Power Supply Series

CAENels
Gear For Science

Remote Control Manual

MAGNET POWER SUPPLY SYSTEMS

Rev. 3.1 – July 2025

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Remote Control Manual – Models

This manual covers the following standard Power Supplies models:

- **FAST-PS**
- **FAST-PS-M**
- **FAST-PS-1K5**
- **NGPS**

Table Of Contents

Document Revisions

Revision	Date	Comment
0.3	April 11th 2016	Draft Release
1.0	June 30th 2016	First Public Release
1.1	July 27th 2016	Added FAST-PS-M Status Register
1.2	March 21th, 2017	Added NGPS Parameter table Fixed minor grammatical errors Fixed document layout
1.3	August 25th, 2017	Added “PID loops settings” section
1.3.1	September 15th, 2017	Added Solid State Relay behavior and command on FAST-PS-1K5 – Firmware 1.2.4 or later
1.4	November 15th, 2017	Added Auto shut down feature on Display
1.5	December 14th, 2017	New Visual window and features added
1.6	March 12th, 2018	New information added to the firmware update procedure
1.7	March 19th, 2018	Advanced Features section added Advanced Features Commands section added
1.8	May 6th, 2019	WAVEFORM:POINTS: command typographical error fixed
1.9	June 18th, 2019	New information added on custom waveform minimum and maximum period
1.10	December 12th, 2019	General reworking related to web server control
1.11	February 5th, 2020	“MSIG” and “MSIGPU” commands updated
1.12	June 19th, 2020	Added OverPower fault, DHCP commands, Wait for OFF, NTP server information, NAK table updated, WAVEFORM commands changed to WAVE commands
2	August 8th 2024	Updated address and revision numbering Updated sampling frequency features
3	January 17th 2025	Add Persistent Switch Command section
3.1	July 24th 2025	Fixed some minor errors

1. Overview

In this manual, the user can find all the information related to the dedicated high-level control and programming language.

Chapter 2 discusses in details the web server control, while chapter 4 the dedicated programming language. When the power supply is controlled via the web server or via programming language, possible operations are the same.

The main difference is that the programming language is a ready-to-use (ASCII-based) proprietary language which allows the user to perform specific routines for its specific application, this guaranteeing high freedom and flexibility.

2. Dedicated Software

The described utilities allow a user-friendly and fast access to the functionalities and configuration of the power module unit.

Two different software packages are available for operation with CAEN ELS power supplies: "*CAENels Device Manager"* and *"Visual"* Software. Both utilities can be downloaded free-of-charge from the CAENels website www.caenels.com. An overview of both utilities is given in the next sections.

2.1 CAENels Device Manager

The *"CAENels Device manager"* software can be used to detect:

- CAEN ELS devices described within this document and connected to the local network;
- Their network configuration;

The *"CAENels Device manager"* is available for Windows and Linux platform. The system requirements are:

1.  Windows minimum system requirements:
   - Windows® XP or newer
   - Intel® or equivalent processor
   - 70 MB available HD space
   - Ethernet network card

2.  Linux minimum system requirements:
   - Linux kernel 2.2.x or newer
   - Intel® or equivalent processor
   - 70 MB available HD space
   - Ethernet network card

2.1.1 Searching for connected devices

The following steps have to be performed in order to carry out a search of all the CAEN ELS units connected to the local network:

- Install the *"CAENels Device manager"* software;
- Launch the software;
- Perform a scan to discover the connected e.g. FAST-PS device(s) by clicking the *"Scan"* button as indicated in **Figure 1**. If there are multiple available connections it is possible to select the network/networks to be scanned in the *"Selected network interfaces"* window available under the "*Options*" menu. All the information about the selected devices are shown in the right side of the main window.

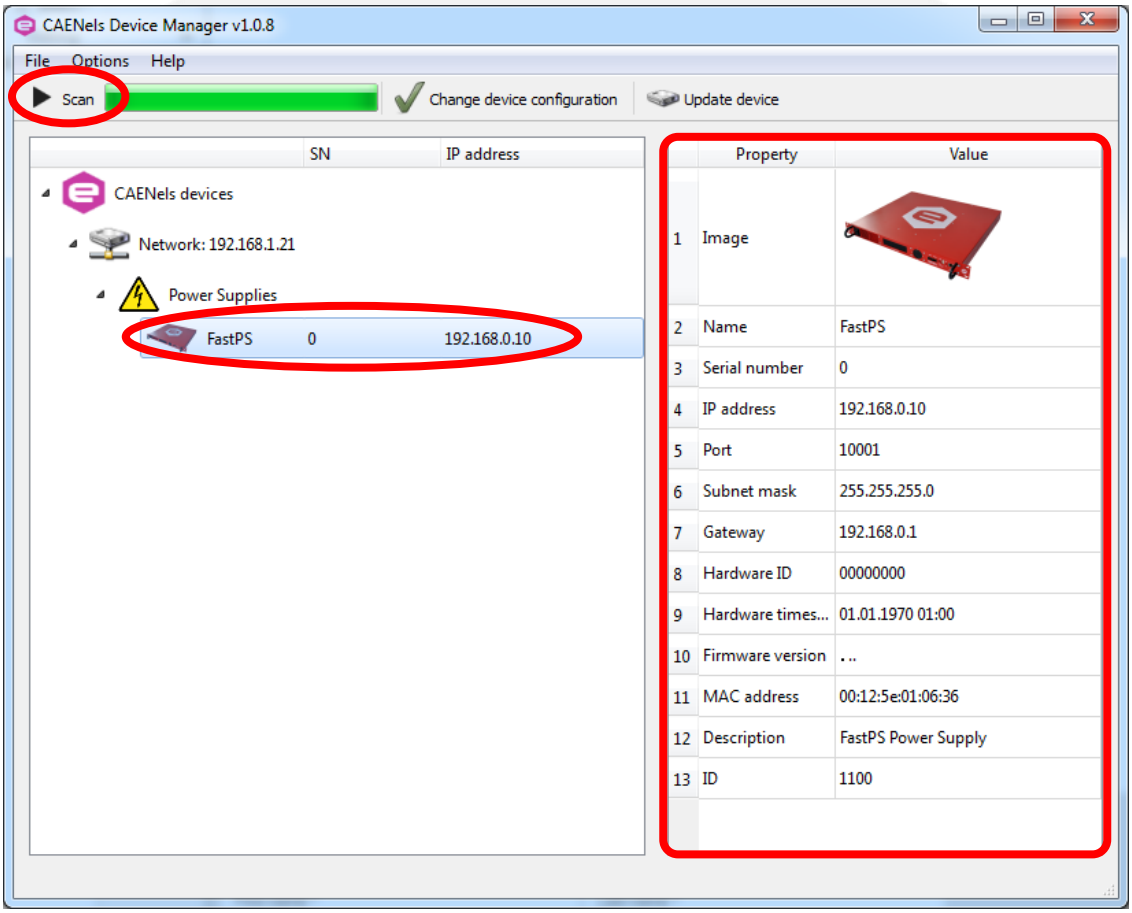


Figure 1: Device Manager - Main interface

Make sure that the firewall is not preventing communication between your computer and the unit(s). The "*CAENels Device manager*" uses **UDP port 30719** to find the device, so ensure that the UDP traffic is allowed in both directions on this port.

