DC LOAD
PL-2000-A / 60V-120A / 2G
USER MANUAL

User Manual Reference: MU-RC2058-EN-01

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MANUAL UPDATES

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MU-RC2058-EN	00	22/06/2018	All	Initial Version.
MU-RC2058-EN	01	28/11/2018	31	Explanations on the pulse width added.

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1. PREAMBLE

1.1 Legal notices

No part of this document may be photocopied, reproduced, or translated to another language without the prior agreement and written consent PUISSANCE +.

1.2 Warranty

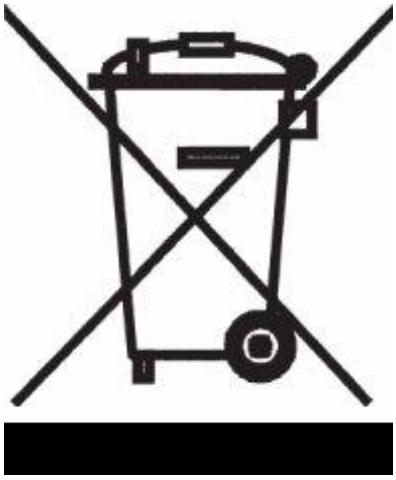
The material contained in this document is provided “as is,” and is subject to being changed, without notice, in future editions.

PUISSANCE + is not responsible if the instrument is used in a dangerous manner, either alone or in conjunction with other equipment. High voltages are present in the instrument making it dangerous if used in conditions not specified by PUISSANCE +. Safety symbols affixed to the instrument indicate these dangerous voltages.

1.3 Waste Electrical and Electronic Equipment (WEEE)

The product label (see below) indicates that you must not discard this electrical/electronic product in domestic household waste.

At the end of their life cycle, you have to eliminate any equipment intended for destruction correctly in order to avoid all attack against the Environment and Human Health. Contact the local authority for advice on recycling.



2. SAFETY

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or instructions elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. PUISSANCE + assumes no liability for the customer's failure to comply with these requirements.

2.1 General

Do not use this product in any manner not specified by PUISSANCE +. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

CAUTION: The perforated panels must be protected by a device to prevent falling object indoors during transport.

2.2 Before applying power

Verify that all safety precautions are taken. Make all connections to the unit before applying power. Note the instrument's external markings described paragraph 2.8 Safety symbols

2.3 Ground the instrument

A general terminal mechanical ground is available at the rear of the instrument to perform, for example, a separate wiring of earth in a bay.

2.4 Fuse

The main power supply is protected by a delayed fuse (cartridge 5x50mm, 250V/5A). It is accessible from the rear of the power supply frame. Replace the fuse only with a fuse of the same type and same characteristics.

WARNING: The DC load contains an internal fuse that is not accessible to customers. In case of problems, please contact customer support.

2.5 Do not remove the instrument cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

2.6 Do not modify the instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to PUISSANCE + for service and repair to ensure that safety features are maintained.

2.7 In case of damage

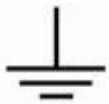
Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

2.8 Safety symbols

A set of labels affixed on the instrument summarizes and reminds the safety instructions to be obeyed when working on the bench. To make formatting of this document easier, the scale of the labels shown herein differs from that of the real labels.

2.8.1 Connection to the mechanical earth

The symbol below indicates that it is not necessary to connect the instrument to the ground because the leakage current is lower than 0.5 mA.



2.8.2 Electrical shock danger/hazard

The symbol is intended to alert the user to the presence of uninsulated "dangerous voltage" within the product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

2.8.3 General warning

This symbol indicates that the user must refer to the manual or caution information to avoid personal injury or damage the product.

3. PRESENTATION

3.1 General

The PL-2000-A is a DC load developed by the Company PUISSANCE +.

The product is based on linear regulation products, with programmable resistance, current and power and high electrical performance to meet the requirements of the equipment incorporated into automatic test systems.

These products are made from 19 inch standard racks (total width 483 mm), 3U high (133 mm).

With a view to making the connection of these DC load easier and quicker, the system interface and RS232 connectors have been selected with screw and locking systems. The power connection of the load is done on the two copper bars.

Moreover, to ensure a maximum safety, the product is provided with different protections including severe conditions (temperature high environment, short circuit at the output, etc.):

- Auxiliary mains protection by fuse accessible on the rear panel,
- Power protection by internal fuse,
- Thermal protection against excessive heating of electronic power components by thermal protector with automatic re-engagement.

The DC load PL-2000-A is equipped with a user interface on a graphic touch screen positioned on the front panel for control and adjustment levels of resistance, current and power, as well as the functions of management.

A system interface connector provides two analogic inputs 0-10 V allowing a dynamic variation of the load.

The DC load is equipped with a forced ventilation low noise for extracting the heat generated internally by the various components. The rotational speed of the fans can be controlled through the user interface. The direction of ventilation is oriented to evacuate hot air from the front to the rear of the rack.

The DC load can be used in:

- Local control:
  The control with graphics and touch screen device disposed in front panel gives access to all control functions and the display of measurements.
- Remote control:
  The control device includes an Ethernet TCP/IP and a RS232 interfaces for drive using the supervision PC. The control can be realised either by using the software Power Plus OPS3 (not provided), or directly via instructions TCP/IP or RS232.

3.2 Hardware description

3.2.1 Mechanical description

The DC load PL-2000-A is integrated in a rectangular frame with the following characteristics:

- Total height: 133 mm (3 U),
- Total width: 483 mm,
- Depth: 494 mm (excluding connectors and handles),
- Weight: 19 kg,
- Bottom cover: steel electro galvanized, 1.5 mm thick,
- Top cover: steel electro galvanized, 1.5 mm thick,
- Front panel: aluminum 4 mm hick, Surtec 650 black,
- Rear panel: aluminum 4 mm hick, Korundal black.

3.2.2 Front face description

The front face of the DC load includes various interfaces allowing the user to visualise the status of the DC load and to access to the various manual controls.

For this, it includes:

- A TFT 5.6 inch touchscreen (PL1). It allows the user to know the status and mode of operation of the DC load and to control the resistance, current and power levels,
- An ON/OFF switch (S1).

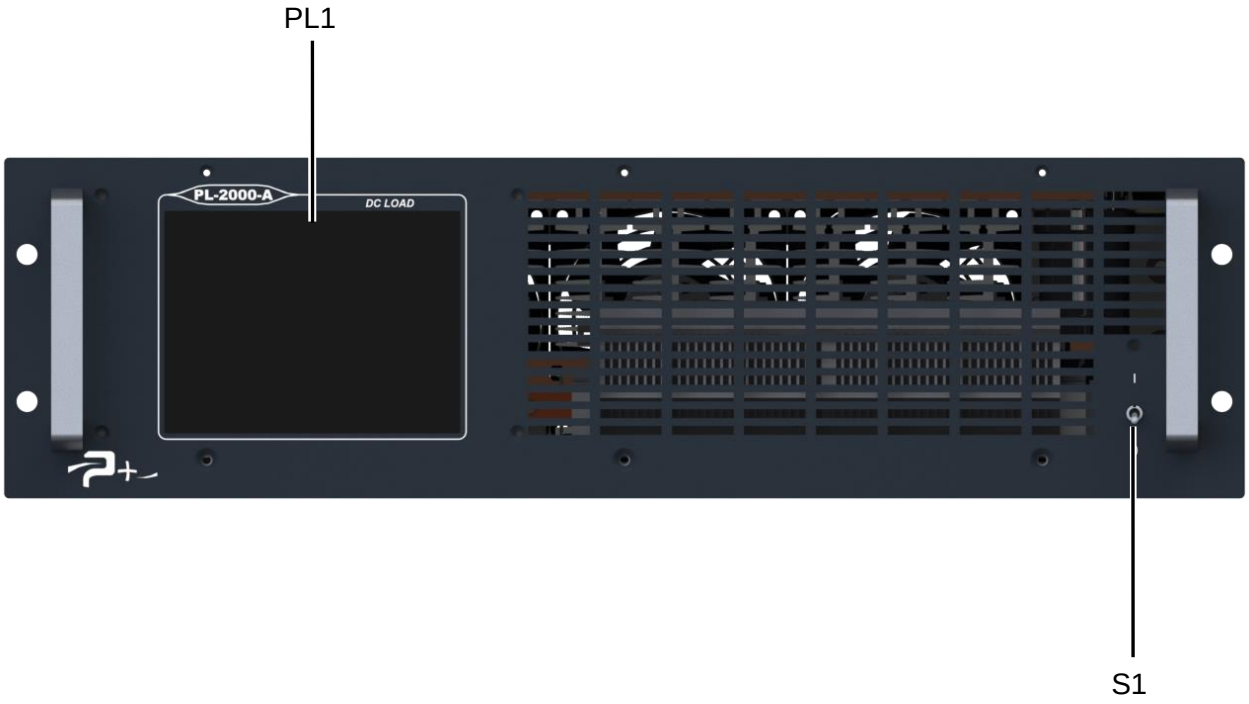


Figure 1 : DC load front face

3.2.3 Rear face description

The rear face of the DC load comprises the various interfaces to perform its electrical connection. It also includes the air outlet grids behind which the hot air exhaust fans are located.

These interfaces are:

- J1: Mains input connector protected by an integrated fuse,
- J3: System interface connector,
- J4: Ethernet TCP/communication connector,
- J7: RS232 connector,
- Positive power input (+): the copper bar has a section of 5x15mm, and is provided with a bore diameter 8.4 mm,
- Negative power input (-): the copper bar has a section of 5x15mm, and is provided with a bore diameter 8.4 mm,
- J11 and J12 connectors: SENSES input connections,

WARNING: In use the power outputs + and – must be protected by the provided cover.

- E1: General terminal mechanical ground to perform, for example, a separate wiring of earth in a bay.

