can be utilized to record the device parameters on a USB flash memory

the **RS485** connector (in the version without display) can be utilized for communication purposes via RS485 interface in MODBUS protocol.

8.1. Pin layout of IN/OUT Interface connector



Pin	Meaning	
1	GND	output of negative feeding voltage
2		not used
3	SW3+	positive terminal of comparator switch 3
4	SW2+	positive terminal of comparator switch 2
5	IP active +	positive terminal of switch Operation IP on
6	IN +	positive terminal of control input INTERLOCK

7	AO	analog output (to refer to ground)
8	SW1 –	negative terminal of switch 1 (over current alarm)
9	+5V	output of positive feeding voltage
10		not used
11	SW3 –	negative terminal of comparator switch 3
12	SW2 –	negative terminal of comparator switch 2
13	IP active –	negative terminal of switch Operation IP on
14	IN –	negative terminal of control input INTERLOCK
15	SW1 +	positive terminal of switch 1 (over current alarm)

If one of the above events reaches such a value the appropriate comparator-switch is connected and the impedance between the terminals + and – is between 11 and 15 Ω. The maximal current through the connected terminals must be limited up to 100 mA.

Maximal permissible voltage between switched off terminals + and – is 30 V.

Above-mentioned polarity for all terminals SW and IN must be kept. All pairs of terminals SW and IN are galvanically insulated. The voltage between pairs must not exceed 100 V.

The supply works only when the control input INTERLOCK is active, that means, that a current from 2 to 10 mA through the terminals IN+ and IN– must flow (see *Sec. 3.2*). Input impedance of circuits IN is about 2 kΩ.

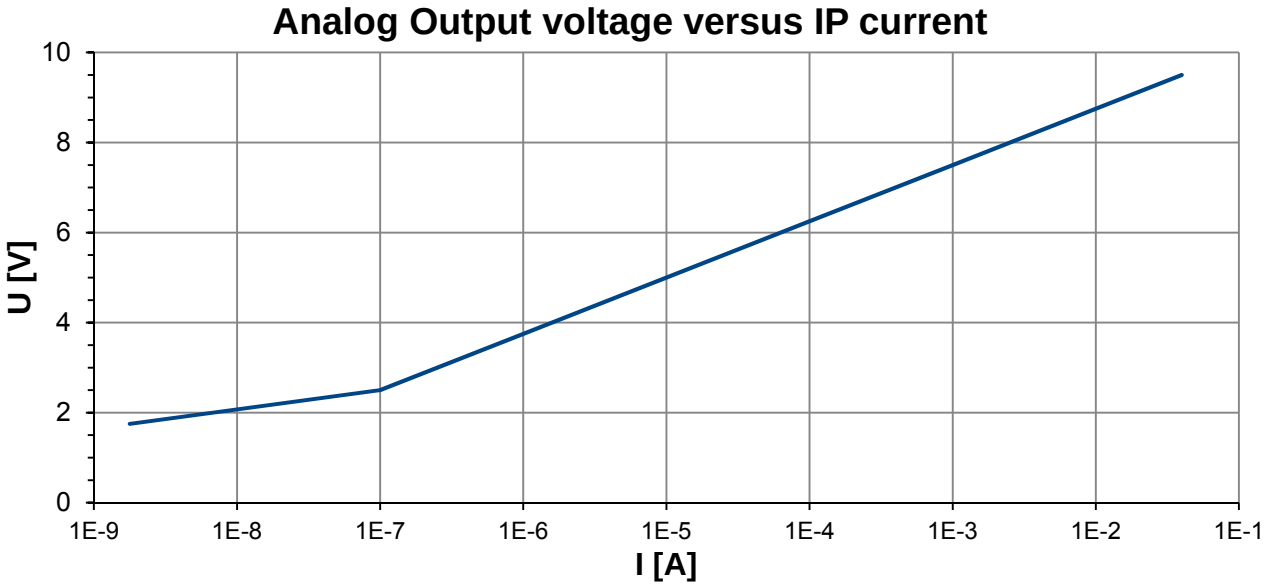
The IP ACTIVE comparator-switch is connected when the pump is powered (Active status).

For the output signals SW1 (over current alarm) SW2 and SW3 see *Sec. 4.3*

For the Analog output signal see next *Sec. 8.2*

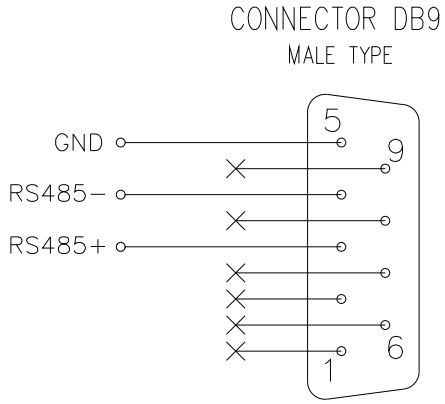
8.2. Analog Output

In the IN/OUT connector the ANALOG OUTPUT is provided for the current/pressure signal (pin 1 and 7). This signal is proportional to logarithm of ion pump current. The limits of the signal are: 0 V for ≤1 nA; 10 V for 100 mA. Pressure scale, must be recalculated accordingly to ion pump sensitivity and chosen pressure unit.



Voltage is referenced to GND pin; minimal load resistance is 100 kΩ.

8.3. RS485 Interface



Pin	Meaning	
5	GND	ground connection
4	RS485 –	negative com. line
3	RS485 +	positive com. line

For communication, the RS485 standard serial interface is used on two-wire. Communication channels are galvanically separated from the frame of the supply.

Default communication baud rate for RS485 is 38400, 8 data bits, 2 stop-bit, without parity bit, flow control none.

Default Modbus slave address is 11 (broadcast is 255).

Control of the supply by means of serial interfaces is described in following chapters.

9. Modbus PDU Communication Protocol

9.1. Implementation Notes

Application Layer	Modbus Application Protocol V1.1b3 (PDU)
	Implemented functions: • (0x03) Read Holding Registers • (0x10) Write Multiple Registers
Physical Layer	RS-485 EIA/TIA Standard

The inter-frame interval has to be at least 4ms.

According to Modbus specification **the power supply does not answer to read requests directed to broadcast slave ID, ever**.

The power supply answers with a *illegal function exception* to any commands which specify a not implemented function.

The power supply answers with *illegal data address exception* to any command which addresses invalid register(s) or try to read/write write/read-only register(s).

The power supply answers with *illegal data value exception* to:

- any command which spans multiple registers and due to an invalid number of registers or/and number of bytes fields control reaches an invalid or misaligned register value.
- any write command which fails validation.

A single word byte order is the same of the specification: MSB first.

Multi-word word order is least-significant-word first, for instance 32bit value 0x33221100 is encoded in two consecutive words 0x1100 0x3322.

CRC is encoded with the same byte order of the specification: LSB first.

Multiple adjacent registers can be read or written with a single command.

9.2. Registers Map

Address	Word	R/W	Type	Name	Description
0x1000	1	R	bit-mask	CARD_TYPE	hardware features
0x1001	1	R	unsigned integer	HW_CODE	hardware revision
0x1002	1	R	unsigned integer	SW_VERSION	software version
0x1003	2	R	unsigned integer	SERIAL_NUMBER	serial number
0x2000	2	R	unsigned integer	LIFE_TIME	total working hours
0x3000	1	R	unsigned integer	TEMPERATURE	internal temperature [K]
0x3001	1	R	unsigned integer	ARCING_NUMBER	number of arcing events from power supply start

0x3002	1	R	bit-mask	STATUS	power supply status
0x3003	1	R	bit-mask	SW_STATUS	status of SW1, SW2 and SW3 output
0x3004	2	R	Uptime	UPTIME	time elapsed since last start [s]
0x3006	1	R	unsigned integer	VIN	current voltage input [dV]
0x3007	1	R	unsigned integer	VOUT	current voltage output [V]
0x3008	2	R	unsigned integer	IOUT	current output current [nA]
0x4000	1	R/W	unsigned integer	VOUT_SETPOINT	output voltage set point [V]
0x4001	2	R/W	unsigned integer	VOUT_RAMP_INTV	output voltage ramping interval [ms]
0x4003	1	R/W	bit-mask	SW_MODE	switches modes for SW1, SW2 and SW3
0x4004	2	R/W	unsigned integer	SW1_THR	switch SW1 threshold [nA]
0x4006	2	R/W	unsigned integer	SW2_THR_MIN	switch SW2 min threshold (or threshold in simple mode) [nA]
0x4008	2	R/W	unsigned integer	SW2_THR_MAX	switch SW2 max threshold (unused in simple mode) [nA]
0x400a	2	R/W	unsigned integer	SW3_THR_MIN	switch SW3 min threshold (or threshold in simple mode) [nA]
0x400c	2	R/W	unsigned integer	SW3_THR_MAX	switch SW3 max threshold (unused in simple mode) [nA]
0x400e	1	R/W	unsigned integer	CONV_RATE	conversion rate [A/Torr]
0x5000	2	R/W	IP address	IP_ADDR	IP address (only for Ethernet model)
0x5002	1	R/W	IP net-mask	IP_NETMASK	IP network mask (only for Ethernet model)
0x5003	3	R	Ethernet MAC address	MAC_ADDR	Ethernet interface mac address (only for Ethernet model)
0x5006	2	R/W	unsigned integer	KEEPALIVE	keepalive time interval
0x6000	1	W	unsigned integer	ENABLE_CMD	enable command (stop:0x0000 start:0x0001 restart:0x0002)
0x6001	1	W	unsigned integer	ALARM_CLEAR	alarm latches clear command
0x7000	1	W	unsigned integer	CRITICAL_STEP1	critical step1 bypass command
0x7001	1	W	unsigned integer	CRITICAL_STEP1	critical step2 bypass command
0x8000	1	W	unsigned integer	MODBUS_ID	power supply Modbus ID
0x8001	1	W	unsigned integer	LIFE_TIME_RESET	total working hours reset

9.3. Registers Detailed Description

A detailed description of the available registers follows.