2.1.2 Device Configuration

The software allows also to change the Network configuration of the found device(s) in the local network.

In order to change the network configuration of the unit it is necessary to select the desired device and click on the "*Change device configuration*" button in the main window as shown in **Figure 2**. The configurable Network options are:

- Device IP address;
- TCP/IP communication port;
- Subnet mask;
- Gateway.

To apply the changes on the device configuration it is necessary to edit the corresponding fields and then to click on the "*Save*" button. A screenshot of a sample device configuration is shown in the following picture:

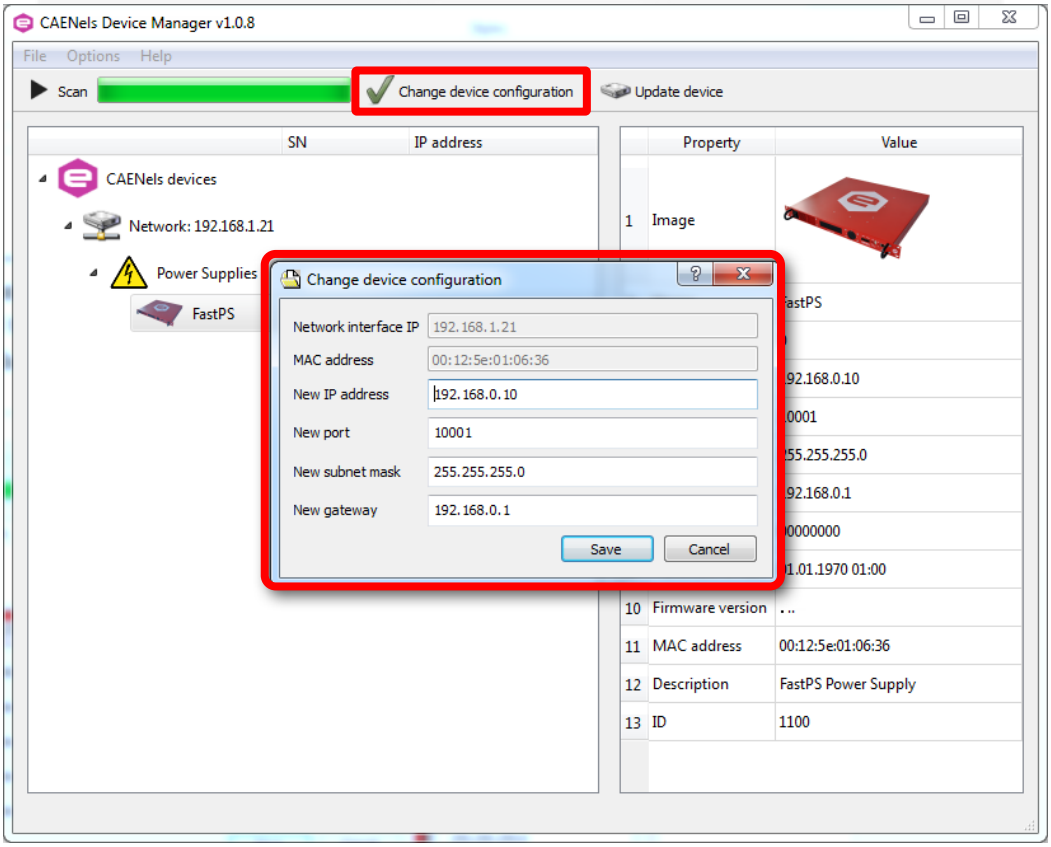


Figure 2: Device Manager - Change device configuration

3. Web Server

A running web server makes it easy to remote control the main features of the CAEN ELS power converters using a Graphic User Interface (GUI).

In order to establish connection with a power unit, be sure that the network configuration of the PC in use allows the connection to the module (same subnet of the power module). Then, it is necessary to type the power supply IP address in the web browser in order to connect to it:

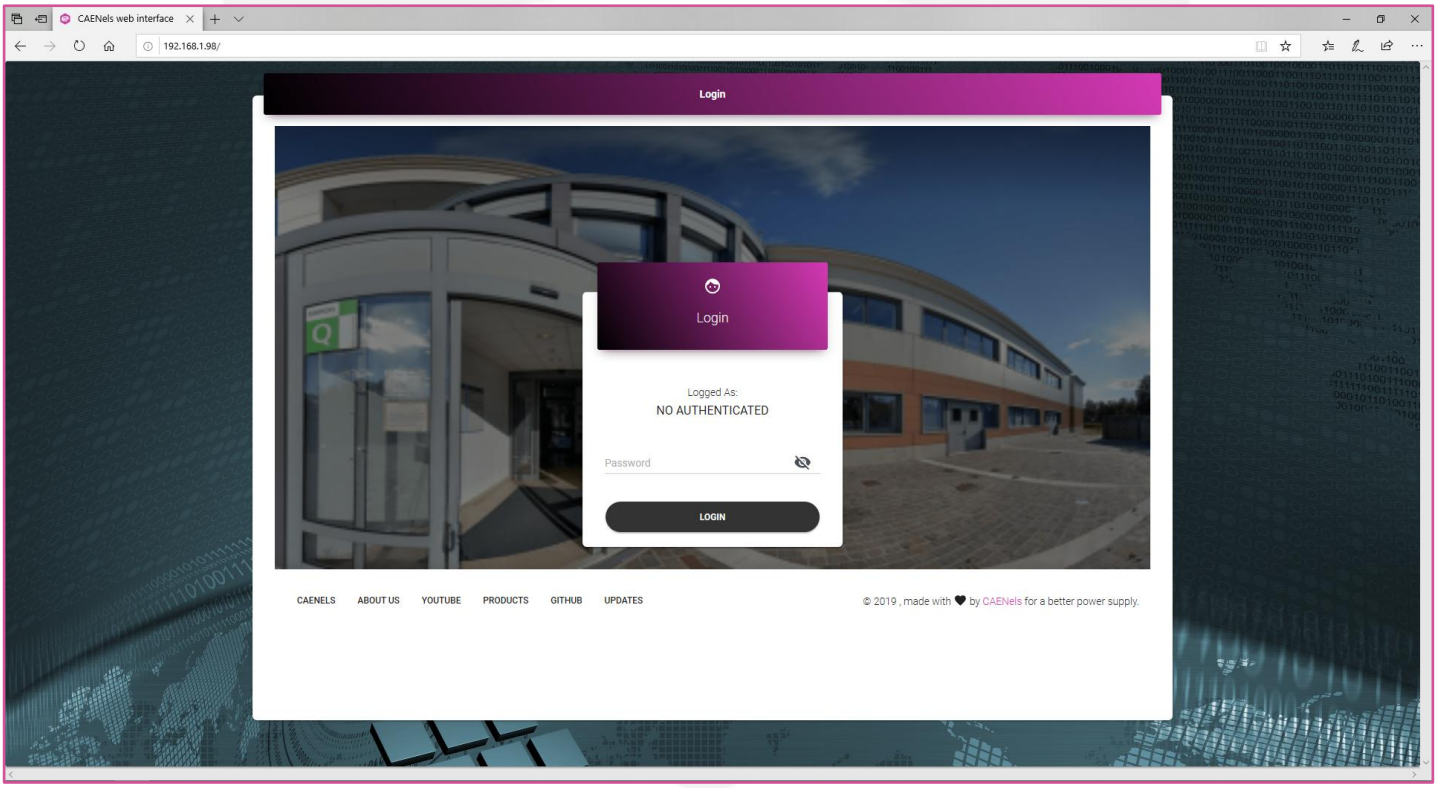


Figure 3: Web Server Login

When in the Login page as shown in **Figure 3**, set Password:

- “user”: for user privileges;
- “ps-admin”: for administrator privileges (unlock password protected memory cells);

In either case, some cells are locked as these are factory protected.

3.1 Main Windows

The web server main window is presented below:

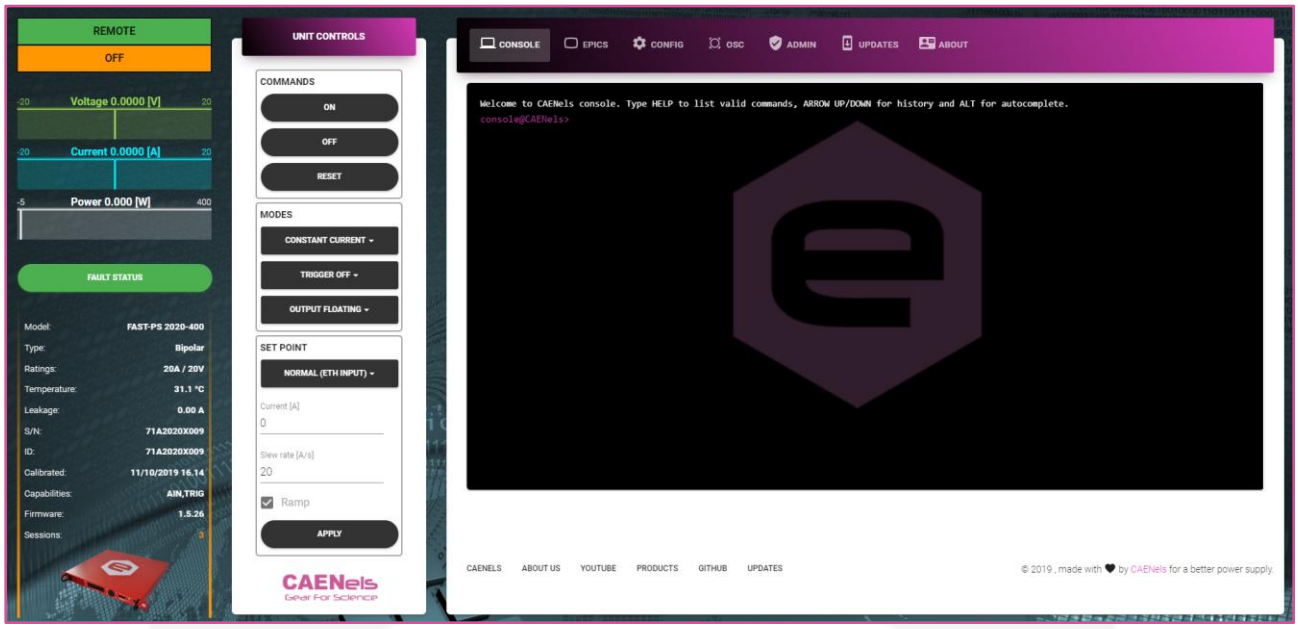


Figure 4: Web Server – Main Window

The "CONSOLE" is used to send direct commands to the power units, (refer to chapter 4 for the supported commands). In addition, by typing "clear", it is possible to reset the console, and by clicking Alt autocomplete of the commands is available.

On the left side, power supply information are reported:

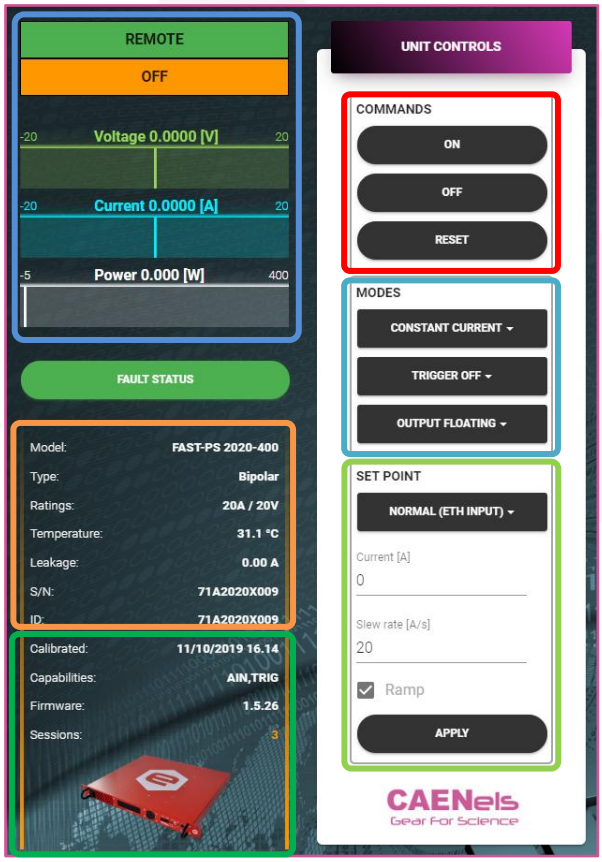


Figure 5: Web Server – Main Window Information

Unit Controls: allow to Switch ON/OFF the unit and to Reset its status register (in case of a fault).