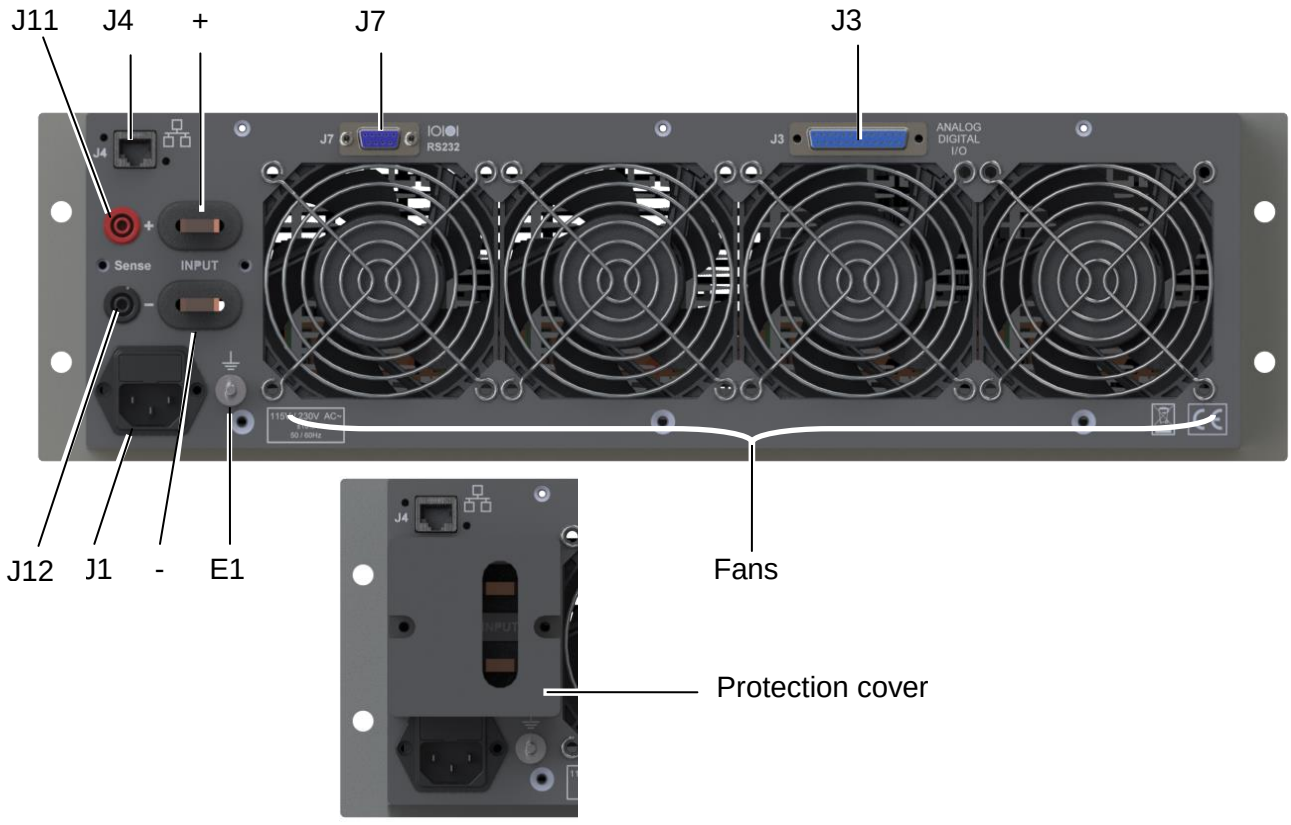


Figure 2 : DC load rear face

3.2.3.1 Mains input (J1)

J1 connector pin-out:

1 Phase
2 Neutral
3 Earth

3.2.3.2 System interface connector (J3)

J7 connector pin-out :

1 « Prog P »: voltage to program the power
2 « Pilot Out »: Pilot signal generated by the DC load
3 « Prog I »: current to program the current
4 Analog voltage reference (0V) for the points 1, 2, 3 and 5
5 Reference (+10V) for the external programming
6 Voltage image
7 Current image
8 Reference for the points 6 and 7

3.2.3.3 Ethernet connector (J4)

J4 connector:

- Receptacle: Amphenol MRJ-5780-01.
  RJ45 female 8 contacts, an Ethernet cable category 5 (at least) should be used for remote control using Ethernet TCP/IP.

3.2.3.4 RS232 connector (J7)

J7 connector:

- Receptacle: FCT F09S0G1A.

3.3 Functional description

The schematic diagram of this DC load is as follows:

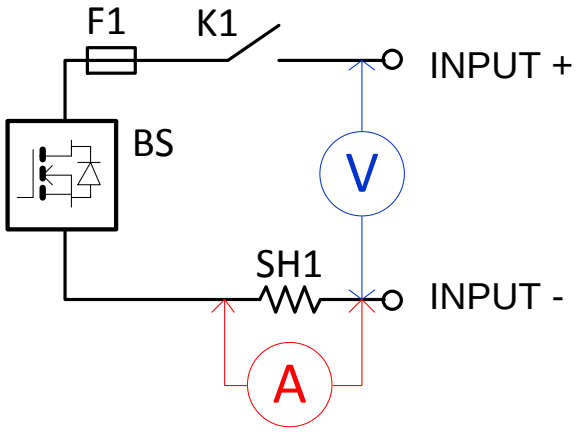


Figure 3 : Functional description

The contactor K1 allows the power on / off of the DC load. The DC load continuously measures the voltage on its input and the current through a shunt. The blocks of transistors BS regulate the load linearly according to the coupling mode:

- Current,
- Resistance,
- Power.

3.4 DC load use

3.4.1 Current regulation

The adjusted current is independent from the voltage applied to the load. The current control is active if the P or R mode does not impose a lower current.

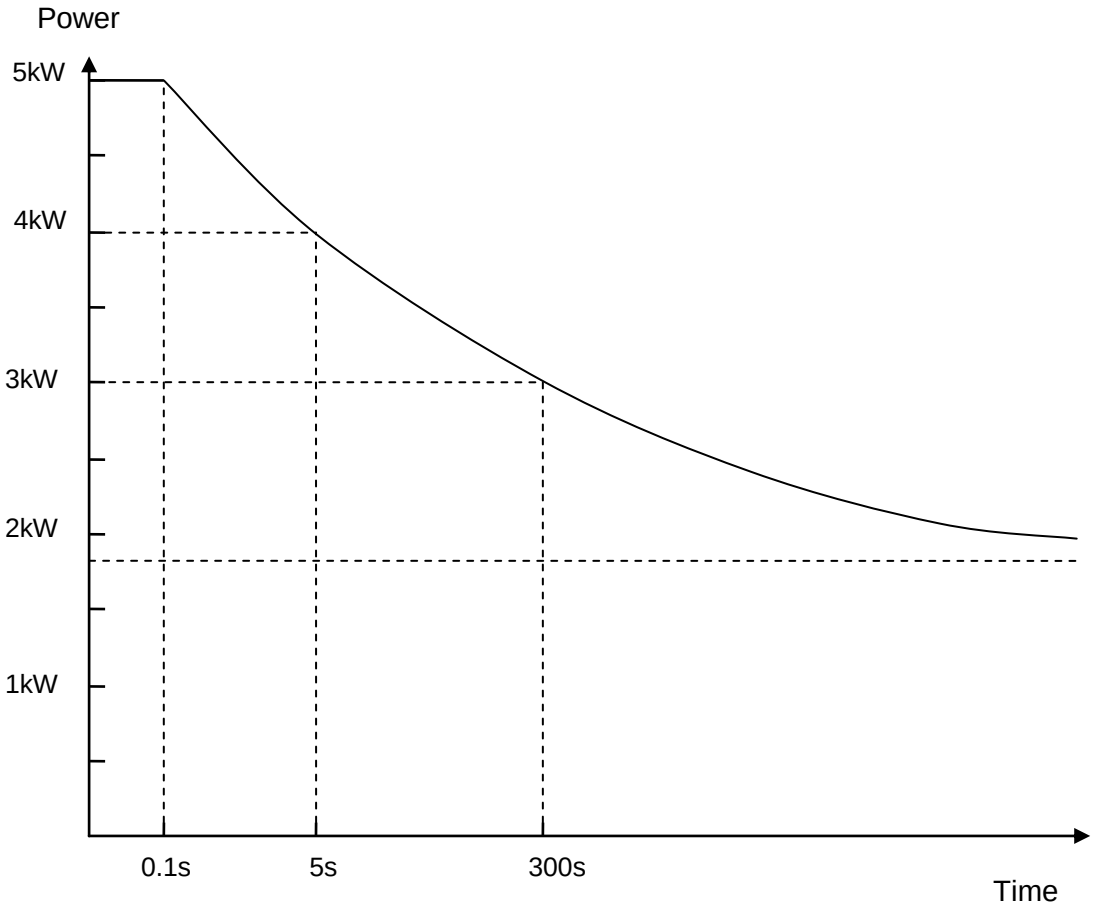
This parameter defines the maximum current of the load for the other modes of regulation.

3.4.2 Power regulation

The DC load measures the input voltage and absorbs a current, so that the power absorbed remains constant. If the voltage applied to the load decreases, the current increases and vice versa.

The power regulation is active if the I mode does not impose a lower current. This parameter defines the maximum power absorbed by the load in I mode.

The power is programmable from 0 to 5000W, the curve below gives the power limits according to the time. Above 1800 Watts, prolonged use may lead to thermal disjunction.



3.4.3 Resistance regulation

The current absorbed by the load corresponds to Ohm's law, it varies linearly with the voltage applied to the load.

The load is programmable in R mode from 0 to 2000Ω

3.4.4 Inrush voltage

Current will only be absorbed if the voltage applied to the load is greater than the inrush voltage.

3.4.5 Under voltage

When the voltage applied to the load drops below the programmed threshold the load is inhibited.

3.4.6 Over voltage

When the voltage applied to the load goes above the programmed threshold the load is inhibited.

3.4.7 Analog input control

In the constant current (CC) and constant power (CP) operating modes, the load setting can be performed by an external control signal. To do this, an analog voltage of 0-10V is required. This voltage must be applied to the J3 connector on the rear panel.
The maximum value (current 12A / 120A or power 5000W) will be reached for 10V. The regulated load level is proportional to the applied analog voltage level and will 'follow' the control signal with the maximum regulation speed.

Remarks:

In analog "current" control, programming of the P parameter remains active.
This parameter defines the maximum power absorbed by the load in I mode even in analog control.

3.5 Electrical characteristics

3.5.1 Main characteristics

Mains (50/60 Hz)	115Vrms or 230Vrms ±10%
Consumption	150VA
Dielectric strength: - mains input / ground - mains input / DC input - DC input / ground	 2000Vrms 2500Vrms 500Vrms
Insulation resistance under 500 VDC - DC input / ground	 > 100 MΩ
Cooling	Forced cooling with variable speed (air input on the front panel, air output on the rear panel)

3.5.2 Output characteristics

Power input specifications			
Voltage:		60V	
Current:		120A	
Permanent power @25°C:		1800W	
Peak power:		5000W	
Minimum voltage:		0.4V @ 120A	
Constant current mode (CC mode)			
Range 1 :	Range 2 :	0-12A	0-120A
Resolution :		3.0mA	30mA
Accuracy :		±0.1% (setpoint + range) for range 120A ±0.2% (setpoint + range) for range 12A	
Constant resistance modee (CR mode)			
Range 1 & Range 2:		0.0055-2000Ω	
Accuracy:		±2% consign I ≥ 10% range and U ≥ 10% range 0.5Ω ≤ R ≤ 50Ω for range 12A 0.05Ω ≤ R ≤ 5Ω for range 120A	
Constant power mode (CP mode)			
Range:		0-1800W	
Resolution:		1.8W	
Accuracy:		±0.5% (setpoint + range)	
Short-circuit mode (Short Mode)			
Resistance:		5.5mΩ ±0.25	
Current:		120Amax	
Voltage measurement			
Range:		60V	
Resolution:		0.015V	
Current:		±0,05% (reading + range)	
Current measurement			
Range 1 :	Range 2 :	0–12A	0-120A
Resolution:		3.0mA	30mA
Accuracy:		±0.2% (reading + range)	
Current image output			
Scale factor:		0.0794 ± 1.5%	
Voltage image output			
Scale factor:		0.158 ± 1.5%	

Tension d'enclenchement	
Range:	0-60V
Resolution:	0.1V
Accuracy:	±0.1% (adjustment + range)
Under voltage	
Range:	0-60V
Resolution:	0.1V
Accuracy:	±0.1% (adjustment + range)
Overvoltage	
Range:	0-60V
Resolution:	0.1V
Accuracy:	±0.1% (adjustment + range)
Dynamic	
10-90% / 90-10% (CC Mode)	≤550µs
Operation in dynamic mode (only in current mode)	
Square mode	
Level 1 / level 2 :	0-12A range 12A 0-120A range 120A
Level 1 duration / level 2 duration:	0,1ms – 1600ms
Rising slope :	1.2mA/µs – 1.2A/µs range 12A 12mA/µs – 12A/µs range 120A
Falling slope :	1.2mA/µs – 1.2A/µs range 12A 12mA/µs – 12A/µs range 120A
Sinusoïdal mode	
Idc :	0-12A range 12A 0-120A range 120A
Iac :	0-3App range 12A 0-30App range 120A
Frequency :	1Hz – 2000Hz

Remark:
Resistance mode can be used in both current ranges. It will be advisable to choose the most adapted range according to the application (no automatic change of range).