Manufacturing Data Registers

These registers are useful to retrieve manufacturing information.

CARD_TYPE – 0x1000 – Card Type

Bit	15	14	13	12	11	10	9	8
	–	–	–	–	–	–	–	–
R/W	R	R	R	R	R	R	R	R

Bit	7	6	5	4	3	2	1	0
	–	–	–	–	–	–	ETHERNET	DISPLAY
R/W	R	R	R	R	R	R	R	R

- Bit 15:2 – Reserved bits

These bits are reserved for future use.

- Bit 1 – Ethernet flag

If this bit is set, it means that Sip Power features a Ethernet connection and network registers are addressable.

- Bit 1 – Display flag

If this bit is set, it means that Sip Power features a display on the front panel.

HW_CODE – 0x1001 – Hardware Code

Bit	15	14	13	12	11	10	9	8
	HARDWARE REVISION - MAJOR NUMBER							
R/W	R	R	R	R	R	R	R	R

Bit	7	6	5	4	3	2	1	0
	HARDWARE REVISION - MINOR NUMBER							
R/W	R	R	R	R	R	R	R	R

- Bit 15:8 – Hardware revision major number

This is the hardware revision major number.

- Bit 7:0 – Hardware revision minor number

This is the hardware revision minor number.

SW_VERSION – 0x1002 – Software Version

Bit	15	14	13	12	11	10	9	8
	SOFTWARE VERSION - MAJOR NUMBER							
R/W	R	R	R	R	R	R	R	R

Bit	7	6	5	4	3	2	1	0
	SOFTWARE VERSION - MINOR NUMBER							
R/W	R	R	R	R	R	R	R	R

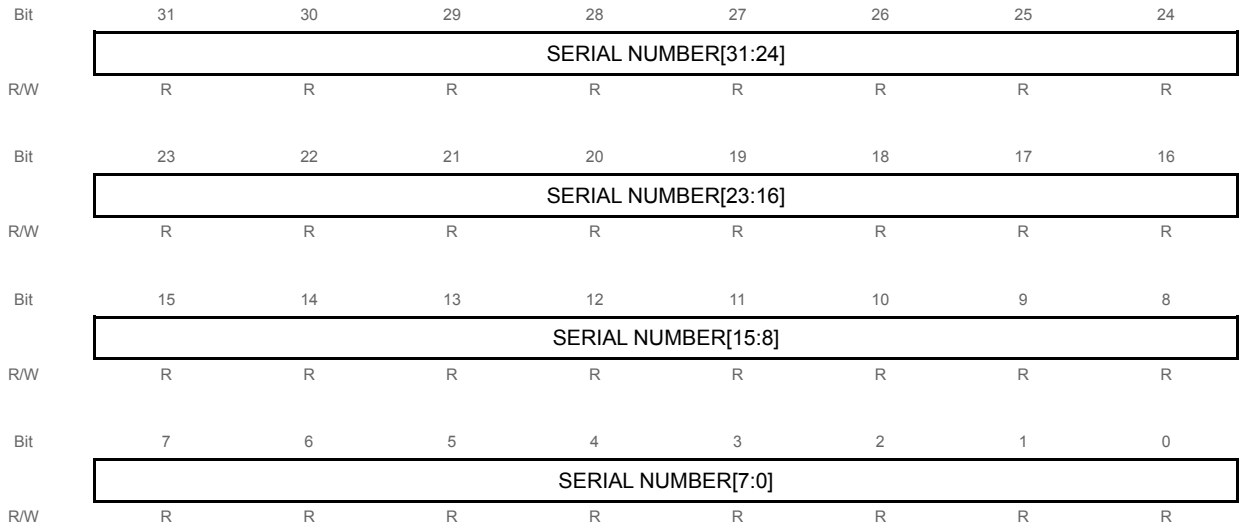
- Bit 15:8 – Software version major number

This is the software version major number.

- Bit 7:0 – Software version minor number

This is the software version minor number.

SERIAL_NUMBER – 0x1003 – Serial number



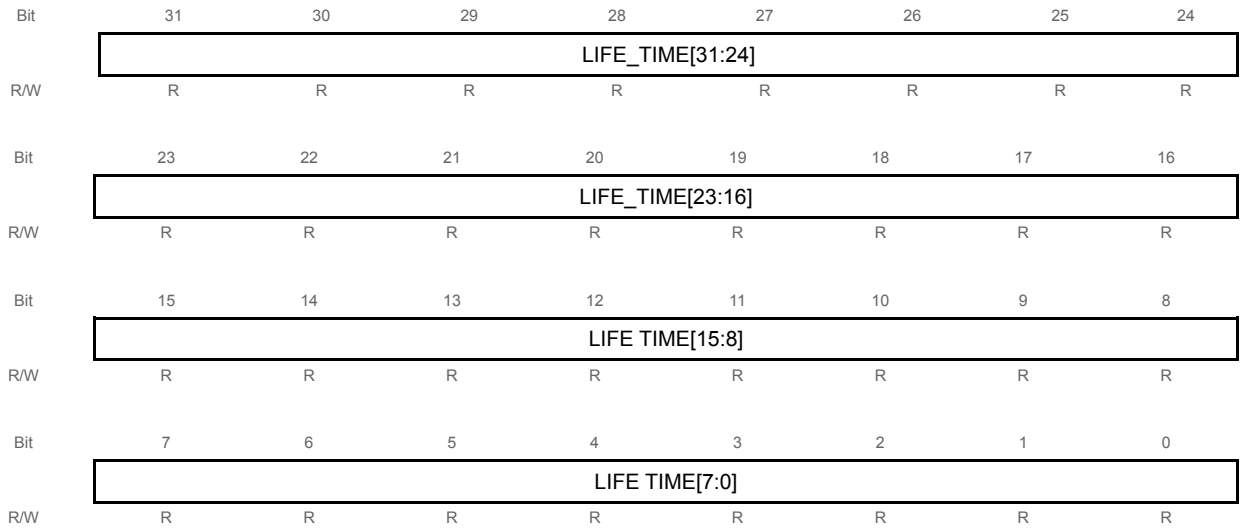
- Bit 3:0 – Serial number

These registers show the device serial number.

Status Registers

These registers are useful to retrieve information about the power supply status.

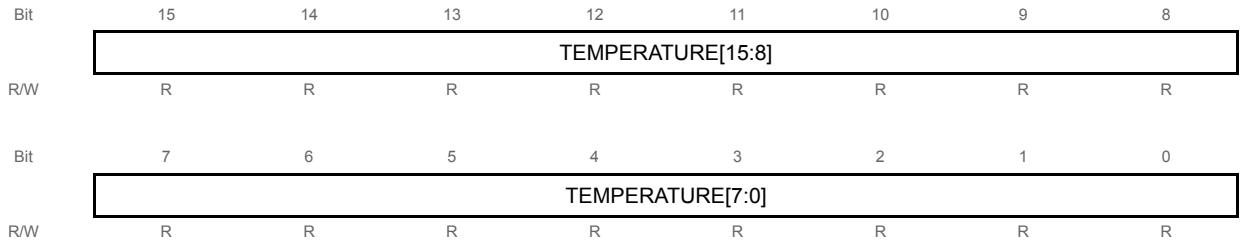
LIFE_TIME – 0x2000 – Total working hours



- Bit 31:0 – Total working hours

These registers show the device total working hours (only the time spent supplying current).

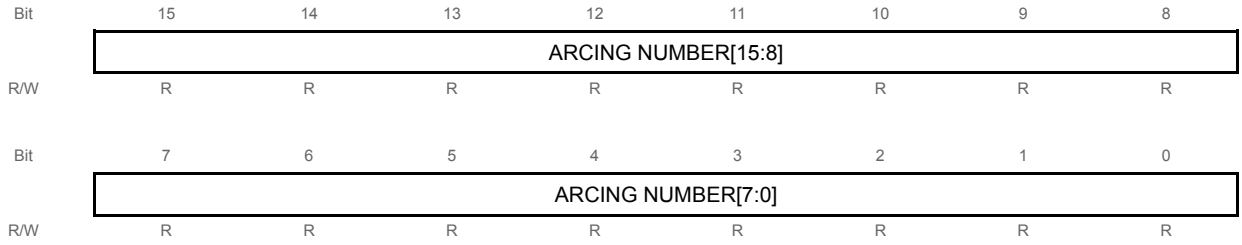
TEMPERATURE – 0x3000 – Internal temperature



- Bit 15:0 – Internal temperature

These registers contain the device internal temperature reading provided in Kelvin degrees.

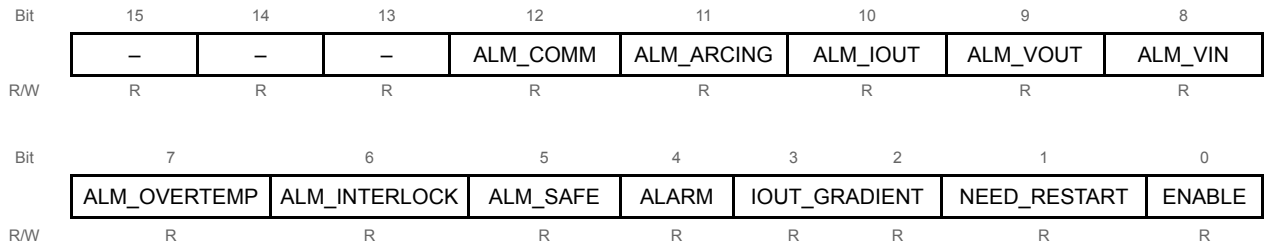
ARCING_NUMBER – 0x3001 – Arcing events number



- Bit 15:0 – Arcing events number

This register contains the number of arcing events since last start (or restart) command.