Regulation mode: allows to select the mode of operation. The regulation mode can be changed only when the unit is switched OFF.

Voltage/Current Set section: this section allows to set the Voltage (for the "*Constant Voltage*" mode) or Current (for the "*Constant Current*" mode) setpoint. To apply a setpoint it is necessary to click on the *Ramp* or *Set* button. The *Ramp* button performs a ramp to the selected setpoint, otherwise the *Set* button applies directly the selected setpoint.

General information: indicates some information regarding the connected unit, like the model and its serial number.

Unit status: indicates some information regarding output status, temperature, current leakage, unit control (local or remote) and fault status. By clicking on the fault status indicator, it is possible to visualize detailed fault status windows.

Output monitor: indicates the actual output voltage, current and power.

3.1.1 Faults reset

Description of the possible faults per each power source can be found in the User's Manual of the power source itself, while the list only per each power source family can be also found at section 4.7 of this Manual.

If a fault happens, the "FAULT STATUS" green button in **Figure 4** and **Figure 5** will turn to red.

To understand the nature of the fault, please click on the red "FAULT STATUS" button, the web interface will show the fault.

In order to reset the fault and thus, to turn the power supply on again:

1. Remove the fault cause (e.g. in the case of earth fault check the earth fuse, eventually replacing it)
2. Click on the RESET button
3. Turn ON the power supply

3.1.2 Unit Controls

The "UNIT CONTROLS" window in **Figure 5** allows to turn the module ON/OFF and to reset eventual faults (when the "FAULT STATUS" widget in **Figure 5** is red). Refer to section 4.7 for further information on faults list.

3.1.3 Regulation Mode

The "MODES" window in **Figure 5** allows to select between two different control modes:

- Constant Current (CC): the module set-point is in [A]
- Constant Voltage (CV): the module set-point is in [V]

In addition, the user can select different triggering options:

- Off: no trigger is used
- Pos: positive edge is used
- Neg: negative edge is used
- Both: both edges (pos and neg) are used

Please refer to the User's Manual of the power source in use in order to have information on the HW operation of the trigger.

For further information on the chain from the trigger signal input to the power source output, refer to section 3.1.4.

In "MODES" window, the user can also select between output floating or grounded. Please refer to the User's Manual of the power source in use in order to have information on the maximum floating voltage allowed as well as instructions on how to set the HW for floating mode (earth fuse must be removed from the power unit).

3.1.4 Set Point Control Modes

CAEN ELS power units may be controlled in different ways:

- Normal: single set point
- Waveform: pre-stored and custom waveforms generation
- Analog: the power source acts as amplifier of an external analog input

In the following sections these three modes are discussed.

3.1.4.1 *Normal*

In this control mode the user can set a single set point. In order to do so, just type the desired value in [A] or [V] (depending on CV or CC, see section 3.1.3) and click “APPLY”:

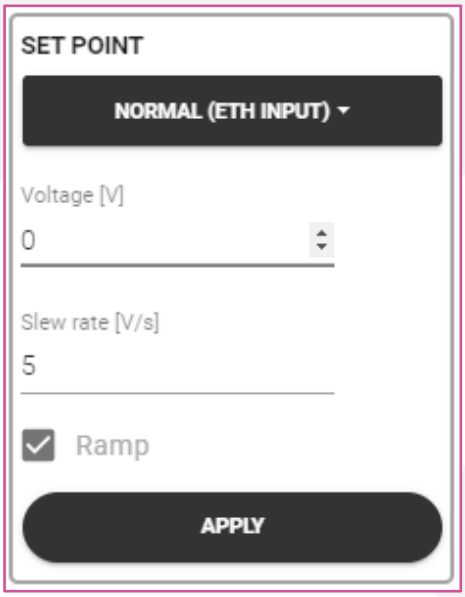


Figure 6: SET POINT – NORMAL

If “Ramp” is selected, the module will apply a specific A/s or V/s ramping to the setpoint (it may be changed by changing the Slew Rate value in **Figure 6**). The A/s or V/s default speed is stored in the internal memory (see section 3.3.3) and it is named “Defaul Current Slew Rate [A/s]” for CC and “Defaul Voltage Slew Rate [V/s]” for CV.

Please note that the maximum current slew rate is equal to the current full scale times ten, and the voltage one is equal to the voltage full scale times ten.

3.1.4.2 *Waveform*

An embedded waveform generator may be used for set-points generation. The arbitrary waveform generator uses a DMA (Direct Memory Access) module to reproduce the waveform's setpoints which are stored in a physical memory, this zeroing the latency time TCP or even UDP protocols would bring.

Figure 7: SET POINT – WAVEFORM

By clicking "EDIT" (**Figure 7**) the user can select between 4 different waveforms:

- Sine Wave
- Square Wave
- Triangular Wave
- Custom Wave

In the following pages these 4 waveforms are discussed.

Sine Wave

Once sine wave is selected, the below page will be accessed on the web server:

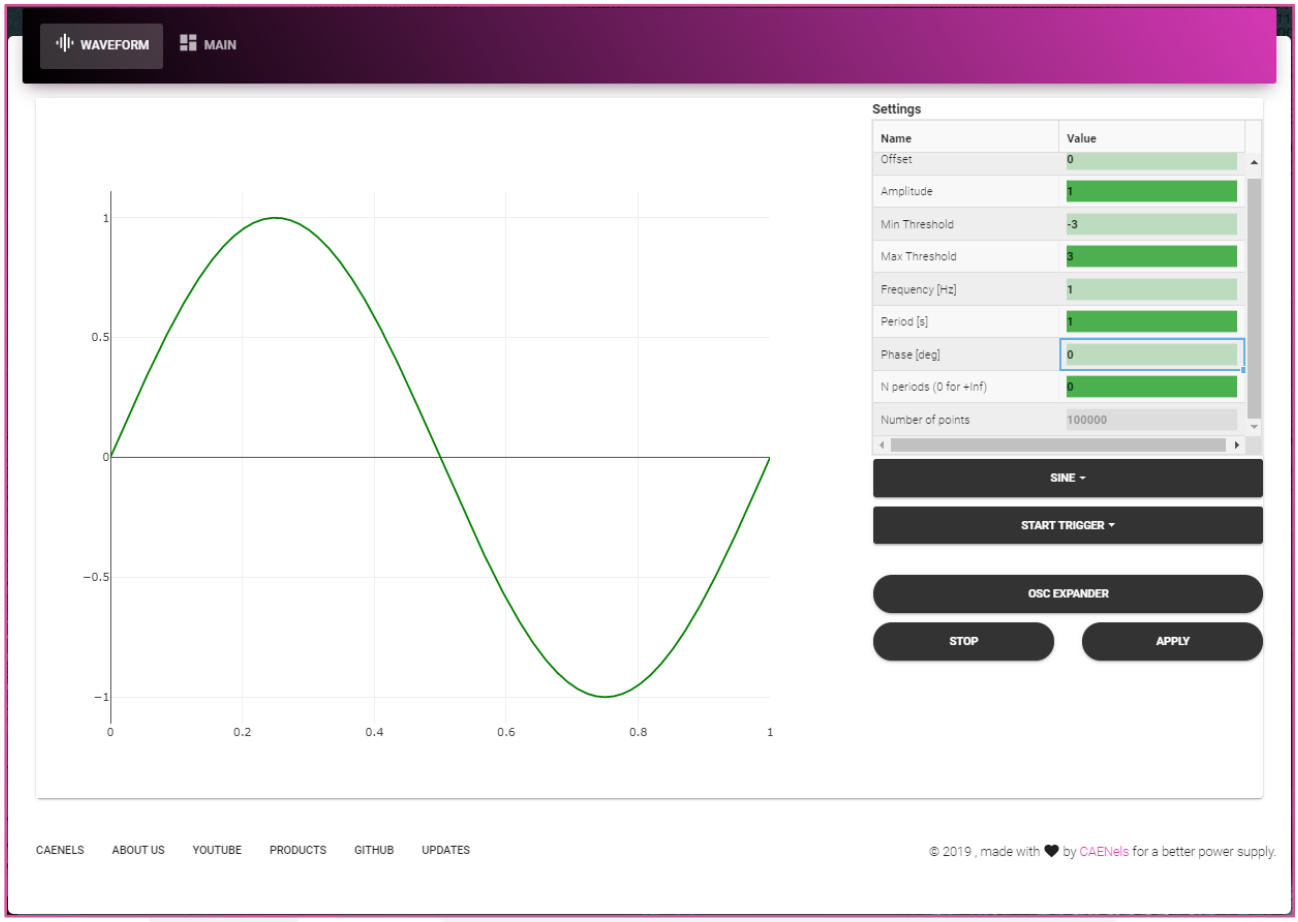


Figure 8: Sine Wave

Several parameters are present on the right side of the window, which the user is allowed to edit. Once the wanted waveform has been described, click “APPLY” in order to reproduce it and “STOP” to stop it.

In addition, two trigger options* are present, if needed:

- START TRIGGER: the entire waveform will be reproduced once the trigger signal will be detected. Trigger must be set in order to do so (see section 3.1.3).
- POINTS TRIGGER: the waveform will be reproduced point by point per each trigger signal detected. Trigger must be set in order to do so (see section 3.1.3).

“OSC EXPANDER” may be used in order to see in parallel the waveform window, the oscilloscope one (see section 3.4), and to also have access to the PID settings (see section 3.3.2), in order to modify in real time the dynamic of the module and to observe the response changing.

* The trigger must be hardware installed (it is optional on FAST PS and FAST PS M families). If installed, it will be present as “TRIG” in General Information - Capabilities (**Figure 5**).

Square Wave

Once square wave is selected, the below page will be accessed on the web server:

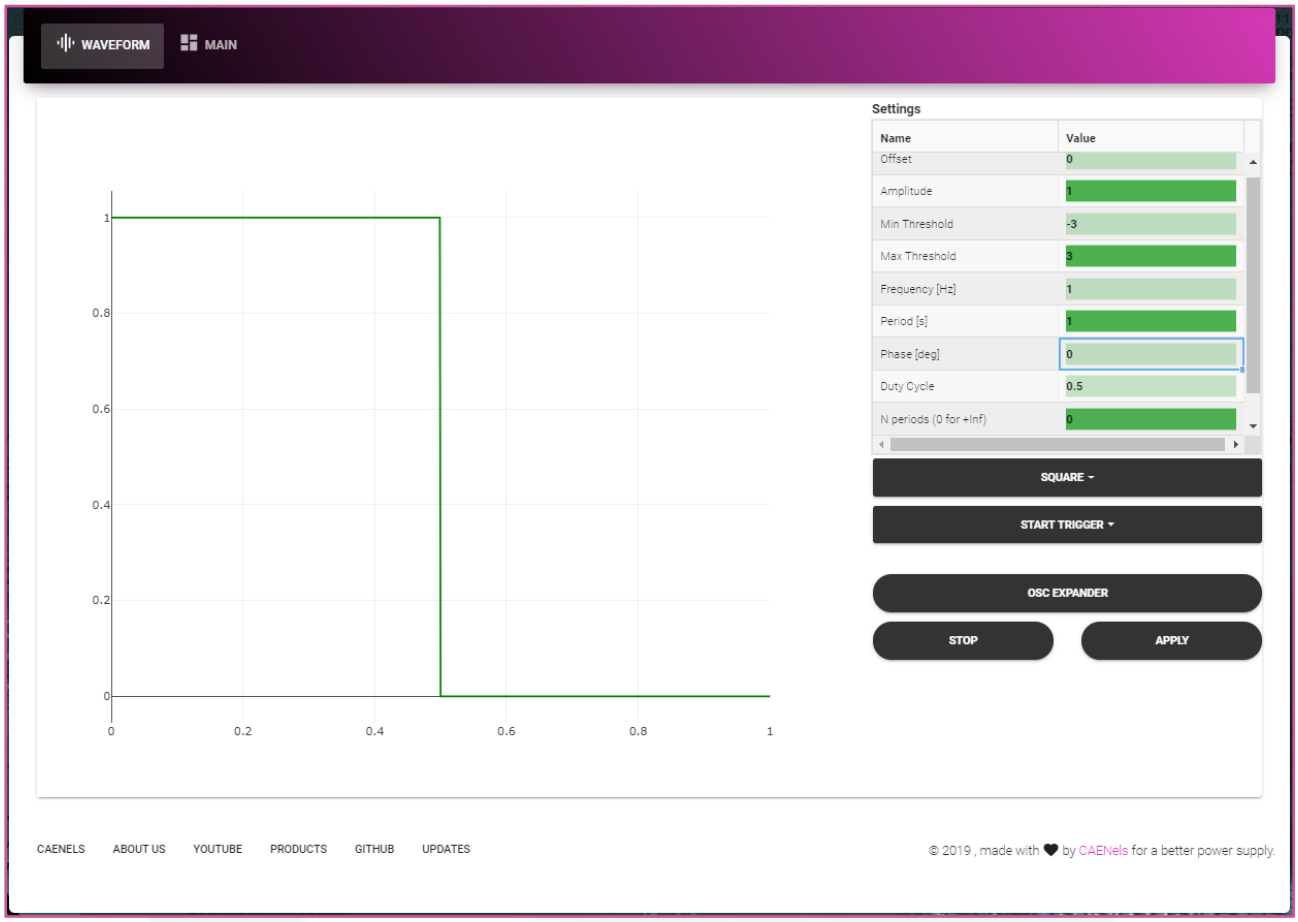


Figure 9: Square Wave

Several parameters are present on the right side of the window, which the user is allowed to edit. Once the wanted waveform has been described, click "APPLY" in order to reproduce it and "STOP" to stop it.