3.5.3 Environment

The specified accuracy is valid after 1/4 hour warm-up, at a temperature ambient of 23 ± 5°C and humidity ambient range between 20% and 80%, non-condensing.

The DC load is equipped with a forced ventilation system. Fresh air is drawn in from the front panel; the hot air is expelled through the rear fans grids.

4. INSTALLATION AND IMPLEMENTATION

4.1 General information

The DC load is equipped with two handles on the sides for easy transport.

It is recommended not to block the ventilation grids located on the front and on the rear of the DC load. Obstruction of these grids would result in an increase of the temperature inside the DC load and therefore a risk of malfunction.

4.2 Inspection the unit

When you receive your DC load, inspect it for any obvious damage that may have occurred during shipment. Carry out a quick appearance check of connector's condition to find any possible defects (connector shell broken, contacts twisted, coaxial contacts damaged, foreign bodies in the connectors).

Until you have checked out the DC load, save the shipping carton and packing materials in case the unit has to be returned

4.3 Environment / ambient conditions of use

The DC load should only be used indoors, on a stable, horizontal and hard support, in a properly illuminated room. The temperature must be comprised between 0 and +35 °C.

4.4 DC load installation

If the DC load is installed in a test bench, the slides must be properly sized to support their weight.

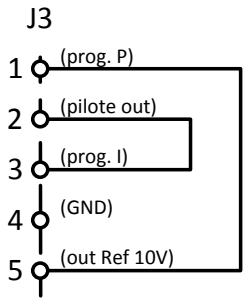
REMINDER: Take into account its high weight (approximately 19 kg). It must not be handled by a single person.

4.5 Implementation

4.5.1 System interface connector (J3) wiring

According to the wanted operating mode perform one the following DC load wiring:

- Operation with local or remote programming setpoints

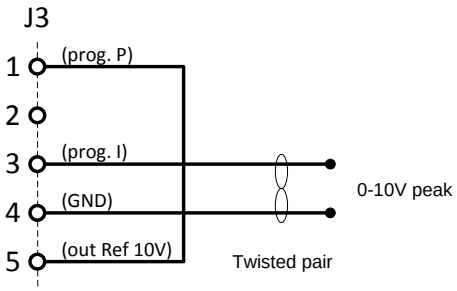


The two links are made inside the J3 connector.

Link between point 1 and point 5: the 10V voltage allows to use the full scale of programming in power.

Link between point 2 and point 3: the output of the internal driver allows varying the current in the load.

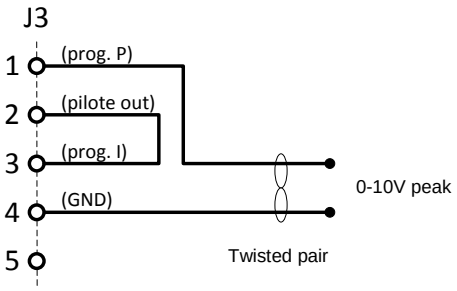
- Operation with external analog current setpoint



Link between point 1 and point 5: the 10V voltage allows using the full scale of programming in power.

The external driver of amplitude + 10V maxi allows varying the current in the load. In this case, the current programming on the front panel touch screen is inactive.

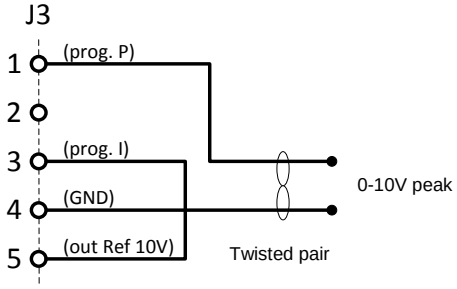
- Operation with external power analog setpoint (case # 1)



Link between point 2 and point 3 allows the programming of the current by the touch screen of the load

The external driver of amplitude + 10V maxi allows varying the power in the load, in proportion to the power programmed on the touch screen on the front panel.

- Operation with external power analog setpoint (case # 2)



The connection between point 3 and point 5 sets the current to the maximum of the selected range. It is no longer programmable.

The external driver of amplitude + 10V maxi allows varying the power in the load, in proportion to the power programmed on the touch screen on the front panel.

4.5.2 Senses use

The senses are intended to provide voltage measurement and power / resistance regulation at the connection points. These points can be connected to the power output, either locally or at the source to be loaded to compensate for the voltage drop online.

WARNING: When connecting the senses to the power output do not reverse the polarity.

CAUTION: The voltage measurement may be distorted by the position of the connection points of the senses with respect to the DC voltage source which supplies the load.

4.5.3 On/Off procedure

Once all the operations necessary for the implementation done, you can turn on the power. To do this, set the power-on switch on front side up.

Loading starts for about 7 seconds, during which time the screen remains dark and ventilation does not work.

After starting the DC load, check the result of the selftest on the screen (see 5.9 Status of DC load).

WARNING: It is imperative to stop the load by setting his instructions to zero before stopping with his switch.

To turn the power off, move the switch down.

4.5.4 Remote control

For operation with remote communication control Ethernet, the application manager communication must wait for complete starting of the DC load to start communicating.

Ethernet and RS232 protocols can be connected and used at the same time. Then, it is imperative to avoid conflicts between queries. If the same parameter is driven to different values, taken value will be that of the last command received.

5. USING THE DC LOAD

5.1 General

The specific functions of this DC load are accessible via its touch screen and provide access to advanced features of the DC load. The corresponding parameters are described § 6.4.

5.2 Using the touch screen

The DC load uses a control card fitted with a touch screen. This screen may be operated with a finger or a stylus by a “click” on the selected object.

Numbers are entered using a keyboard which is as follows:

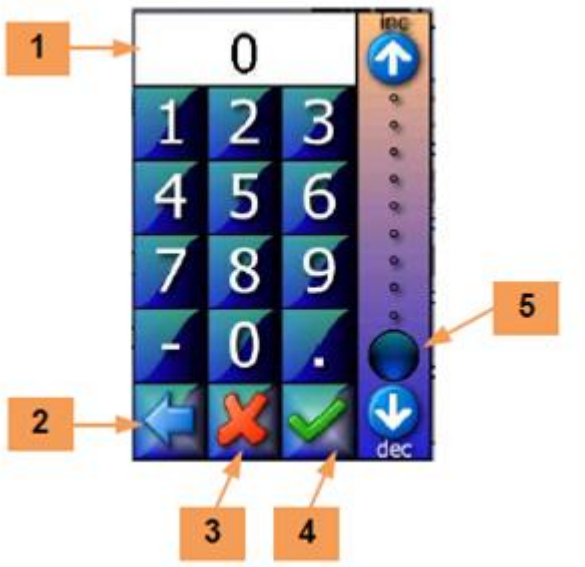


Figure 4 : Keyboard MMI

Field **1** receives the value entered. **2** button deletes the previous character.

The **3** button closes the window without validating. The **4** button validates data entry.

Scale **5** allows a summary entry of the value between 0 and 100% of the limits of the programmable parameter.

In case of failure or warning, the software displays a message on the touch screen in a message popup (for example):

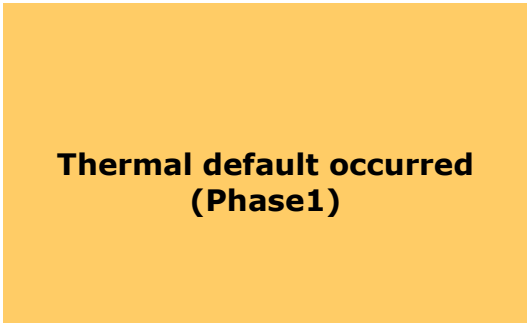


Figure 5 : Example of error message

The display remains in this status until the popup has not been acknowledged.

Acknowledge is done by a simple “click” on the popup.

If the fault disappears before acknowledge, the message changes to inform of the disappearance of the fault but the popup remains displayed: it must still be acknowledged. This principle allows knowing that a fault has been detected, although it has disappeared.

On the various screens appears the following button:

Figure 6 : Access to the general information MMI

Pressing this button displays:

- Coordinates of Puissance on **6** area,
- The name of the product in area **7**,
- The serial number of the product in area **8**,
- The revision of software installed in area **9**.

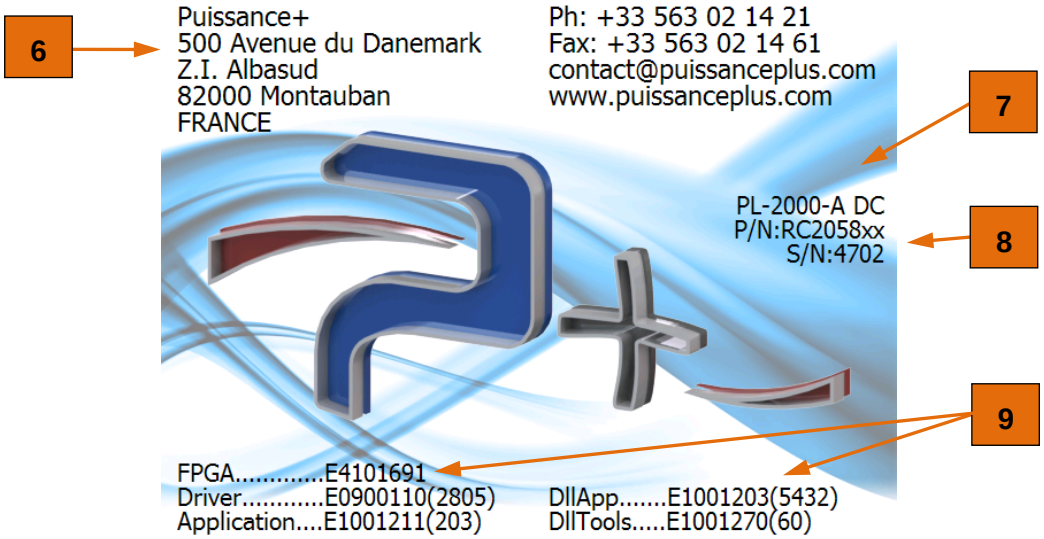


Figure 7 : General information MMI

A “click” on this screen clears it and returns to the previous screen.