STATUS – 0x3002 – Power supply status



- Bit 15:13 – Reserved bits

These bits are reserved for future use.

- Bit 12 – Communication alarm

This alarm latch is set when the device (Modbus Master or Ethernet Master) who started the power supply (sent enable start or enable restart commands) does not send any request for KEEPALIVE ms.

- Bit 11 – Arcing alarm

This alarm latch is set when the power supply detects a arcing event.

- Bit 10 – Output over-current alarm

This alarm latch is set when the power supply detects a output over-current event. This alarm latch is set only if switch SW1 mode is set to ON and the output current increases over

SW1_THRESHOLD.

- Bit 9 – Output over-voltage alarm

This alarm latch is set when the power supply detects a output voltage the 5% over the given set-point.

- Bit 8 – Input voltage alarm

This alarm latch is set when the power supply detects an input over/under-voltage of 25% the rated input voltage.

- Bit 7 – Over temperature alarm

This alarm latch is set when the power supply internal temperature increases over 80°C.

- Bit 6 – Interlock alarm

This alarm latch is set when interlock input signal is missing.

- Bit 5 – Safe alarm

This alarm latch is set when safe input signal is missing.

- Bit 4 – Global alarm

This flag is set when at least one alarm latch is set.

- Bit 3:2 – Output current gradient

This field has three valid value:
0 – current is holding (HOLD)
1 – current is rising (UP)
2 – current is falling (DOWN)

- Bit 1 – Need restart

This flag is set when the power supply detects three arcing events or three overcurrent events in less than 45 seconds. When this flag is set there are two ways for starting again the power supply:
° by sending enable off command and then enable restart command.
° by sending enable restart command.

- Bit 0 – Enable

This flag shows the current power supply status, if set means the power supply have been started, if not set the power supply is stopped.

SW_STATUS – 0x3003 – Switches output status

Bit	15	14	13	12	11	10	9	8
	–	–	–	–	–	–	–	–
R/W	R	R	R	R	R	R	R	R

Bit	7	6	5	4	3	2	1	0
	–	–	–	–	–	SW3_OUT	SW2_OUT	SW1_OUT
R/W	R	R	R	R	R	R	R	R

- Bit 15:3 – Reserved bits

These bits are reserved for future use.

- Bit 2 – SW3 Output state

This flag shows output status of SW3 switch.

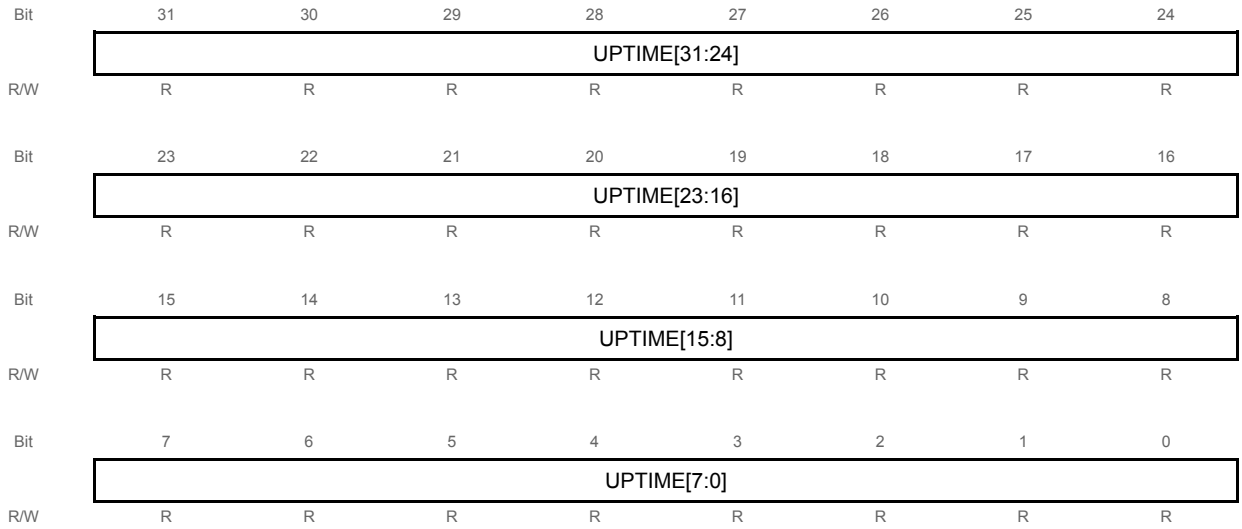
- Bit 1 – SW2 Output state

This flag shows output status of SW2 switch.

- Bit 0 – SW1 Output state

This flag shows output status of SW1 switch.

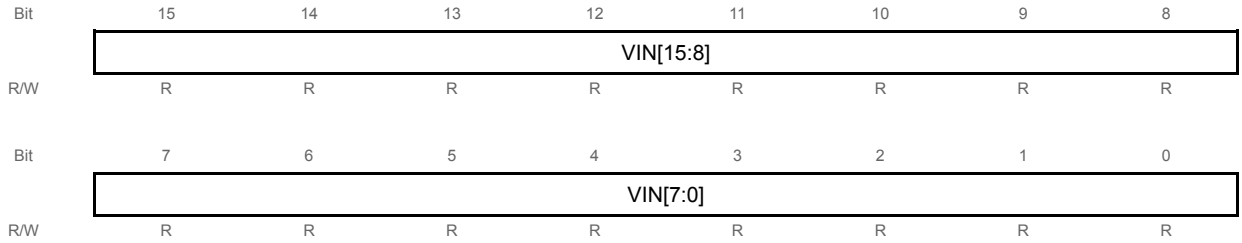
UPTIME – 0x3004 – Time elapsed since last start



- Bit 31:0 – Time elapsed since last start

These registers show the number of seconds elapsed from the last start (or restart).

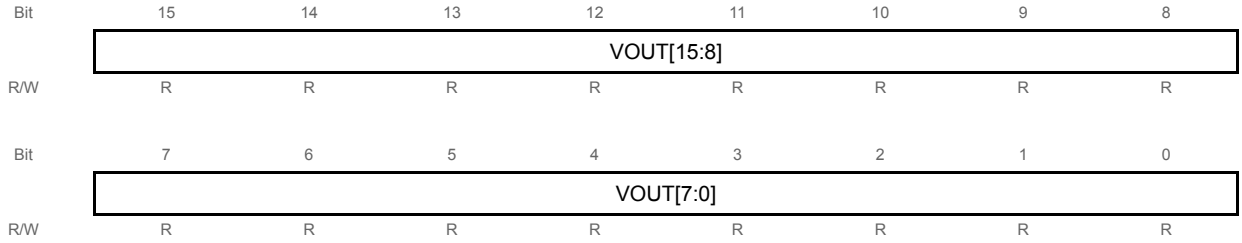
VIN – 0x3006 – Input Voltage



- Bit 15:0 – Input voltage

This register shows current input voltage in dV units (sampled in the same time slice of VOUT and IOUT).

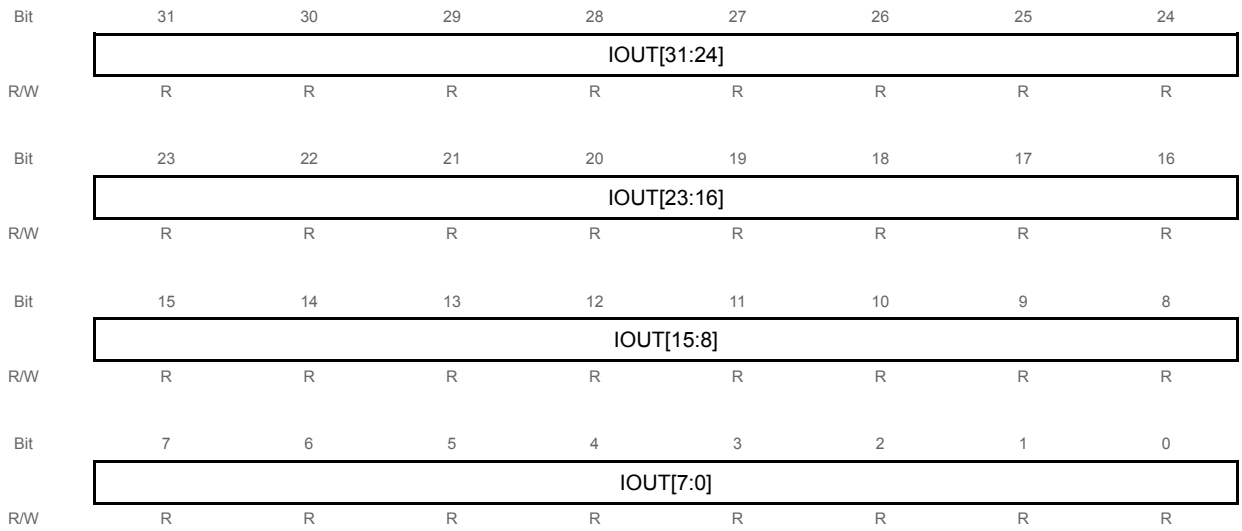
VOUT – 0x3007 – Output voltage



- Bit 15:0 – Output voltage

This register shows output voltage in V units (sampled in the same time slice of VIN and IOUT).