In addition, two trigger options* are present, if needed:

- START TRIGGER: the entire waveform will be reproduced once the trigger signal will be detected. Trigger must be set in order to do so (see section 3.1.3).
- POINTS TRIGGER: the waveform will be reproduced point by point per each trigger signal detected. Trigger must be set in order to do so (see section 3.1.3).

"OSC EXPANDER" may be used in order to see in parallel the waveform window, the oscilloscope one (see section 3.4), and to also have access to the PID settings (see section 3.3.2), in order to modify in real time the dynamic of the module and to observe the response changing.

* The trigger must be hardware installed (it is optional on FAST PS and FAST PS M families). If installed, it will be present as "TRIG" in General Information - Capabilities (**Figure 5**).

Triangular Wave

Once triangular wave is selected, the below page will be accessed on the web server:

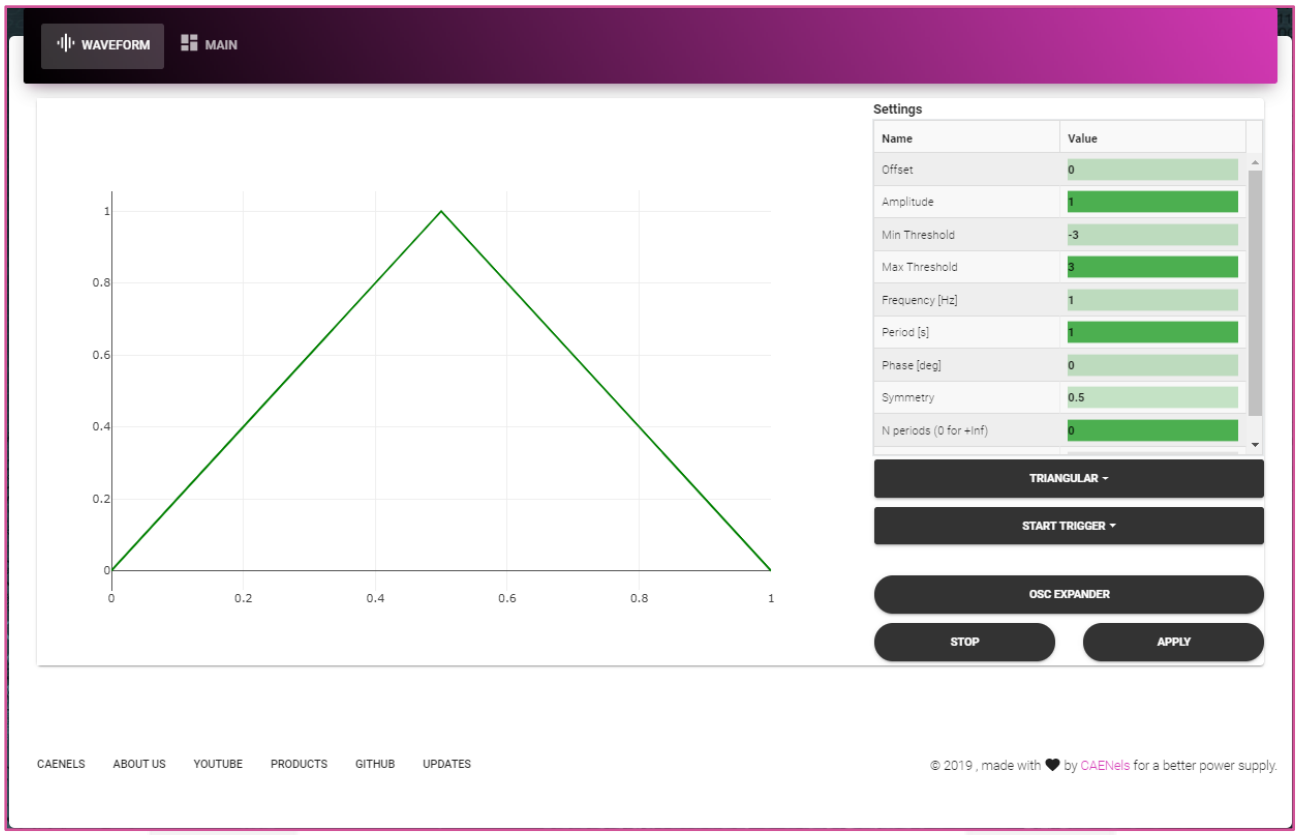


Figure 10: Triangular Wave

Several parameters are present on the right side of the window, which the user is allowed to edit. Once the wanted waveform has been described, click “APPLY” in order to reproduce it and “STOP” to stop it.

In addition, two trigger options* are present, if needed:

- START TRIGGER: the entire waveform will be reproduced once the trigger signal will be detected. Trigger must be set in order to do so (see section 3.1.3).
- POINTS TRIGGER: the waveform will be reproduced point by point per each trigger signal detected. Trigger must be set in order to do so (see section 3.1.3).

“OSC EXPANDER” may be used in order to see in parallel the waveform window, the oscilloscope one (see section 3.4), and to also have access to the PID settings (see section 3.3.2), in order to modify in real time the dynamic of the module and to observe the response changing.

* The trigger must be hardware installed (it is optional on FAST PS and FAST PS M families). If installed, it will be present as “TRIG” in General Information - Capabilities (**Figure 5**).