5.3 Start screen

When the DC load starts, the following screen is displayed:

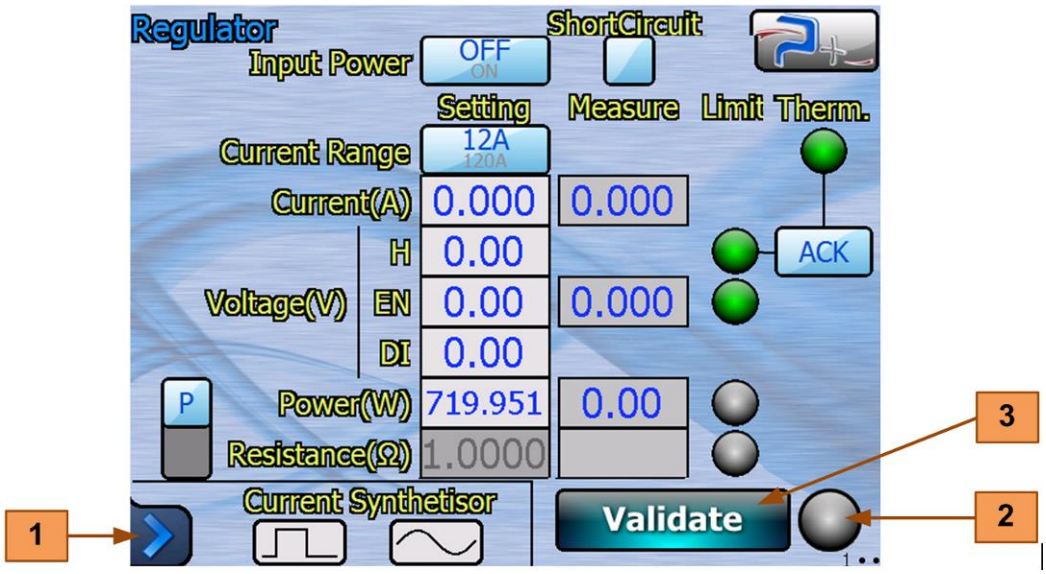


Figure 8 : Start screen

The button **3** validates the modifications made on programmable parameters.

The light **2** displays the status of the system:

- Light **Green**: no fault has been detected,
- Light **Gray**: modification has not yet been validated,
- Light **Blue**: modification in progress,
- Light **Red**: a failure has occurred.

The blue arrow **1** in the lower left corner of the screen gives access to the general menu (see § 5.4 General menu).

5.4 General menu

This menu is opened clicking the blue arrow **1** in the lower left corner (see 5.3 Start screen).

The general software menu is divided in three main tabs:

- Tab "**PL-2000-A DC…**" **4** displaying the buttons giving access to the DC load settings (see 5.4.1 “PL-2000-A DC…” tab).
- Tab "**System…**" **8** displaying the functions which can be configured to control the DC load (see 5.4.2 “System…” tab),
- Tab "**Maintenance…**" **14** providing access to the “factory setup” of the system. This access is password-protected and reserved for Puissance +.

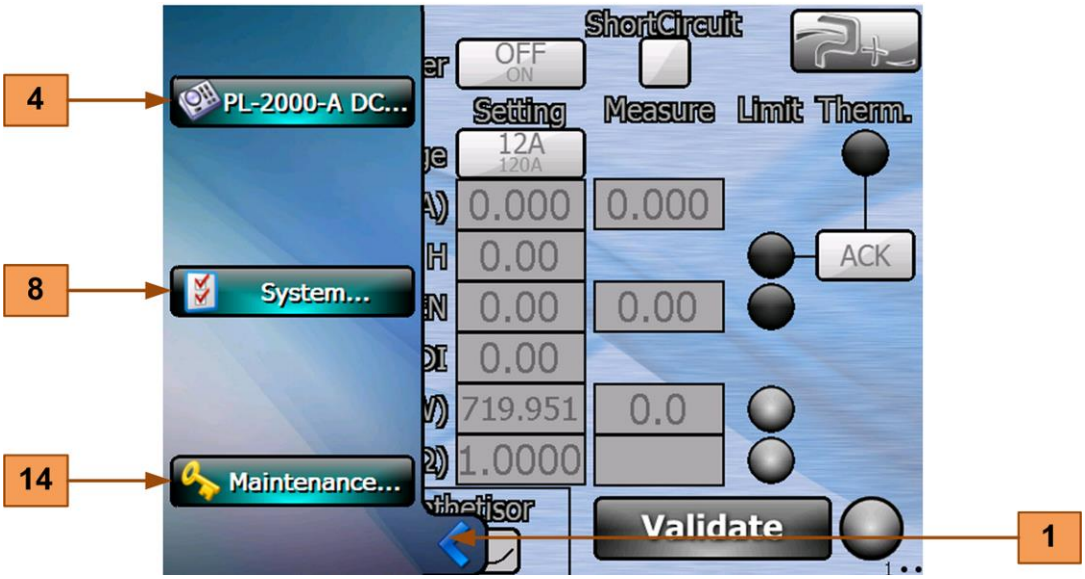


Figure 9 : General menu

The blue arrow **1** in the lower left corner of the screen returns to the previous screen.

5.4.1 "PL-2000-A DC…" tab

The "**PL-2000-A DC…**" tab gives access to the three main screens:

- **Regulator** **4** to program the DC load (see § 5.5.1 DC load programming),
- **PulseSynth** **5** to configure the current square pulse (see § 5.5.2 Square current pulse programming (PulseSynth)),
- **RippleSynth** **7** to configure the sinusoidal current ripple (see § 5.5.3 Sinusoid current ripple programming (RippleSynth)),

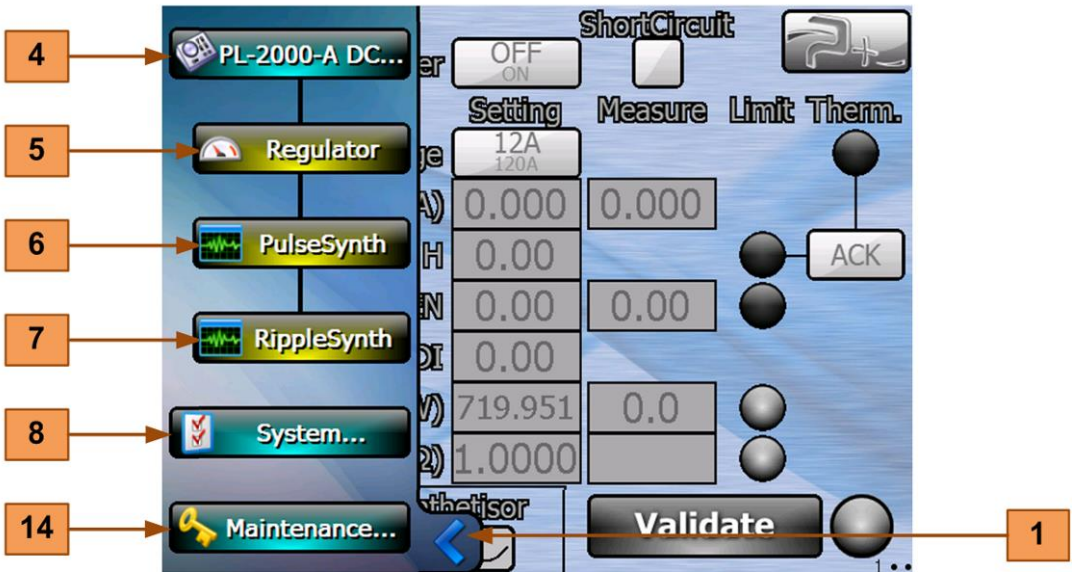


Figure 10 : PL-2000-A DC… menu

5.4.2 “System…” tab

The “**System…**” tab comprises the buttons giving access to the configuration screens of the different controls of the DC load. The five configuration screens are:

- "**Ethernet**" screen, accessible using **9** button, allows the configuration of the Ethernet link (see § 5.6 Setting of Ethernet link),
- "**RS232**" screen accessible using **10** button, allows the configuration of the RS232 serial link (see § 5.7 Setting of serial RS232 link),
- "**Fan Setting**" screen accessible using **11** button, allows the configuration of air forced cooling (see § 5.8 Fan settings),
- "**SelfTest**" screen accessible using **12** button, displays the result of the self-test of the source (see § 5.9 Status of DC load),
- "**Screen Calib.**" screen, accessible using the **13** button, allows the adjustment of the touch screen (see § 5.10 The configuration of the touch screen).

When one of these screens is displayed, the corresponding screen number appears at the bottom right (1 • • • • for the Ethernet screen and so on).

Note: Once the first configuration screen is displayed, switching to the following configuration screen may also be made by a horizontal sweep on the screen with a finger or a stylus.

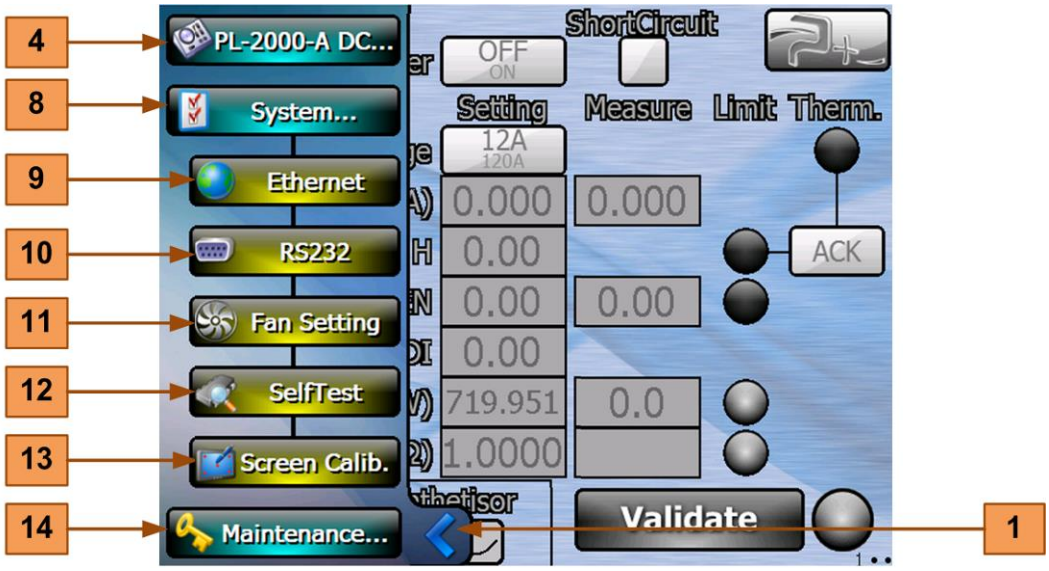


Figure 11 : System… menu

5.5 Using the DC load

5.5.1 DC load programming

This menu is opened clicking the **Regulator** button 5 described § 5.4.1 “PL-2000-A DC…” tab.