IOUT – 0x3008 – Output current



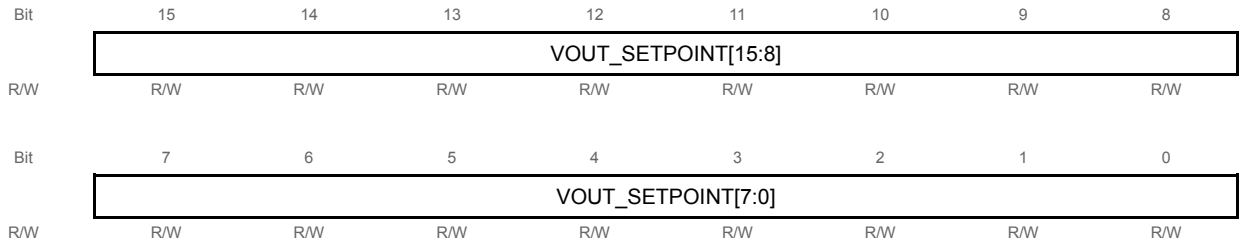
- Bit 31:0 – Output current

These registers show output current in nA units (sampled in the same time slice of VIN and VOUT).

Settings Registers

These registers are useful to retrieve or set current power supply settings.

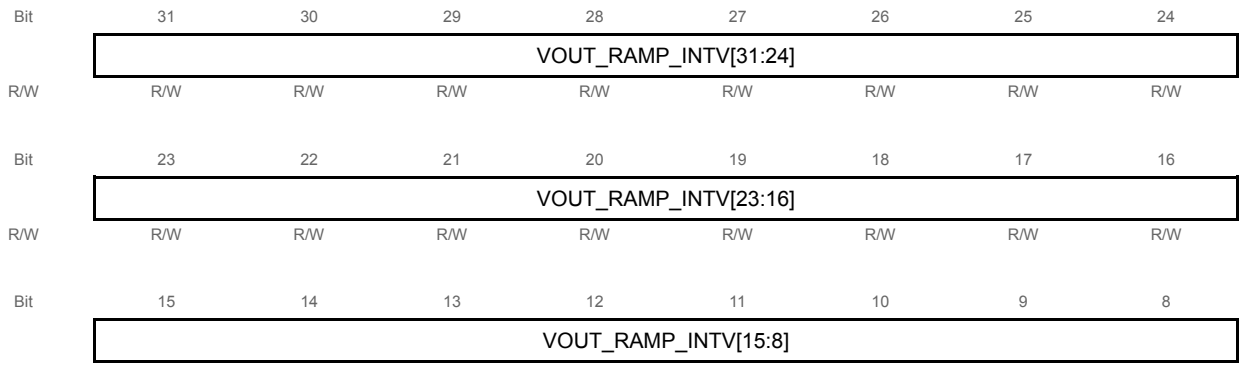
VOUT_SETPOINT – 0x4000 – Output voltage set-point



- Bit 15:0 – Output voltage set-point

This register contains output voltage set point in V units. The minimum allowed value is 1000V, the maximum allowed value is 6000V.

VOUT_RAMP_INTV – 0x4001 – Output voltage ramping interval



R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0
	VOUT_RAMP_INTV[7:0]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

- Bit 31:0 – Output voltage ramping interval

These registers contain output voltage ramping interval in ms units. The minimum allowed value is 1000 ms, the maximum allowed value is 60000ms.

SW_MODE – 0x4003 – Switches mode

Bit	15	14	13	12	11	10	9	8
	–	–	–	–	–	–	–	–
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0
	–	–	SW3_MODE		SW2_MODE		SW1_MODE	
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

- Bit 15:6 – Reserved bits

These bits are reserved for future use.

- Bit 5:4 – SW3 Mode

This field contains switch SW3 mode. Allowed modes are:
0 – SW3 switch is bypassed (OFF)
1 – SW3 switch is in simple mode (SIMPLE)
2 – SW3 switch is in window mode (WINDOW)

- Bit 3:2 – SW2 Mode

This field contains switch SW2 mode. Allowed modes are:
0 – SW2 switch is bypassed (OFF)
1 – SW2 switch is in simple mode (SIMPLE)
2 – SW2 switch is in window mode (WINDOW)

- Bit 1:0 – SW1 Mode

This field contains switch SW1 mode. Allowed modes are:
0 – SW2 switch is bypassed (OFF)
1 – SW2 switch is in simple mode (SIMPLE)

SW1_THR – 0x4004 – Switch SW1 threshold

Bit	31	30	29	28	27	26	25	24
	SW1_THR[31:24]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	23	22	21	20	19	18	17	16
	SW1_THR[23:16]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	15	14	13	12	11	10	9	8
	SW1_THR[15:8]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0

SW1_THR[7:0]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

- Bit 31:0 – Switch SW1 threshold

These registers contain switch SW1 threshold in nA units.

SW2_THR_MIN – 0x4006 – Switch SW2 low threshold

Bit	31	30	29	28	27	26	25	24
SW2_THR_MIN[31:24]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	23	22	21	20	19	18	17	16
SW2_THR_MIN[23:16]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	15	14	13	12	11	10	9	8
SW2_THR_MIN[15:8]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0
SW2_THR_MIN[7:0]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

- Bit 31:0 – Switch SW2 low threshold

These registers contain switch SW2 low threshold in nA units.

SW2_THR_MAX – 0x4008 – Switch SW2 high threshold

Bit	31	30	29	28	27	26	25	24
SW2_THR_MAX[31:24]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	23	22	21	20	19	18	17	16
SW2_THR_MAX[23:16]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	15	14	13	12	11	10	9	8
SW2_THR_MAX[15:8]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0
SW2_THR_MAX[7:0]								
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

- Bit 31:0 – Switch SW2 high threshold

These registers contain switch SW2 high threshold in nA units.

SW3_THR_MIN – 0x400a – Switch SW3 low threshold

Bit	31	30	29	28	27	26	25	24

	SW3_THR_MIN[31:24]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	23	22	21	20	19	18	17	16
	SW3_THR_MIN[23:16]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	15	14	13	12	11	10	9	8
	SW3_THR_MIN[15:8]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0
	SW3_THR_MIN[7:0]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

- Bit 31:0 – Switch SW3 low threshold

These registers contain switch SW3 low threshold in nA units.

SW3_THR_MAX – 0x400c – Switch SW3 high threshold

Bit	31	30	29	28	27	26	25	24
	SW3_THR_MAX[31:24]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	23	22	21	20	19	18	17	16
	SW3_THR_MAX[23:16]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	15	14	13	12	11	10	9	8
	SW3_THR_MAX[15:8]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0
	SW3_THR_MAX[7:0]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

- Bit 31:0 – Switch SW3 high threshold

These registers contain switch SW3 high threshold in nA units.

CONV_RATE – 0x400e – Conversion rate

Bit	15	14	13	12	11	10	9	8
	CONV_RATE[15:8]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W
Bit	7	6	5	4	3	2	1	0
	CONV_RATE[7:0]							
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W

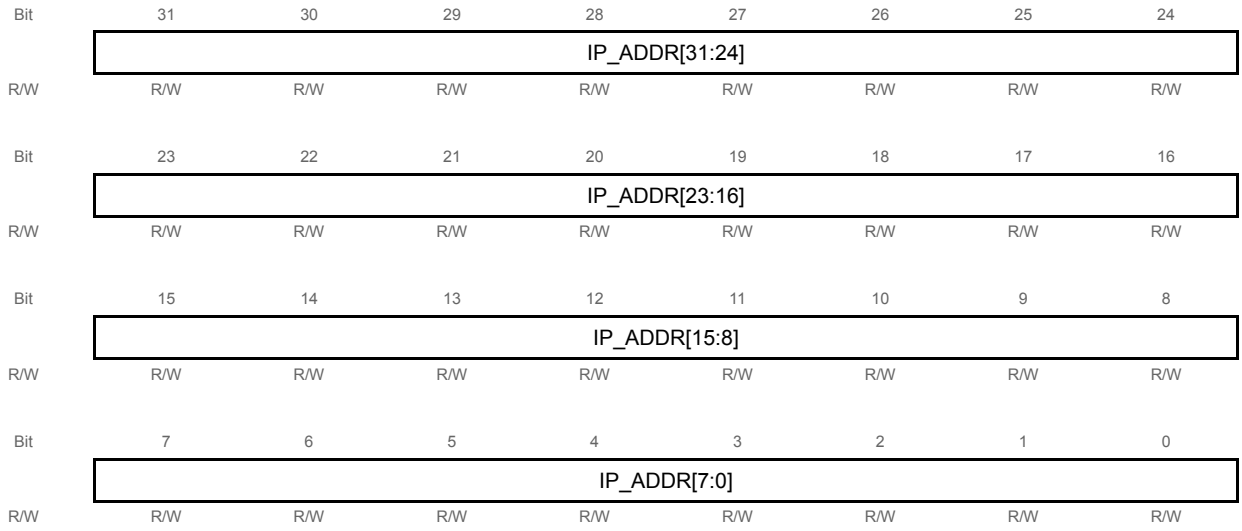
- Bit 31:0 – Conversion rate

This register contains the conversion rate in A/Torr units useful to compute chamber pressure from output current.

Networking Data Registers

Following registers are useful to set and retrieve networking settings. These registers are available only if ETHERNET flag is set in CARD_TYPE register.