Custom Wave

Once triangular wave is selected, the below page will be accessed on the web server:

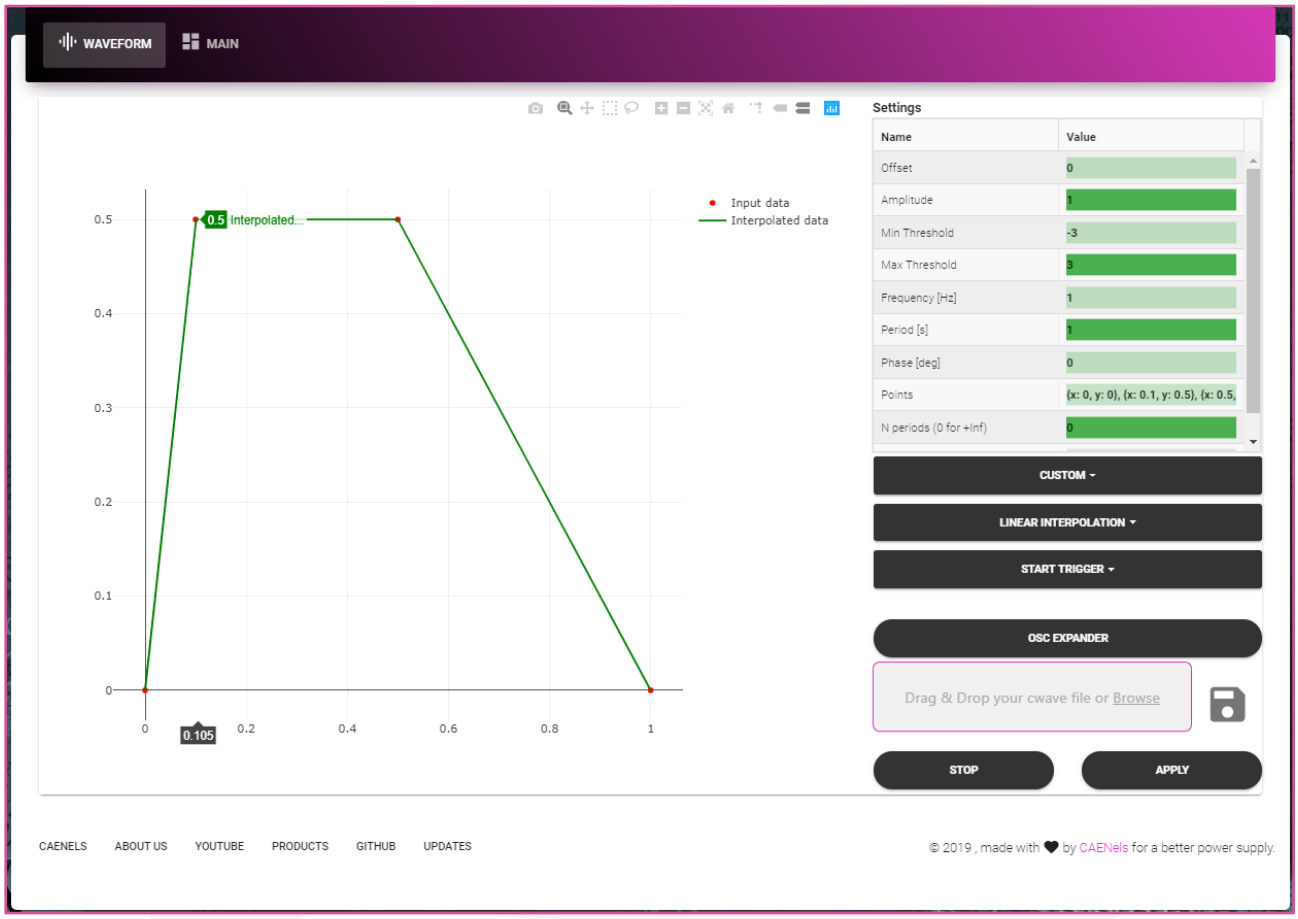


Figure 11: Custom Wave

The custom waveform can be uploaded to the power unit by preparing a text file (e.g. .txt files) with following formatting:

{x: x0, y: y0}, {x: x1, y: y1}, … ,{x: xn, y: yn}

Where xi and yi are respectively time and value of each point, and n is a number lower than 500'000. The file can then be dragged and dropped in the purple framed rectangle in **Figure 11**.

Different interpolations of the points are then available:

- Linear
- Step
- Polynomial
- Spline

. Once the wanted waveform has been described, click "APPLY" in order to reproduce it and "STOP" to stop it.

In addition, two trigger options* are present, if needed:

- START TRIGGER: the entire waveform will be reproduced once the trigger signal will be detected. Trigger must be set in order to do so (see section 3.1.3).
- POINTS TRIGGER: the waveform will be reproduced point by point per each trigger signal detected. Trigger must be set in order to do so (see section 3.1.3).

"OSC EXPANDER" may be used in order to see in parallel the waveform window, the oscilloscope one (see section 3.4), and to also have access to the PID settings (see section 3.3.2), in order to modify in real time the dynamic of the module and to observe the response changing.

* The trigger must be hardware installed (it is optional on FAST PS and FAST PS M families). If installed, it will be present as "TRIG" in General Information - Capabilities (**Figure 5**).

3.1.4.3 *SFP Transceiver for Optical Communication*

SFP control mode once selected is shown in **Figure 12**:

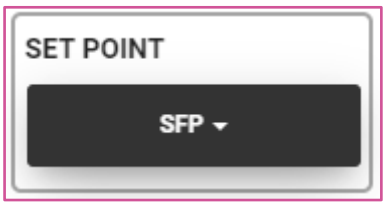


Figure 12: SFP control

In order to correctly use optical communication, the user should ensure that SFP transceivers are inserted into SFP ports 1 and 2, then please note that communication is performed as in **Figure 13** a. For multi modules architecture, the system uses a daisy chain as shown in **Figure 13** b, so the user has to also ensure that the optical cables follow such infrastructure.