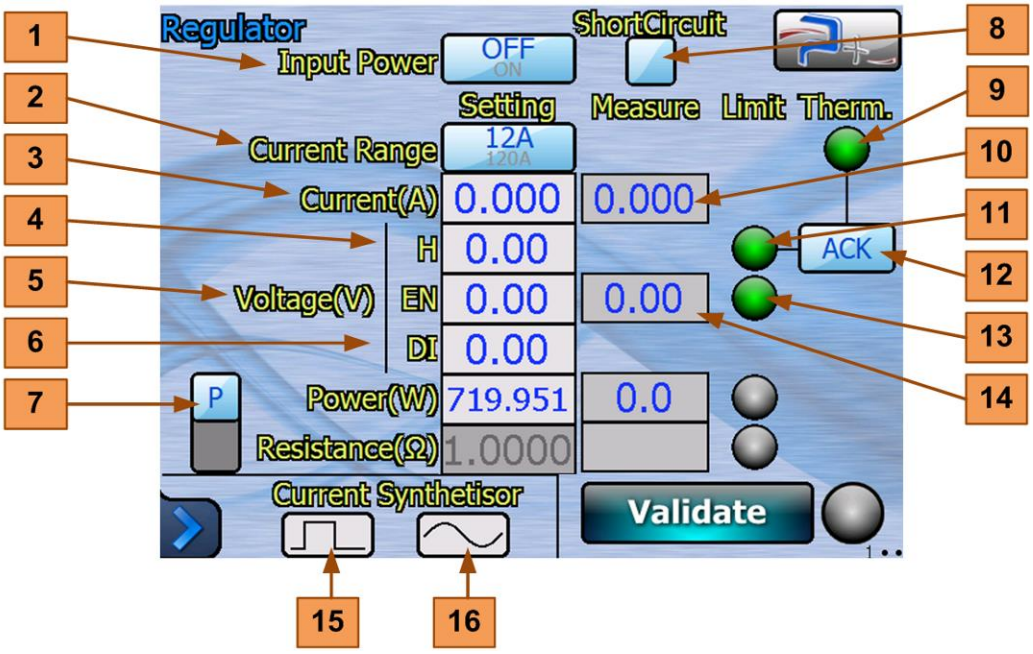


Figure 12 : DC load programming screen

The "**Input Power**" button 1 is used to close (ON text in blue) or to open (OFF text in blue) the DC load input relay. At startup, the relay is open

The "**Current Range**" button 2 selects the current range of the DC load, 12A or 120A, according to the type of limitation. The input area "**Current(A)**" 3 receives the setpoint value of the maximum current. The field 10 displays the instantaneous value of the current measured by the DC load.

The "**Voltage(V)**" input fields marked "**H**" 4, "**EN**" 5 and "**DI**" 6 receive the voltage setpoints. The aim of these three fileds is as follows:

- The field "**EN**" (enable) 5 defines the start threshold of the load: as long as the voltage is below this threshold, the load does not start, the indicator light 13 is off (gray). It lights green as soon as the input voltage is higher than the programmed threshold,
- The field "**H**" (high) 4 defines the threshold of DC load high cutoff: if the voltage becomes higher than this threshold, the load is cut off. The indicator light 11 will then illuminate red and the message "**OverVoltage occured**" is displayed. In order to use the load again, the user must acknowledge the fault by pressing the "**ACK**" button 12,
- the field "**DI**" (disable) 6 defines the threshold of DC load low cutoff: if the voltage becomes lower than this threshold, the load is cut.

Thus, the "H" threshold must always be greater than the "EN" threshold. The "EN" threshold must always be greater than the "DI" threshold. Otherwise, the DC load does not work.

The field 14 displays the instantaneous value of the voltage measured by the DC load.

The button **7** allows you to choose the type of regulation: power (P) or resistance (R) see following paragraphs.

The "**Short Circuit**" check box **8** activates the short-circuit mode: the load has a resistance of 3.0 ± 1 mohm. In this configuration, the programming of ranges, voltages and waveforms are greyed out (inaccessible).

The "**Therm**" light indicator **9** normally lit green. In case of overheating of the power elements, this indicator lights up in red and the DC load switches off instantly. The user is notified by the display of the message "**Thermal Default**".

He must wait for the load to cool down. This results in the green lighting of this indicator. However, in order to use the load again, the user must acknowledge the fault by pressing the "**ACK**" button **12**.

The button **15** allows programming a square current ripple (see 5.5.2 Square current pulse programming (PulseSynth)).

The button **16** allows programming a sinusoidal current ripple (see 5.5.3 Sinusoid current ripple programming (RippleSynth)).

When these waveforms are used, the buttons **15** and **16** are displayed with a green background.

5.5.1.1 Analog input use

The inputs available on the J3 connector on the DC load rear panel allow the DC load control by an analog setpoint.

This operation is not possible in "**Resistance**" configuration.

The "**Current**" input, available between points 3 and 4 of J3, allows you to program the current from 0 to 100% of the selected range.

The "**Power**" input, available between points 1 and 4 of J3, allows you to program the power from 0 to 100% of the selected range.

5.5.1.2 "Power" regulation configuration screen

The button **7** is used to select the type of control: power (**P**) or resistance (**R**).

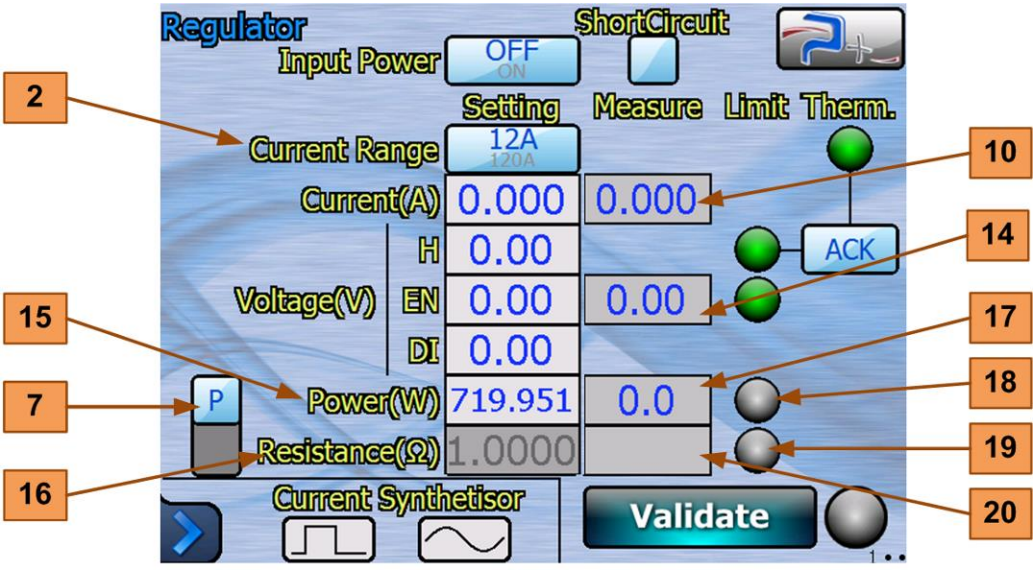


Figure 13 : Power regulator mode programming screen

The field "**Power(W)**" **15** is programmable (it is no longer grayed out). It allows programming the power:

- From 0 to 720 W if "**Current Range**" **2** is "12A",
- From 0 to 5000 W if "**Current Range**" **2** is "120A".

The field **10** displays the instantaneous value of the current measured by the DC load.

The field **14** displays the instantaneous value of the voltage measured by the DC load.

The field **17** displays the instantaneous value of the power dissipated by the DC load.

The light indicator **18** is normally off. It lights up red if the instantaneous power exceeds the programmed value.

5.5.1.3 "Resistance" regulation configuration screen

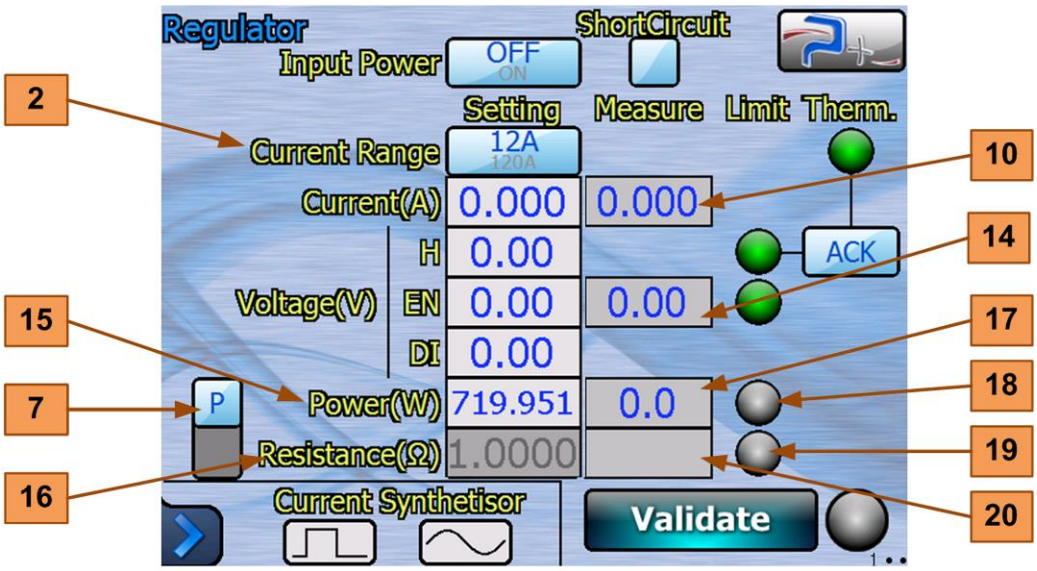


Figure 14 : Resistance regulator mode programming screen

The field "**Resistance(Ω)**" **16** is programmable (it is no longer grayed out). It allows programming the resistance from 0 to 2000Ω.

The field **10** displays the instantaneous value of the current measured by the DC load.

The field **14** displays the instantaneous value of the voltage measured by the DC load.

The field **20** displays the instantaneous value of the resistance simulated by the DC load.

The light indicator **19** is normally off. It lights up red if the instantaneous power exceeds the programmed value.

5.5.2 Square current pulse programming (PulseSynth)

This menu is opened clicking either the **PulseSynth** button **6** described § 5.4.1 “PL-2000-A DC…” tab or the button **15** described Figure 12 : DC load programming screen.

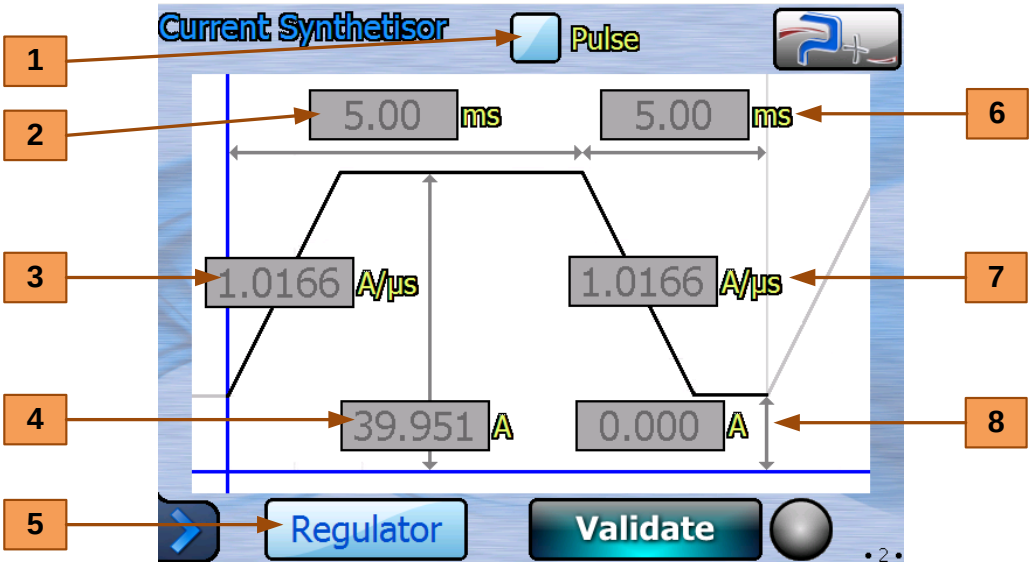


Figure 15 : Square current pulse programming screen

The checkbox "**Pulse**" **1** allows activating or deactivating its use.