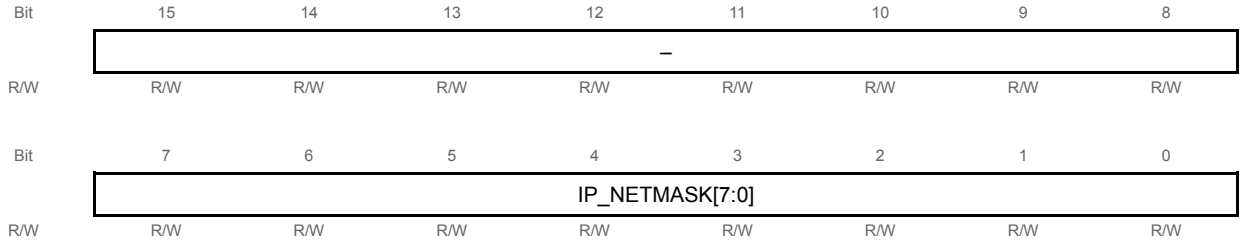
IP_ADDR – 0x5000 – IP address



- Bit 31:0 – IP address

These registers contain power supply IP address (available only if ETHERNET flag is set in CARD_TYPE register).

IP_NETMASK – 0x5002 – IP network mask



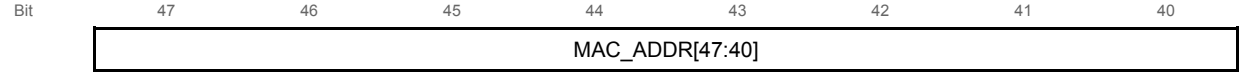
- Bit 15:8 – Unused bits

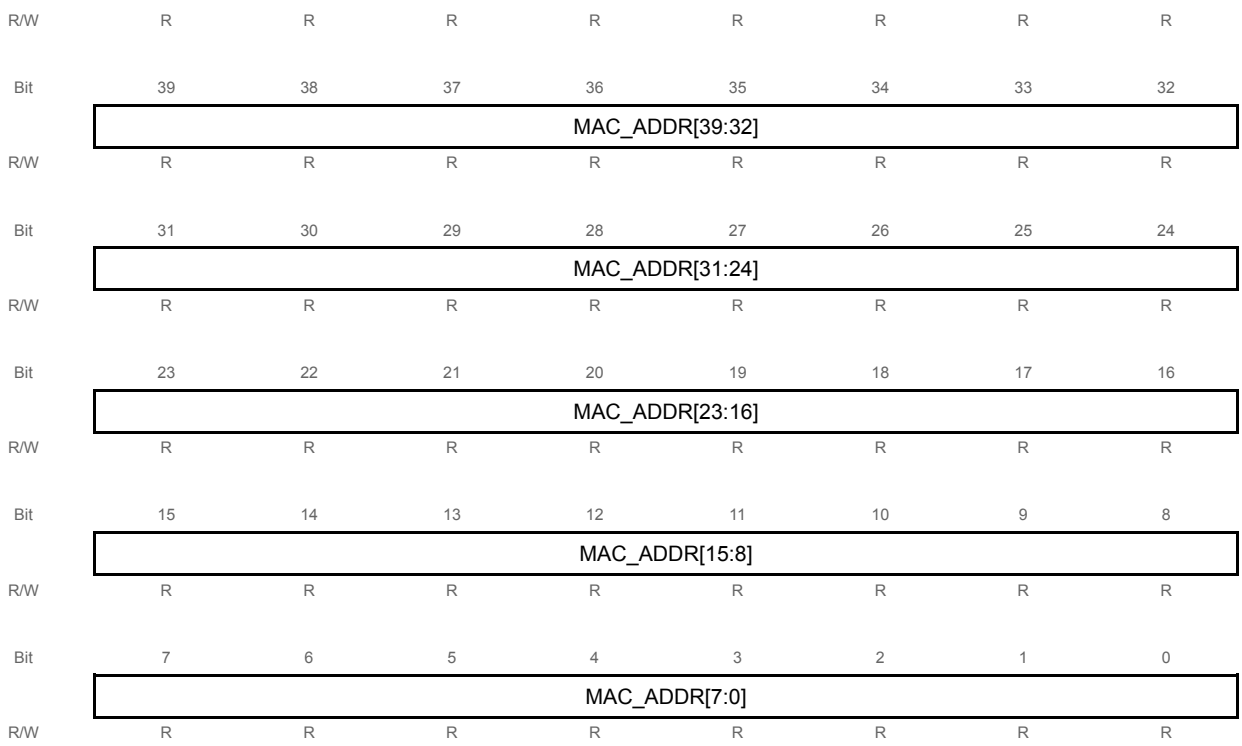
These bits are unused.

- Bit 7:0 – IP network mask

These bytes contains IP network mask (CIDR notation, available only if ETHERNET flag is set in CARD_TYPE register).

MAC_ADDR – 0x5003 – Ethernet MAC address

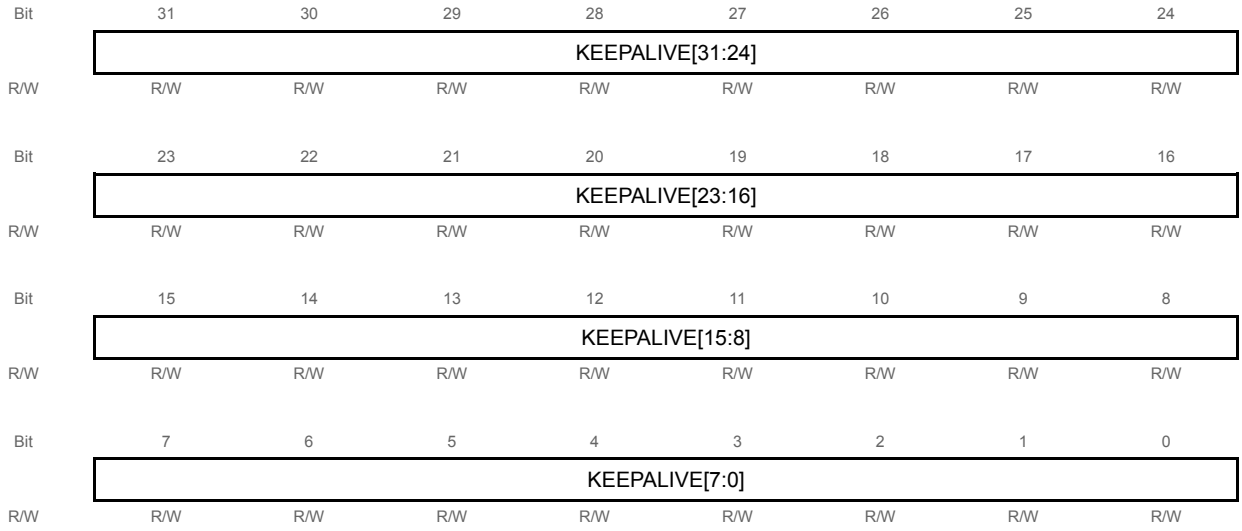




- Bit 47:0 – Mac address

These registers show power supply Ethernet MAC address (available only if ETHERNET flag is set in CARD_TYPE register).

KEEPALIVE – 0x5006 – Keepalive interval

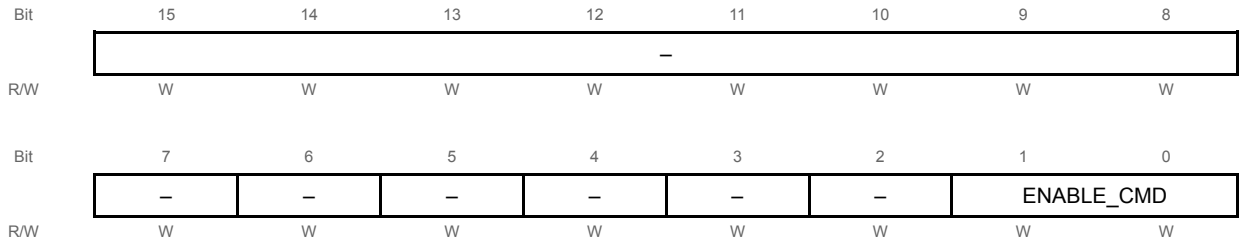


- Bit 31:0 – Keepalive interval

These registers contain keepalive time interval in ms units. When keepalive interval is different from 0 ms the power supply expects to be polled within a period not greater than keepalive interval by whom last sent to it the enable command, otherwise it stops and sets communication alarm latch. Keepalive timer resets after any successfully processed Modbus frame (frames that rise an exception do not reset keepalive timer). Keepalive interval cannot be lower than 1000 ms, the only exception is 0 ms which disables keepalive timer.

Command Registers

ENABLE – 0x6000 – Enable command



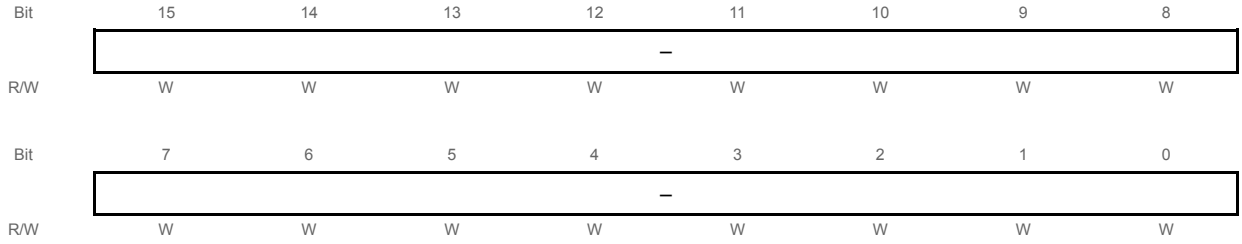
- Bit 15:2 – Reserved bits

These bits are reserved for future use.