The fields **2** (pulse width) and **6** allow to program the duration of the high level and the low level between 0 and 6553 ms.

The fields **3** and **7** allow to program the rise time and the fall time according to the current range:

- For the range "12A": between 0.0012 and 1.2 A / µs,
- For the range "120A": between 0.012 and 12 A / µs.

The fields **4** and **8** allow to program the high level and the low level according to the current range:

- For the range "12A": between 0 and 12 A,
- For the range "120A": between 0 and 120 A.

The "**Regulator**" button **5** returns to the general programming screen.

Note:

The pulse width is defined between the time the current starts to rise (beginning of the increasing ramp) and the time it starts to decrease (beginning of the decreasing ramp).

The accuracy on this width, provided to program a width multiple of the resolution step is ± 10µs. The programming resolution is 50µs on the 1st range (12 A) and 100µs on the 2nd (120A).

If the programmed value is different from a multiple of the resolution, the value taken into account will be the nearest multiple value: accuracy = ± 35µs for the 1st range and ± 60µs for the 2nd.

5.5.3 Sinusoid current ripple programming (RippleSynth)

This menu is opened clicking either the **RippleSynth** button **7** described § 5.4.1 “PL-2000-A DC…” tab or the button **16** described Figure 12 : DC load programming screen.

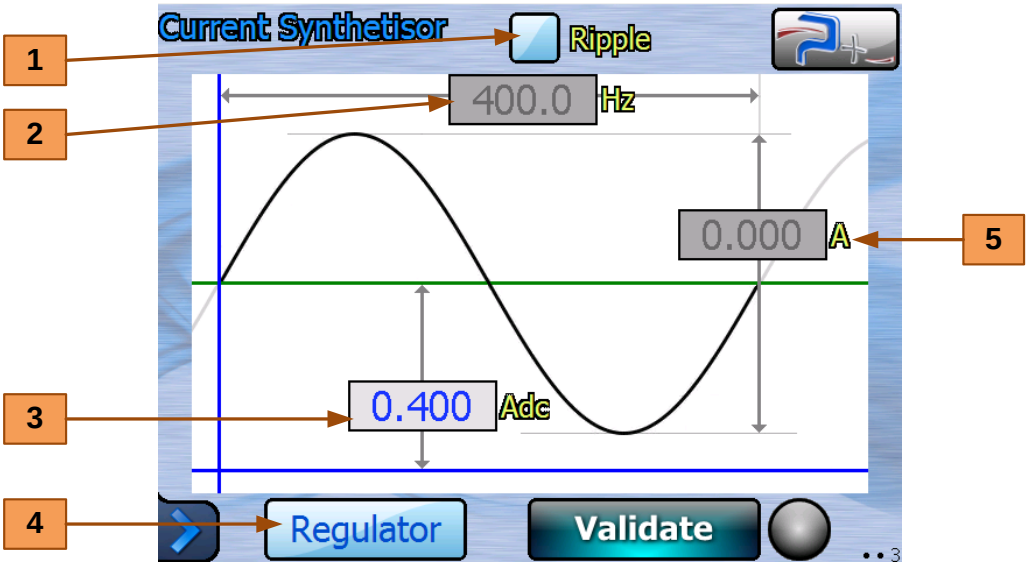


Figure 16 : Square current ripple programming screen

The checkbox "**Ripple**" **1** allows activating or deactivating its use.

The fields **2** allows to program the ripple frequency between 1 and 2000 Hz.

The fields **3** allows to program the offset according to the current range:

- For the range "12A": between 0 and 12 A,
- For the range "120A": between 0 and 120 A.

The fields **5** allows to program the peak to peak amplitude according to the current range:

- For the range "12A": between 0 and 3 A,
- For the range "120A": between 0 and 30 A.

The "**Regulator**" button **4** returns to the general programming screen.

5.6 Setting of Ethernet link

This menu is opened clicking the “**Ethernet**” button **1** described § 5.4.2 “System…” tab.

These parameters must be modified only in accordance with your network administrator

The button "**Touch Screen**" **1** of the panel below displays the operating mode, Local (Touch screen field = **Enable**) or Remote (Touch screen field = **Disable)**. The DC load switches to remote mode as soon as it receives a valid command frame.

In remote mode, the screens remain accessible but no command can be entered (a red indicator recalls it). Pressing this button allows to return to mode LOCAL (touch screen enabled).

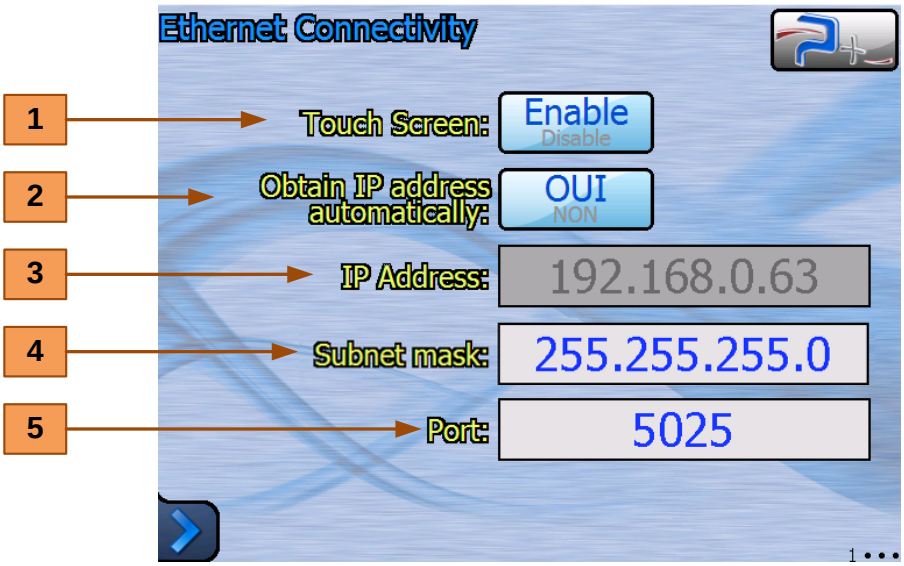


Figure 17 : Ethernet settings menu

The Button "**Obtain IP address automatically**" **2** selects the choice of assigning an IP address:

- Obtained automatically if **OUI** (DHCP mode),
- Manual specification if **NON**.

If the " **Obtain IP address automatically** " field **2** specification is manual, the input boxes “**IP Address**” **3**, and "**Subnet mask**" **4** must be filled.

Field “**Port**” **5** should be informed in all cases.

After changing one of these parameters, click the **Save** button to record your new configuration.

After recording, this new configuration will be taken into account only during a restart of the control card. It can be forced, without turning off the DC load, clicking the **RESET** button.

5.7 Setting of serial RS232 link

This menu is opened clicking the “**RS232**” button **3** described § 5.4.2 “System…” tab.

The button "**Touch screen**" **5** of the panel below displays the operating mode, Local (**Touch screen** field = **Enable**) or Remote (**Touch screen** field = **Disable**). The DC load switches to remote mode as soon as it receives a valid command frame.

In remote mode, the screens remain accessible but no command can be entered (a red indicator recalls it). Pressing this button allows to return to mode LOCAL (touch screen enabled).

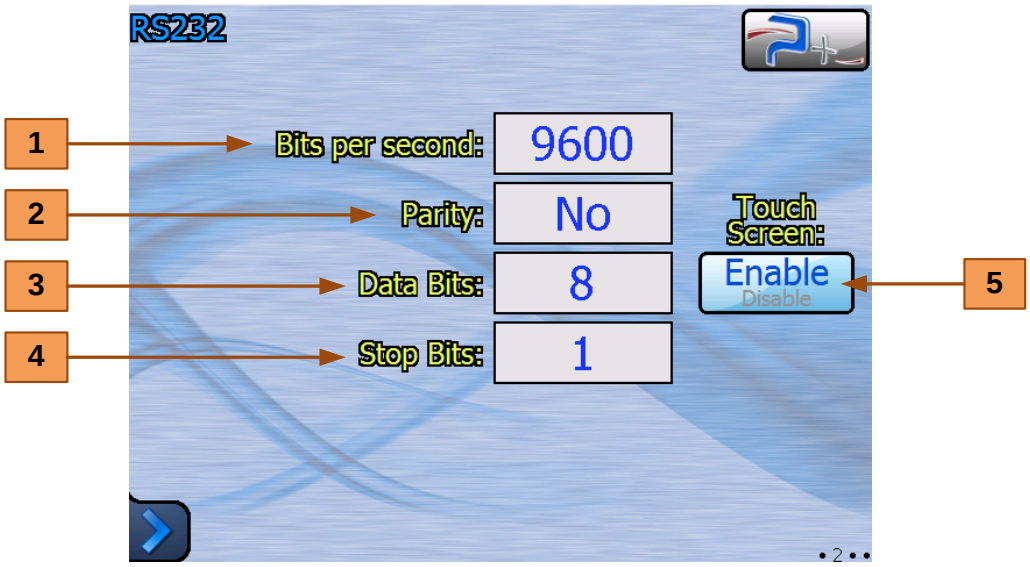


Figure 18 : RS232 settings menu

The “**Bits per second**” menu **1** selects the communications speed. The allowed values are 4800, 9600 (default), 19200, 38400, 57600 and 115200 baud.

The “**Parity**” **2** menu allows to set the parity among three possibilities:

- “**No**” parity (default value),
- "**Odd**" odd parity,
- "**Even'** parity.

The menu "**Data Bits**" **3** lets choose the number of data bits among two possibilities:

- “**7**”,
- “**8**” (default value).

The “**Stop Bits**” menu **4** allows to choose the number of stop bits among three possibilities:

- "**1**" (default value),
- “**1.5**”
- “**2**”.

Taking account of the modifications is immediate and does not require a restart of the DC load. The changes are stored in non-volatile memory: they are kept upon the power-off of the DC load.

5.8 Fan settings

This menu is opened clicking the "**Fan Setting**" button **4** described § 5.4.2 "System…" tab.

This DC load manages the speed of the fans, from 0% to 100%, according to the temperature of the elements of power.

The box "**Thermal(°C)**" **1** allows the input of the expected temperature. As soon as the indicator exceeds this value, fans start.

The boxes "**Kp**" **2** and "**Ki**" **3** are for fans speed.

The boxes "**Fan min speed(%)**" **4** and "**Fan max speed(%)**" **5** are maximal and minimal values of fans speed.

The indicator "**Fan speed(%)**" **6** displays actual fans speed. The button **9** allows the fan activation/deactivation if "**Autospeed**" parameter is set to OFF.

The button "**Autospeed**" **7** allows to enable or disable automatic fans regulation. It may be interesting to force fans speed for more efficient cooling after a thermal alarm for example.

The indicator "**Measure**" **8** displays the actual temperature for each phases.

It is more efficient to use DC load with "Autospeed" ON.
A regulated ventilation too slightly will involve a more important risk of thermal alarm.

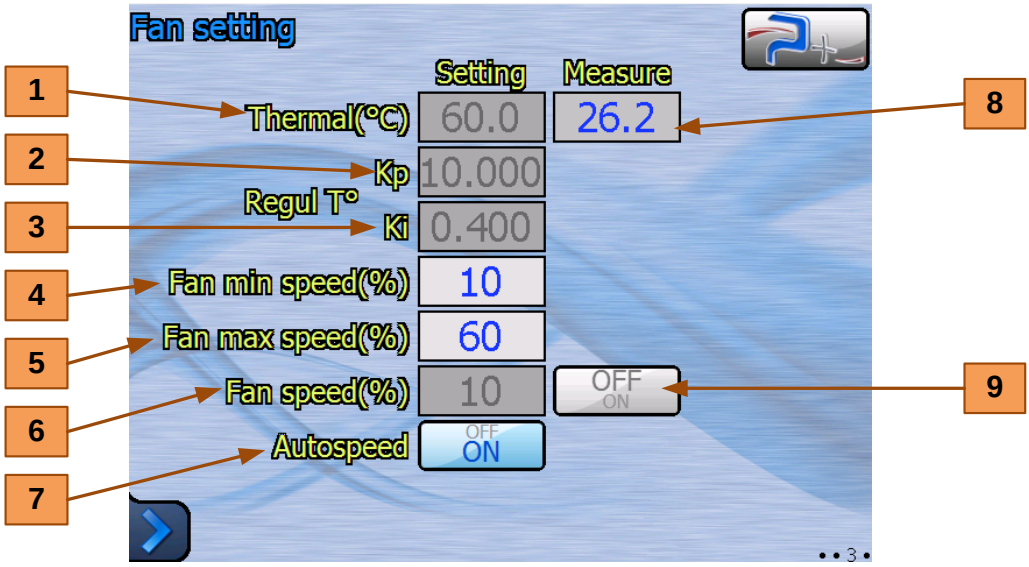


Figure 19 : Fan settings menu

5.9 Status of DC load

This menu is opened clicking the “**SelfTest**” button **5** described § 5.4.2 “System…” tab.

Light is green on normal operation, red in case of failure.

Light **1** is for the stage of amplification and regulation of the load.

Light **2** is for the generation card of the pilot signals.

This self-test is made only upon starting the software. It is necessary to restart the software to run a new self-test.

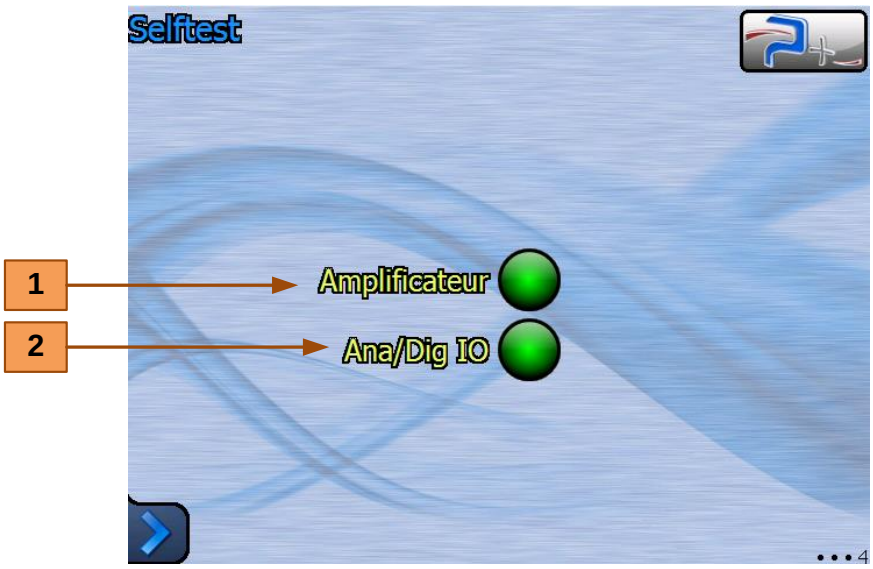


Figure 20 : Selftest menu

5.10 The configuration of the touch screen

This menu is opened clicking the "**Screen Calib.**" button **6** described § 5.4.2 "System…" tab.

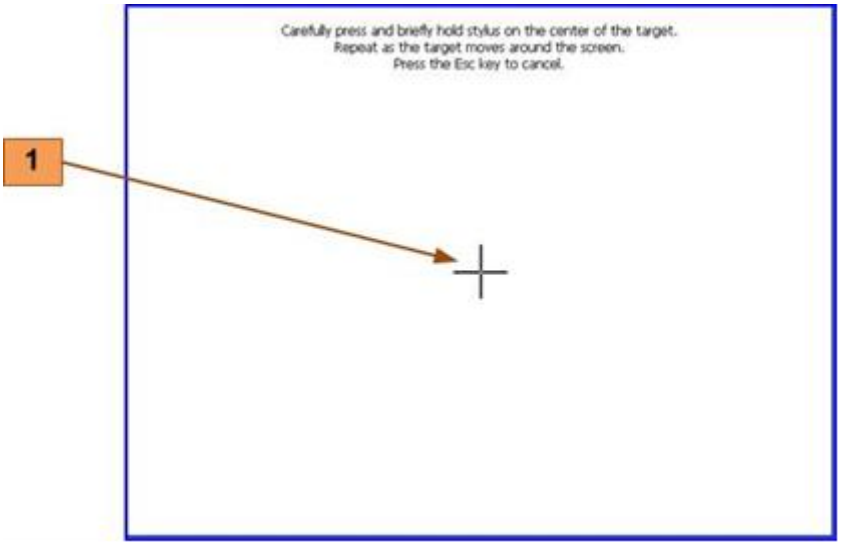


Figure 21 : Touch screen settings menu

The operator has just click the cross **1** which will appear in different places on the screen then to match the image to display with the size of the screen.

6. PROGRAMMATION

The remote control is performed using a TCP/IP communication on Ethernet bus or a serial communication on RS232.

6.1 Ethernet link

It is configured by the “Ethernet” page described in § 5.6 Setting of Ethernet link.

Ethernet is the physical standard used to transmit commands that can fly the generator via a LAN.

The instrument uses standard architecture client/server **TCP/IP WinSock** on the chosen port. The instrument behaves as a **Server**, to which equipment seeking to control the generator will come to connect as a **Client** by opening a **socket** communication.

The commands are ASCII strings transported on the TCP protocol.

6.2 RS232 link

Communication is configurable (speed, parity, data bits, stop bits) by the "Serial Port" page described in § 5.7 Setting of serial RS232 link.

The commands are ASCII character strings terminated with CR characters (ASCII code 0x13) and LF (ASCII code 0x10).

6.3 Programmables parameters for the Ethernet and RS232 links

They begin with the characters "P" and are positioned following the syntax:

➔ 'keyword = value' (followed by LF)

They are followed by a reply from the current generator:

🡐 'OK' (followed by LF) if the order is correct

or

🡐 "ERRxxx" (followed by LF) if the order is not correct. The error codes are described in § 6.5 List of error codes.

Coherence is in the format of the command: command is fully in (literal) standard.
Example for an analog value standard:

➔ P_123CurrLimit = 2.9 (followed by LF)

🡐 OK (followed by LF)

6.4 List of commands:

NOTE: Non-volatile configuration communication parameters: the set value is saved in non-volatile memory. The software takes this value each start or reboot. The "Default value" column shows values taken at each start or reboot.

Parameter Adr	Parameter Name	Panel	Possible Programming Values	Conversion Standard/hexa	Default value	Volatile
0h	P_SysDisplay	None	Regulator PulseSynth RippleSynth Ethernet RS232 Fan SelfTest CalibP+1 CalibP+2	Regulator/00h PulseSynth/01h RippleSynth/02h Ethernet/40h RS232/41h Fan/45h SelfTest/46h CalibP+1/50h CalibP+2/51h	Regulator	YES
1h	*RST	None	/	/	/	YES
2h	*IDN	None	PUISSANCE-PLUS,RC2058,0,E1001203 + E0900110 + E4101691 + E1001211 + E1001270	/	/	/
3h	OPC	None	No Yes	No/0000h Yes/0001h	Yes	YES
4h	P_InputPower	Regulator	OFF ON	OFF/0001h ON/0000h	OFF	NO
5h	P_ShortCircuit	Regulator	OFF ON	OFF/0001h ON/0000h	OFF	NO
6h	P_AmpliRange	Regulator	12A 120A	12A/0002h 120A/0001h	12A	NO
7h	P_Current	Regulator RippleSynth	*P_AmpliRange=12A* Min : 00.000A Max : 12.000A *P_AmpliRange=120A* Min : 000.00A Max : 120.00A	Hexa= PrAn*0FFFh/Max	00.00A	NO
8h	M_Current	Regulator	*P_AmpliRange=12A* Min : 00.000A Max : 12.600A *P_AmpliRange=120A* Min : 000.00A Max : 126.00A	ReAn= Hexa*Max/0FFFh		
9h	P_AckDefault	Regulator	OFF ON *Automatic reset to OFF*	OFF/0000h ON/0001h	OFF	NO
Ah	P_OverVoltLev	Regulator	Min : 00.00V Max : 60.00V	ReAn= Hexa*64/0FFFh	0	NO
Bh	M_OverVolt	Regulator	*(Red)* KO *(Green)* OK	KO/0000h OK/0001h		
Ch	P_EnableVoltLev	Regulator	Min : 00.00V Max : 60.00V	ReAn= Hexa*64/0FFFh	0	NO
Dh	M_EnableVolt	Regulator	*(Gray)* KO *(Green)* OK	KO/0000h OK/0001h		
Eh	P_DisablVoltLev	Regulator	Min : 00.00V Max : 60.00V	ReAn= Hexa*64/0FFFh	0	NO

Parameter Adr	Name	Panel	Possible Programming Values	Conversion Standard/hexa	Default value	Volatile
10h	M_Voltage	Regulator	Min : 00.000V Max : 64.000V	ReAn= Hexa*Max/0FFFh		
11h	P_RegulMode	Regulator	P R	P/0000h R/0001h	P	NO
12h	P_Power *Available when P_RegulMode=P*	Regulator	*P_AmpliRange=12A* Min : 000.00W Max : 720.00W *P_AmpliRange=120A* Min : 0000.0W Max : 5000.0W	*P_AmpliRange=12A* Hexa= PrAn*0FFFh/806.4 *P_AmpliRange=120A* Hexa= PrAn*0FFFh/8064	720.00W	NO
13h	M_Power	Regulator	*P_AmpliRange=12A* Min : 000.00W Max : 806.40W *P_AmpliRange=120A* Min : 0000.0W Max : 8064.0W	*P_AmpliRange=12A* Hexa= PrAn*0FFFh/806.4 *P_AmpliRange=120A* Hexa= PrAn*0FFFh/8064		
14h	M_PowerLimit	Regulator	*(Gray)* OFF *(Green)* ON	OFF/0000h ON/0001h		
15h	P_Resistance *Available when P_RegulMode=R*	Regulator	Min : 0000.0000Ω Max : 2000.0000Ω		1.0000Ω	NO
16h	M_Resistance	Regulator	Min : 00000.0000Ω Max : 99999.9999Ω			
17h	M_ResistLimit	Regulator	*(Gray)* OFF *(Green)* ON	OFF/0000h ON/0001h		
18h	M_ThermalState	Regulator	*(Green)* OK *(Red)* KO *(Green)* OK *(Green)* OK	OK/0000h KO/0001h OK/0002h OK/0003h		
19h	M_PulseState	Regulator	*(Gray)* OFF *(Green)* ON	OFF/0000h ON/0001h		
1Ah	M_RippleState	Regulator	*(Gray)* OFF *(Green)* ON	OFF/0000h ON/0001h		
1Bh	P_PulseEnable	PulseSynth	OFF ON	OFF/0000h ON/0001h	OFF	NO
1Ch	P_PulseLevel1	PulseSynth	*P_AmpliRange=12A* Min : 00.000A Max : 12.000A *P_AmpliRange=120A* Min : 000.00A Max : 120.00A	Hexa= PrAn*0FFFh/Max	0	NO
1Dh	P_PulseSlope1	PulseSynth	*P_AmpliRange=12A* Min : 0.0012A/µs Max : 1.2000A/µs *P_AmpliRange=120A* Min : 00.012A/µs Max : 12.000A/µs	Hexa= PrAn*3FFh/Max	1.2A/µs	NO
1Eh	P_PulseDur1	PulseSynth	*P_PulseDurResol=50us* Min : 0000.05ms Max : 3276.75ms *P_PulseDurResol=100us* Min : 0000.1ms Max : 6553.5ms	Hexa= PrAn*FFFFh/Max	1ms	NO
1Fh	P_PulseLevel2	PulseSynth	*P_AmpliRange=12A* Min : 00.000A Max : 12.000A *P_AmpliRange=120A* Min : 000.00A Max : 120.00A	Hexa= PrAn*0FFFh/Max	0	NO