- Bit 1:2 – Enable command

This field sets the current enable command, there are three valid values:
0 – stops the power supply (ENABLE_STOP)
1 – starts the power supply when flag NEED_RESTART is not set (ENABLE_START)
2 – restart the power supply when flag NEED_RESTART is set (ENABLE_RESTART)

ALARM_CLEAR – 0x6001 – Alarm clear command



- Bit 15:0 – Reserved bits

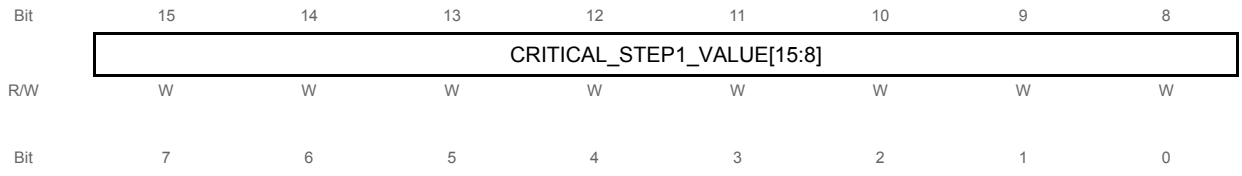
These bits are reserved for future use.

This register is just a placeholder for alarm clear command, there is no need to write any particular value in it, when the register is correctly addressed with a write multiple register Modbus function all the alarm latches are cleared.

Special Purpose Registers

Following register are used for special purposes such as changing the slave Modbus ID of the power supply.

CRITICAL_STEP1 – 0x7000 – Critical step bypass 1



	CRITICAL_STEP1_VALUE[7:0]							
R/W	W	W	W	W	W	W	W	W

- Bit 15:0 – Critical step bypass 1 value

Value to enable the bypass, the only allowed value is 0x5a5a

This is one of the two registers used to enable critical operations, such as changing Modbus ID. In order to enable the bypass you have to write the bypass value in this register.

CRITICAL_STEP1 – 0x7001 – Critical step bypass 2

Bit	15	14	13	12	11	10	9	8
	CRITICAL_STEP1_VALUE[15:8]							
R/W	W	W	W	W	W	W	W	W
Bit	7	6	5	4	3	2	1	0
	CRITICAL_STEP1_VALUE[7:0]							
R/W	W	W	W	W	W	W	W	W

- Bit 15:0 – Critical step bypass 2 value

Value to enable the bypass, the only allowed value is 0xa5a5

This is one of the two registers used to enable critical operations, such as changing Modbus ID. In order to enable the bypass you have to write the bypass value in this register.

MODBUS_ID – 0x8000 – Salve Modbus ID write

Bit	15	14	13	12	11	10	9	8
	–							
R/W	W	W	W	W	W	W	W	W
Bit	7	6	5	4	3	2	1	0
	MODBUS_ID[7:0]							
R/W	W	W	W	W	W	W	W	W

- Bit 15:8 – Unused bits

These bits are unused.

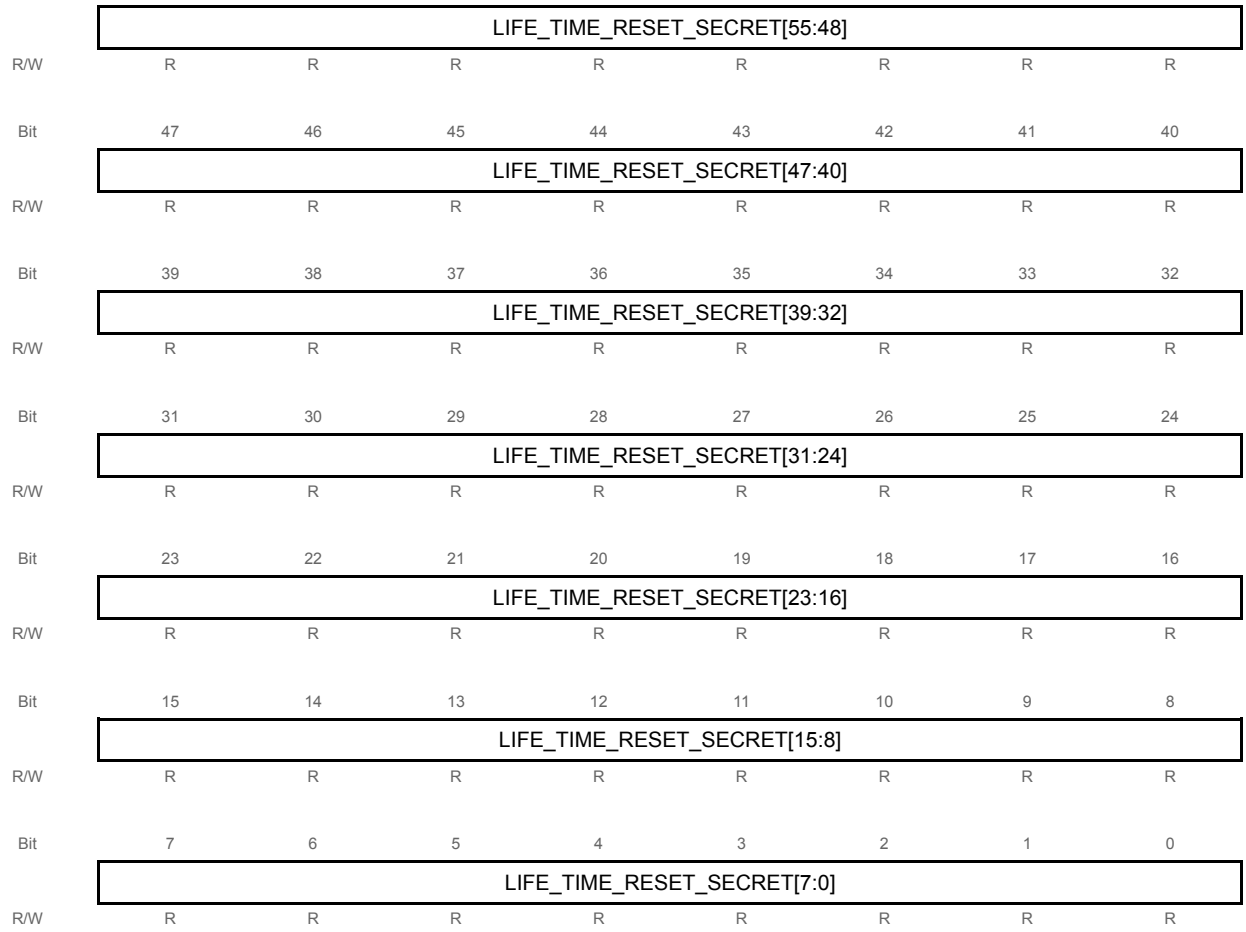
- Bit 7:0 – Slave Modbus ID

This field has to be written with a valid Modbus ID (1-247).

To change the slave Modbus ID critical step 1 and critical step 2 bypasses have to be previously enabled.

LIFE_TIME_RESET – 0x8001 – Salve Modbus ID write

Bit	63	62	61	60	59	58	57	56
	LIFE_TIME_RESET_SECRET[63:56]							
R/W	R	R	R	R	R	R	R	R
Bit	55	54	53	52	51	50	49	48



- Bit 63:0 – Life time reset secret

These registers contain the life time reset secret.

To reset the total working hours counter of the power supply you have to enable *critical step1* and *critical step2* bypass then write the life time reset secret in LIFE_TIME_RESET register.

10. IP - UDP communication protocol

Sip Power provided with Ethernet connectivity can be managed through a custom UDP protocol, each Sip Power acts as a slave device which answers only if a request is successfully received.

Default IP address is 10.0.0.10

A packet (UDP payload) has a maximum length of 302bytes. The packed structure is shown below.

Byte	0	1	2 – 302
	VERSION	COMMAND	PAYLOAD

Version field have to be set to 0x01.

Command can be one of the following values:

- **0x01 – Start** command to activate the output power. Requires no payload.
- **0x02 – Stop** command to deactivate the output power. Requires no payload.
- **0x03 – Reset** command to restore Sip Power status after 3 arcing alarm in less than 45 seconds or 3 over current alarm in less than 45 seconds. Requires no payload.
- **0x04 – Clear Alarm** command to reset all alarm latches. Requires no payload.
- **0x05 – Read All** command to read status, working parameters and network settings. Requires no payload.
- **0x40 – Set Working Parameters** command to set working parameters. A payload is required.
- **0x41 – Set IP address** command to set IP address and netmask. A payload is required.
- **0x80 – Read All Answer** this command is used only by Sip Power to answer to *Read All* command. A payload is provided.

Commands *Start*, *Stop*, *Reset*, *Clear Alarm*, *Set Working Parameters*, *Set IP Address* can be sent to network broadcast address and all Sip Power under that network will execute the command accordingly. *Read All commands* sent to broadcast address will be ignored by Sip Power.

Beware that no confirmation protocol is present, thus it's up to the user application to verify a command execution by reading current Sip Power status, working parameters or network settings.

Payload is ignored by Sip Power for commands *Start*, *Stop*, *Reset*, *Clear Alarm*, *Read All* and is required for commands *Set Working Parameters* and *Set IP Address*. *Read All Answer* command is issued only by Sip Power as answer to *Read All* command, it provide a payload.

Payload is different for each command that requires or provides it. The byte order in a payload is the same as the network order, big-endian.

In following sections the structure of each type of payload is described. Field length has been highlighted with colors, orange for 8 bit, blue for 16 bit and green for 32bit.

10.1. Payload for 0x40 – Set Working Parameters Command

0 16bits 15	16 32bits 47	48 8bits 55	56 32bits 87	88 32bits 119
VOUT_SETPOINT	VOUT_RAMP_INTV	SW_MODE	SW1_THR	SW2_THR_MIN
120 32bits 151	152 32bits 183	184 32bits 215	216 32bits 247	248 16bits 263
SW2_THR_MAX	SW3_THR_MIN	SW3_THR_MAX	KEEPALIVE	CONV_RATE
264 8bits 271				
MODBUS_ID				

- **Bit 0:15 – Output voltage set-point**

This field contains output voltage set point in V units. The minimum allowed value is 1000V, the maximum allowed value is 6000V.

- **Bit 16:47 – Output voltage ramping interval**

This field contains output voltage ramping interval in ms units. The minimum allowed value is 1000ms, the maximum allowed value is 60000ms.

- **Bit 48:55 – Switches modes**

This byte is structured as follows

  - **Bit 5:4 – SW3 Mode**

This field contains switch SW3 mode. Allowed modes are:
    - **0 –** SW3 switch is bypassed (OFF)
    - **1 –** SW3 switch is in simple mode (SIMPLE)
    - **2 –** SW3 switch is in window mode (WINDOW)

  - **Bit 3:2 – SW2 Mode**

This field contains switch SW2 mode. Allowed modes are:
    - **0 –** SW2 switch is bypassed (OFF)
    - **1 –** SW2 switch is in simple mode (SIMPLE)
    - **2 –** SW2 switch is in window mode (WINDOW)

  - **Bit 1:0 – SW1 Mode**

This field contains switch SW1 mode. Allowed modes are:
    - **0 –** SW2 switch is bypassed (OFF)
    - **1 –** SW2 switch is in simple mode (SIMPLE)

- **Bit 56:87 – Switch SW1 threshold**

This field contains switch SW1 threshold in nA units.

- **Bit 88:119 – Switch SW2 low threshold**

This field contains switch SW2 low threshold in nA units. This is also SW2 threshold in *SIMPLE* mode.

- **Bit 120:151 – Switch SW2 high threshold**

This field contains switch SW2 high threshold in nA units.

- **Bit 152:183 – Switch SW3 low threshold**

This field contains switch SW3 low threshold in nA units. This is also SW3 threshold in *SIMPLE* mode.

- **Bit 184:215 – Switch SW3 high threshold**

This field contains switch SW3 high threshold in nA units.

- **Bit 216:247 – Keepalive interval**

This field contains keepalive time interval in ms units. When keepalive interval is different from 0 ms the power supply expects to be polled within a period not greater than keepalive interval by whom last sent to it the enable command, otherwise it stops and sets communication alarm latch. Keepalive timer resets after any successfully processed command. Keepalive interval cannot be lower than 1000 ms, the only exception is 0 ms which disables keepalive timer.

- **Bit 248:263 – Conversion rate**

This field contains the conversion rate in A/Torr units useful to compute chamber pressure from output current.

- **Bit 264:271 – Slave Modbus ID**

When Modbus is available this field allows to change the slave Modbus ID (Allowed IDs: 1-247).

10.2. Payload for 0x41 – Set IP Address Command

0 32bits 31	32 32bits 63
IP_ADDR	IP_NETMASK

- **Bit 0:31 – New IP address**

This field contains the new Sip Power IP address.

- **Bit 32:63 – New IP network mask**

This field contains the new Sip Power IP network mask.

10.3. Payload for 0x80 – Read All Answer Command

0 16bits 15	16 16bits 31	32 16bits 47	48 32bits 79	80 32bits 111
CARD_TYPE	HW_CODE	SW_VERSION	SERIAL_NUMBER	IOUT
112 16bits 127	128 16bits 143	144 16bits 159	160 16bits 175	176 16bits 191
VOUT	VIN	RESERVED	TEMPERATURE	ARCING_NUMBER
192 32bits 223	224 32bits 255	256 16bits 271	272 8bits 279	280 520bits 799
LIFE_TIME	UPTIME	STATUS	SW_STATUS	RESERVED

- **Bit 48:55 – Card type**

This field is structured as follow:

  - **Bit 15:2 – Reserved bits**

These bits are reserved for future use.

- **Bit 1 – Ethernet flag**

If this bit is set, it means that Sip Power features a Ethernet connection.

- **Bit 0 – Display flag**

If this bit is set, it means that Sip Power features a display on the front panel.

- **Bit 16:31 – Hardware revision number**

This field is structured as follow:

- **Bit 15:8 – Hardware revision major number**

This is the hardware revision major number.

- **Bit 7:0 – Hardware revision minor number**

This is the hardware revision minor number.

- **Bit 32:47 – Software version**
- **Bit 15:8 – Software version major number**

This is the software version major number.

- **Bit 7:0 – Software version minor number**

This is the software version minor number.

- **Bit 48:79 – Serial number**

This field shows the device serial number.

- **Bit 80:111 – Output current**

This field shows output current in nA units (sampled in the same time slice of VIN and VOUT).

- **Bit 112:127 – Output voltage**

This field shows output voltage in V units (sampled in the same time slice of VIN and IOUT).

- **Bit 128:143 – Input voltage**

This field shows current input voltage in dV units (sampled in the same time slice of VOUT and IOUT).

- **Bit 144:159 – Reserved**

This field is reserved for future use.

- **Bit 160:175 – Internal temperature**

This field contains the device internal temperature reading provided in Kelvin degrees.

- **Bit 176:191 – Arcing events number**

This field contains the number of arcing events since last start (or restart) command.

- **Bit 192:223 – Total working hours**

This field contains the device total working hours (only the time spent supplying current).

- **Bit 224:255 – Time elapsed since last start**

This field contains the number of seconds elapsed from the last start (or restart).

- **Bit 256:271 – Power supply status**

This field is structured as follow:

- **Bit 15:13 – Reserved bits**

These bits are reserved for future use.

- **Bit 12 – Communication alarm**

This alarm latch is set when the device (Modbus Master or Ethernet Master) who started the power supply (sent enable start or enable restart commands) does not send any request for KEEPALIVE ms.

- **Bit 11 – Arcing alarm**

This alarm latch is set when the power supply detects a arcing event.

- **Bit 10 – Output over-current alarm**

This alarm latch is set when the power supply detects a output over-current event. This alarm latch is set only if switch SW1 mode is set to ON and the output current increases over SW1_THRESHOLD.

- **Bit 9 – Output over-voltage alarm**

This alarm latch is set when the power supply detects a output voltage the 5% over the given set-point.

- **Bit 8 – Input voltage alarm**

This alarm latch is set when the power supply detects an input over/under-voltage of 25% the rated input voltage.

- **Bit 7 – Over temperature alarm**

This alarm latch is set when the power supply internal temperature increases over 80°C.

- **Bit 6 – Interlock alarm**

This alarm latch is set when interlock input signal is missing.

- **Bit 5 – Safe alarm**

This alarm latch is set when safe input signal is missing.

- **Bit 4 – Global alarm**

This flag is set when at least one alarm latch is set.

- **Bit 3:2 – Output current gradient**

This field has three valid value:

- **0 –** current is holding (HOLD)
- **1 –** current is rising (UP)
- **2 –** current is falling (DOWN)

- **Bit 1 – Need restart**

This flag is set when the power supply detects three arcing event or three overcurrent event in less than 45 seconds. When this flag is set there are two ways for starting again the power supply:

- by sending enable off command and then enable restart command.
- by sending enable restart command.

- **Bit 0 – Enable**

This flag shows the current power supply status, if set it means the power supply have been started, if not set the power supply is stopped.

- **Bit 272:279 – Switches output status**
  - **Bit 15:3 – Reserved bits**

These bits are reserved for future use.

- **Bit 2 – SW3 Output state**

This flag shows output status of SW3 switch.

- **Bit 1 – SW2 Output state**

This flag shows output status of SW2 switch.

- **Bit 0 – SW1 Output state**

This flag shows output status of SW1 switch.

- **Bit 280:799 – Reserved for future use**

800 16bits 815	816 32bits 847	848 8bits 855	856 32bits 887	888 32bits 919
VOUT_SETPOINT	VOUT_RAMP_INTV	SW_MODE	SW1_THR	SW2_THR_MIN
920 32bits 951	952 32bits 983	984 32bits 1015	1016 32bits 1047	1048 16bits 1063
SW2_THR_MAX	SW3_THR_MIN	SW3_THR_MAX	KEEPALIVE	CONV_RATE
1064 8bits 1071	1072 528bits 1599			
MODBUS_ID	RESERVED			

Fields description is the same of Section 10.1 with a offset of 800 bits. Bits between 1072 and 1599 are reserved for future use.

1600 32bits 1631	1632 32bits 1663	1664 8bits 1671	1672 8bits 1679	1680 8bits 1687
IP_ADDR	IP_NETMASK	MAC_ADDR_B0	MAC_ADDR_B1	MAC_ADDR_B2
1688 8bits 1695	1696 8bits 1703	1704 8bits 1711	1712 688bits 2399	
MAC_ADDR_B3	MAC_ADDR_B4	MAC_ADDR_B5	RESERVED	

- **Bit 1600:1631 – New IP address**

This field contains the new Sip Power IP address.

- **Bit 1632:1663 – New IP network mask**

This field contains the new Sip Power IP network mask.

- **Bit 1664:1671 – MAC address byte 0**
- **Bit 1672:1679 – MAC address byte 1**
- **Bit 1680:1687 – MAC address byte 2**
- **Bit 1688:1695 – MAC address byte 3**
- **Bit 1696:1703 – MAC address byte 4**
- **Bit 1704:1711 – MAC address byte 5**
- **Bit 1712:2399 – Reserved for future use**

11. MAINTENANCE AND TROUBLESHOOTING

The supply needs minimum maintenance. Depending on the dust levels in the environment where the device is being operated, a periodic check of the vents on upper and lower side of the device and outlet of the fan is desirable. In case of dust contamination it can be cleaned by means of a vacuum cleaner.

For repair the supply should be shipped back to Saes Group S.p.A..

11.1. IP troubleshooting

During a running mode of the ION pump these messages may be displayed:

(for more details see *Cap. 7*)

- ***Arcing*** - The message will appear after automatic switching off of the power supply due to either an unstable electric arc in ion element or an arc of high voltage in the circuit of ion element cable. In this situation, the power supply will try to switch on and if the third attempt is not successful, the supply remains permanently switched off with error report. The remedy is to forepump to higher vacuum or to remove the reason of arcing. It is possible to switch on the supply unit again by pushing the **START/STOP** pushbutton.