Parameter Adr	Name	Panel	Possible Programming Values	Conversion Standard/hexa	Default value	Volatile
20h	P_PulseSlope2	PulseSynth	*P_AmpliRange=12A* Min : 0.0012A/µs Max : 1.2000A/µs *P_AmpliRange=120A* Min : 00.012A/µs Max : 12.000A/µs	Hexa= PrAn*3FFh/Max	1.2A/µs	NO
21h	P_PulseDur2	PulseSynth	*P_PulseDurResol=50us* Min : 0000.05ms Max : 3276.75ms *P_PulseDurResol=100us* Min : 0000.1ms Max : 6553.5ms	Hexa= PrAn*FFFFh/Max	1ms	NO
22h	P_RippleEnable	RippleSynth	OFF ON	OFF/0000h ON/0001h	OFF	NO
23h	P_Iac_AmplPkPk	RippleSynth	*P_AmpliRange=12A* Min : 0.000A Max : 3.000A *P_AmpliRange=120A* Min : 00.00A Max : 30.00A	*P_AmpliRange=12A* Hexa= PrAn*0FFFh/12 *P_AmpliRange=120A* Hexa= PrAn*0FFFh/120	0.0000A	NO
24h	P_Iac_Freq	RippleSynth	Min : 0001.0Hz Max : 2000.0Hz	Hexa= PrAn*FFFFh/6553.5	50.0	NO
25h	P_PulseDurResol	None	100us 50us	100us/0000h 50us/0001h	100us	NO
CDh	P_Validate	None	OFF ON *Automatic reset to OFF*	OFF/0000h ON/0001h	OFF	YES
CEh	M_Status	Calib	*(Red)* KO *(Green)* OK *(Gray)* Modified *(Bleu)* Running	KO/0000h OK/0001h Modified/0002h Running/0003h		
D0h	A_Amplifier	SelfTest	*(Red)* KO *(Green)* OK	KO:0000h OK:0001h		
D1h	A_AnaDigIO	SelfTest	*(Red)* KO *(Green)* OK	KO:0000h OK:0001h		
	P_FanAutoSpeed	Fan	OFF ON	OFF/0001h ON/0000h	ON	NO
	P_FanEnable	Fan	OFF ON	OFF/0001h ON/0000h	ON	NO
	P_FanMinSpeed	Fan	Min : 000% Max : 050%	Hexa= PrAn*64h/Max	0%	NO
	P_FanSpeed	Fan	Min : 000% Max : 100%	Hexa= PrAn*64h/Max	10%	NO
	P_FanMaxSpeed	Fan	Min : 050% Max : 100%	Hexa= PrAn*64h/Max	100%	NO
	M_ThermalValue	Fan	Min : 000.0°C Max : 100.0°C	ReAn= Hexa*Max/03FFh		
	P_ThermalSet	Fan	Min : 000.0°C Max : 100.0°C	Hexa= PrAn*0FFFh/Max	60°C	NO
	C_FanRegkp	Fan	Min : 000.000 Max : 100.000	/	10	NO
	C_FanRegki	Fan	Min : 000.000 Max : 100.000	/	0.5	NO

Parameter Adr	Name	Panel	Possible Programming Values	Conversion Standard/hexa	Default value	Volatile
E8h	P_RS232_Speed	RS232	4800 9600 19200 38400 57600 115200	4800:0000h 9600:0001h 19200:0002h 38400:0003h 57600:0004h 115200:0005h	9600	NO
E9h	P_RS232_Parity	RS232	No Odd Even	No:0000h Odd:0001h Even:0002h	No	NO
EAh	P_RS232_Data	RS232	7 8	7:0007h 8:0008h	8	NO
EBh	P_RS232_Stop	RS232	1 1.5 2	1:0000h 1.5:0001h 2:0002h	1	NO

Table 1: list of parameters or commands

6.5 List of error codes

Error codes

In the event of faulty operation, the generator returns an error in the form ERRxxx instead of OK.

Possible values are:

BAD_PARAMETER	ERR0x001
BAD_FORMAT_OR_COMMAND	ERR0x002
BAD_VALUE	ERR0x004
SYSTEM_ERROR	ERR0x008
SENDREAD_TIMEOUT	ERR0x010
DISABLED_PARAM_OR_CONNECT	ERR0x020
CKSUM_ERROR	ERR0x040
ID_ERROR	ERR0x080
ANOTHER_ACTION_RUNNING	ERR0x100
FPGA_FO_DEVICEIO_ERROR_CODE	ERR0x010000
FPGA_FO_BUSY_ERROR_CODE	ERR0x020000
FPGA_FO_NODATA_ERROR_CODE	ERR0x040000
FPGA_FO_TIMEOUT_ERROR_CODE	ERR0x080000

7. MAINTENANCE

7.1 Preventive maintenance

RISK OF ELECTRIC SHOCK: To prevent electrical shock, disconnect the DC load from the mains before cleaning and disconnect all the cables from the DC load.

Annually, perform the following:

- Clean the load:
  - Gently blow with compressed air (dry air **without oil**) in order to eliminate the dust accumulated in the grids.
    CAUTION: Too much air pressure can damage electrical connections,
- Check of the load general state (tightening of the covers and panels, holding and operating of connectors ...):
  - Check the operation of the fans,
  - Check the state of tightness of accessible electrical connections,
  - Check that there are no apparent anomalies (components, wires or connections overheated, blackened), or suspicious noise (fan, ...): contact Puissance + if necessary

7.2 Faults and Diagnostics

Symptoms	Possible causes
The action of the ON/OFF switch of the DC load has no effect.	1) The power cord is not locked. 2) The fuse is broken (located in the mains socket).
Display does not light up when the DC load is turned on.	1) The internal power supply fuse of the control board is broken
One of the lights is lit in red on the self-test screen.	1) The fiber optic link between the control board and the regulation board is faulty. 2) The power supply of the regulation board is faulty.
A "Thermal fault" indicator is lit in red on the measurement screen or the message "Thermal fault" appears on the display	1) The DC load ventilation is faulty (a fan no longer works). 2) The ambient air is too hot to cool the load properly. 3) Programming of the ventilation is insufficient.

8. STORAGE CONDITIONS

During storage, DC load should be stored in their original packaging with all guards in place. Accessories / cables or connectors must also be stored in the same package.

They must be stored on shelves, away from humidity and at a temperature between -10 ° C and + 65 ° C.

9. APPENDIX 1 : MECHANICAL DIMENSIONING

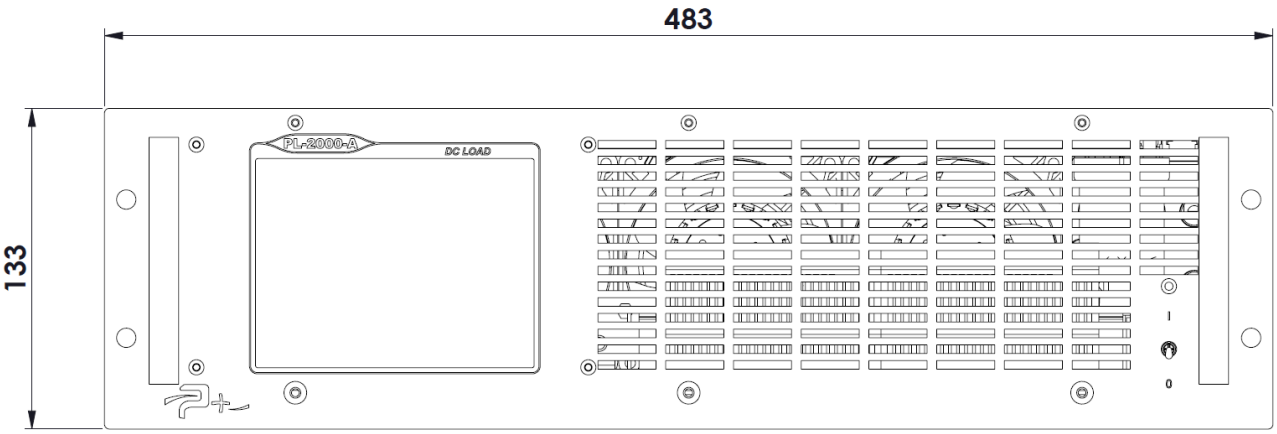


Figure 22 : Mechanical dimensioning – Front face

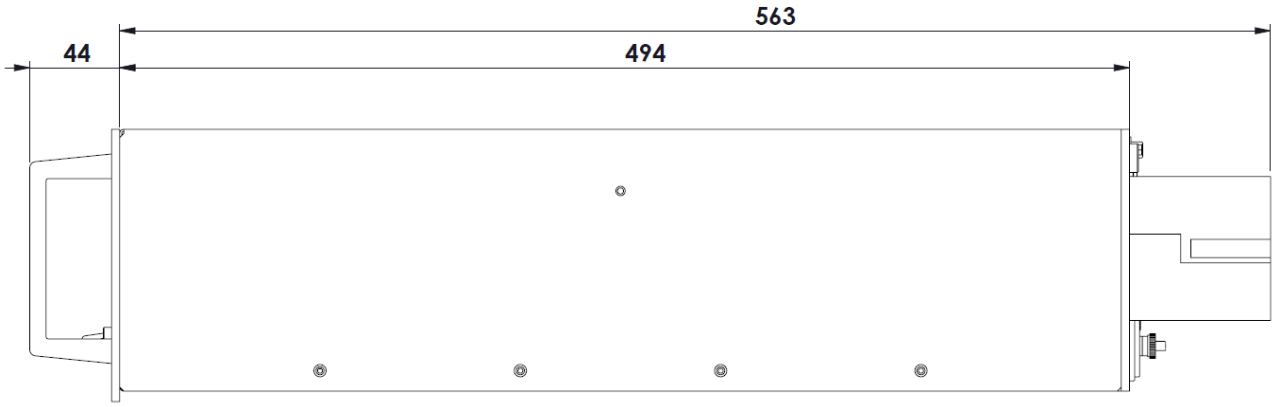


Figure 23 : Mechanical dimensioning – Side view