- ***Over Temperature*** - The supply is switched off as a consequence of overheating the generator HV. This circumstance can occur at high ambient temperature and simultaneously maximal output power of the supply.
  After decrease of inner temperature the supply will start automatically again.
  If the failure lasts too long time or it appears too often the reason for it might be:
  - Excessive high ambient temperature.
    Reduce the ambient temperature or load of the supply.
  - An insufficient flow of cooling air through lateral grids
    Ensure a sufficient air flow, leave the supply switched on.

- ***Low Voltage*** - The supply is switched off as a consequence of low mains voltage (under low margin of working extent) apparently at high output power.
  As long as this state remains it is probable that the failure message and operating regime will change periodically until sufficient mains voltage is ensured.

Warning

In the case the HV cable is disconnected, the current will be 0 nA.

12. SPECIFICATIONS

IP Section

Pump output (HV) connector	BNC (HV)
Nominal output voltage	5 kV±2 %
Range of adjustment	1÷6 kV
Output voltage polarity	positive
Maximum output current	65mA @ 350Vdc
Obtainable output power	25–35 W

Output Protections

Current electronically limited at 3.0 A (@ 6kV)

Complete unit

Outputs

4× current comparators-switches*		on: Z = 13±2 Ω
positive feeding voltage		+5 V / 20 mA
negative terminal		GND
** max. voltage between switched off terminals*		*30 V*
max. current through connected terminals		*100 mA*

Inputs

interlock enable input		2–10 mA / 2 kΩ
Communication interface	Ethernet	standard interface
	RS485	38400 Bd, 8 data bits, 2 stop-bit
Input voltage		24 Vdc
Maximal input current		2 A
Weight		1 kg
Ambient temperature at operation		5÷40 °C
Relative humidity		20÷80 %

13. DECLARATION OF CE CONFORMITY

SAES Getters S.p.A.

Dichiarazione di conformità CE
Declaration of CE conformity

Denominazione della macchina : SIP POWER
Type of machine: models: with/without display, with/without RS485 interface
with/without USB and Ethernet interface

Il sottoscritto dichiara che l'impianto in oggetto è conforme a quanto prescritto dalle seguenti Direttive e Norme:
The undersigned hereby declares that the above-referenced product, to which this declaration relates, is in conformity with the following Directive(s) and Norm(s):

Direttiva 2004/108/CE "Compatibilità elettromagnetica" EMC
Directive 2004/108/CE "Electromagnetic Compatibili"

Direttiva 2011/65/CE "RoHS 2 – Restrizione dell'uso di determinate sostanze pericolose nelle apparecchiature elettriche ed elettroniche"
Directive 2011/65/CE "RoHS 2 - Restriction of Hazardous Substances"

In conformità con gli standard:
In conformity with the standard:

EN 61000-6-2: 2005 + EC: 2005 + IS1: 2005 - "Compatibilità elettromagnetica (EMC)"
EN 61000-6-2: 2005 + EC: 2005 + IS1: 2005 - "Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments"

EN 61000-6-4: 2007 + A1: 2011 - "Compatibilità elettromagnetica (EMC)"
EN 61000-6-4: 2007 + A1: 2011 - "Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments"

EN 61000-3-3: 2008 - "Compatibilità elettromagnetica (EMC)"
EN 61000-3-3: 2008 - "Electromagnetic compatibility (EMC). Limits. Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection"

EN 61000-3-2: 2006 + A1: 2009 + A2: 2009 - "Compatibilità elettromagnetica (EMC)"
EN 61000-3-2: 2006 + A1: 2009 + A2: 2009 - "Electromagnetic compatibility (EMC). Limits. Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)"

EN 61326-1: 2013 - "Apparecchi elettrici di misura, controllo e laboratorio - Prescrizioni di compatibilità elettromagnetica - Parte 1: Prescrizioni generali"
EN 61326-1:2006 - " Electrical equipment for measurement; control and laboratory use EMC - Part 1: General requirements

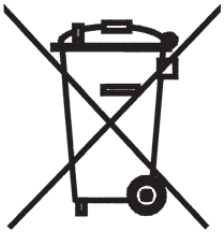
Lainate 20/05/2015

Il Legale Rappresentante
Legal Representative
SAES Getters S.p.A.
President
Dr. Ing. Massimo della Porta

Corporate Headquarters – Sede Legale, Direzione e Amministrazione
Viale Italia,77 – 20020 Lainate (MI) Italy – Tel. +39 02 93178.1 – saes-ul@pec.it
Fax +39 02 93178.250 (Corporate HQS) +39 02 93178.320 (Commercial Dept.) +39 02 93178.370 (Administration Dept.)
Registro delle Imprese di Milano, Partita IVA e Codice Fiscale 00774910152 – R.E.A. Milano 317232 – R.E.A. Varese 116941
Numero Meccanografico MI 002143 – Capitale Sociale Euro 12.220.000 interamente versato
www.saesgroup.com

14. INSTRUCTION FOR INSTRUMENT DISPOSAL

The instrument disposal has to be carried out in compliance with the user's country applicable regulations.
The information below is issued in compliance with the regulations as set out by the 2012/19/EU directive (Waste Electrical and Electronic Equipment).



The instrument contains materials which may endanger the environment and it's not allowed to dispose it with unsorted urban waste.
The equipment shall also be disassembled by material for disposal.
The different materials shall be collected separately in accordance with local waste disposal legislations.
Neither the collection nor the transport of thus collected and separated materials is subject to any special requirements.

15. PRODUCT CONFIGURATIONS AND ACCESSORIES

Configurations and accessories are given in the following section:

Code	Product description
3B0506	SIP POWER (with display, standard ETHERNET interface and USB pendrive interface)
3B0507	SIP POWER LOCAL (only with display)
3B0508	SIP POWER LEDS (with standard ETHERNET interface and USB pendrive interface)
3B0509	SIP POWER LEDS and RS485
3B0510	AC/DC Adapter for SIP POWER
3B0338	MAIN INPUT CABLE with European plug Schuko P660 – 3 m length
3B0511	Rechargeable Battery Pack for SIP POWER
3B0410	OUTPUT CABLE ION 3m length (standard)

16. WARRANTY CONDITIONS

SAES guarantees that the Products delivered shall be free from operational and material defects and shall comply with the construction and functional data and specifications indicated in the Contractual Documents.
This warranty shall have a term of TWELVE (12) MONTHS. For Products which require installation at BUYER's facility by SAES personnel, the warranty shall have a term of TWELVE (12) MONTHS from the date of installation or FOURTEEN (14) MONTHS from the date of delivery, whichever term is shorter. Subject to the remainder of this Article 14, any action by BUYER for any alleged breach of this warranty shall be brought in writing by BUYER within thirty (30) days of BUYER's discovery of the breach. This warranty shall only apply to the BUYER and may not be assigned.
During the term of the warranty set forth above, SAES will promptly repair the Products which for their features can be repaired and which do not conform to the specifications and which BUYER returns to SAES at the address provided. Unless otherwise agreed and specified, BUYER shall be responsible for all transportation charges incurred in returning Products to SAES for repair; BUYER shall have obtained a Returned Material Authorization ("RMA") number and specific shipping instructions from SAES prior to its shipping of the Products to SAES. SAES shall not unreasonably deny BUYER authorization to ship Products to SAES. SAES shall return repaired Products to BUYER, with transportation charges prepaid by SAES, unless otherwise agreed. Additional information is available on the General conditions of sales.

17. SERVICE

For a request of return of the component contact a SAES Customer Service and will receive a **Return Merchandise Authorization** (RMA) number.

17.1. Sales & Service Locations:

Europe, Middle East and Africa:

SAES Getters S.p.A.
Viale Italia 77
20020 Lainate (Milan) - Italy
Ph. +39 02 93178 1 - Fax +39 02 93178 320

European Customer Relations:
Ph. +39 02 9317 8402 - Fax +39 02 93178320
E-mail: CRM_SALES@saes-group.com

Asia and Oceania:

SAES Getters S.p.A. - Japan Technical Service - Branch Office
2nd Gotanda Fujikoshi Bldg.
23-1 Higashi Gotanda 5-Chome
Tokyo 141, Japan
Ph. +81 3 542 00431 - Fax +81 3 542 00438

SAES Getters (Nanjing) Co.,Ltd.
56 Xingangdadao, Xinshengwei
Nanjing Economic & Technical Development Zone
Nanjing 210038, Jangsu Province, P.R. of China
Ph. +86 25 8580 2335 - Fax +86 25 8580 1639

SAES Getters Korea Corporation
7th Fl. Dongwon Bldg. 143-28
Samsung-dong, Gangnam-gu
Seoul 135-877, Korea
Ph. +82 2 3404 2400 - Fax +82 2 3452 4510/11

SAES Getters S.p.A. - Taiwan Branch Office
6F-1, No. 1071, Zhongzheng Road,
Taoyuan City, Taoyuan County 330
Taiwan, R.O.C.
Ph. +886 3 346 3866 - Fax +886 3 346 8290

North and South America:

SAES Getters USA, Inc.
1122 East Cheyenne Mountain Blvd.
Colorado Springs, CO 80906 - USA
Ph. +1 719 576 3200 - Fax +1 719 576 5025

Remember that SAES cannot accept any instrument which contains biological or chemical hazards or radioactive substances. Please clearly inform SAES Customer Service should this have

happened during pump use, so to discuss adequate solutions.

SAES GETTERS S.p.A. – Italy
www.saesgroup.com