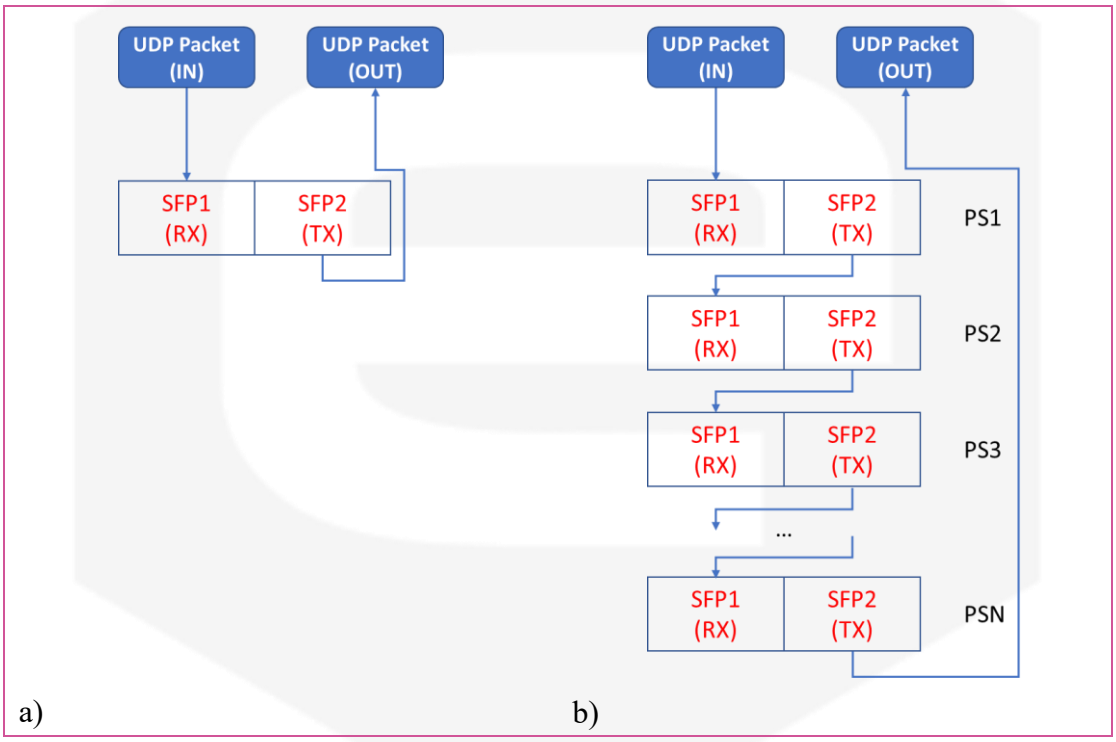


Figure 13: Daisy Chain

The UDP packet has to respect these constraints:

- It is a standard UDP packet IPv4 (IETF RFC 768)
- It is a Multicast or Broadcast
- It follows the structure described in the following paragraphs “UDP Packet for one module” and “UDP Packet for N modules”

UDP Packet for one module (as in Figure 12 a)

The Fast Feedbacks packets will follow the standard UDP packets IPv4 (IETF RFC 768). This transmission model has a minimum protocol mechanism and it has no handshaking dialogues.

The UDP header consists of 4 fields, each of 16 bits (source port, destination port, length and checksum), and the UDP header is concatenated with UDP data.

UDP header (64 bits):

Word #	*bit [31:24]*	*bit [23:16]*	*bit [15:8]*	*bit [7:0]*
1	**Source port**		**Destination port**	
2	**Length**		**Checksum**	
...	**UDP data**			

Source port (16 bits):
This field identifies the sender's port.

Destination port (16 bits):
This field identifies the receiver's port and will be a predefined port number: 30721.

Length (16 bits):
This field identifies the length in bytes of the UDP header and UDP data. The length will be constant:

- UDP Packet IN length is 28 bytes
- UDP Packet OUT length is 44 bytes.

Checksum (16 bit\s):
This field is used for error-checking of the UDP header and data. For UDP Command packets (which are generated from the user), if the packet does not contain the checksum field (the checksum field uses all-zeros value), then the checksum control will not be performed.

UDP data:

The structure of the UDP command packet data is the following:

Word #	*bit [31:24]*	*bit [23:16]*	*bit [15:8]*	*bit [7:0]*
1	**Command**		**Magic**	
2	**Nonce (LSB)**			
3	**Nonce (MSB)**			
4	**Fast-PS setpoint (LSB)**		**Fast-PS address**	
5	**Fast-PS address**		**Fast-PS setpoint (MSB)**	
6	**Fast-PS setpoint (MSB)**		**Fast-PS setpoint (LSB)**	
...				

Magic (16 bits):
Magic number 0x7631.

Command (16 bits):
This field identifies the command to configure the power module actions.

Command code		
Bits	**Name**	**Description**
[0]	**Enable readback**	**0: disable readback, 1:enable readback. When enabled, the setpoint is replaced with the readback value from the power source**
[1]	**I/V readback**	**0: current readback, 1: voltage readback.**
[31:2]	**Not used**	**Not used**

Nonce (64 bits):
This field identifies nonce parameter.

Fast-PS address (16 bits):
This field identifies the Fast-PS address.

Fast-PS setpoint (32 bits):
This field identifies the setpoint (in float32-bit representation). The setpoint is applied to the Fast-PS only if the correspondent Fast-PS address matches the receiver Fast-PS address.

UDP Packet for N modules (as in Figure 12 b)

In this case the UDP is structured in the same way as described in the paragraph "UDP Packet for one module", with the exception that the fields "FAST-PS setpoint (LSB)", "FAST-PS address", "FAST-PS address", "FAST-PS setpoint (MSB)", "FAST-PS setpoint (MSB)", "FAST-PS setpoint (LSB)" are repeated N times where N equals the number of power sources in the chain.

E.g., for three modules, the UDP data structure will be the following:

Word #	*bit [31:24]*	*bit [23:16]*	*bit [15:8]*	*bit [7:0]*
1	**Command**		**Magic**	
2	**Nonce (LSB)**			
3	**Nonce (MSB)**			
4	**Fast-PS 1 setpoint (LSB)**		**FastPS 1 address**	
5	**Fast-PS 1 address**		**Fast-PS 1 setpoint (MSB)**	
6	**Fast-PS 1 setpoint (MSB)**		**Fast-PS 1 setpoint (LSB)**	
7	**Fast-PS 2 setpoint (LSB)**		**FastPS 2 address**	
8	**Fast-PS 2 address**		**Fast-PS 2 setpoint (MSB)**	
9	**Fast-PS 2 setpoint (MSB)**		**Fast-PS 2 setpoint (LSB)**	
10	**Fast-PS 3 setpoint (LSB)**		**FastPS 3 address**	
11	**Fast-PS 3 address**		**Fast-PS 3 setpoint (MSB)**	
12	**Fast-PS 3 setpoint (MSB)**		**Fast-PS 3 setpoint (LSB)**	

3.1.4.4 *Analog (Voltage Input)*

Analog control mode once selected is shown in **Figure 14**:

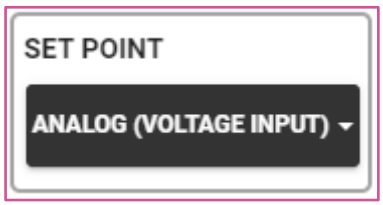


Figure 14: Analog Control

When in analog control mode, the power source input accepts signals ranging from -10V to +10V (for bipolar units) or from 0V to +10V (for unipolar units) and it generates an output which is proportional to the input signal.

An example of the relation between the analog input signal and the output (can be either current or voltage, depending on the Regulation mode) is shown in **Figure 15**:

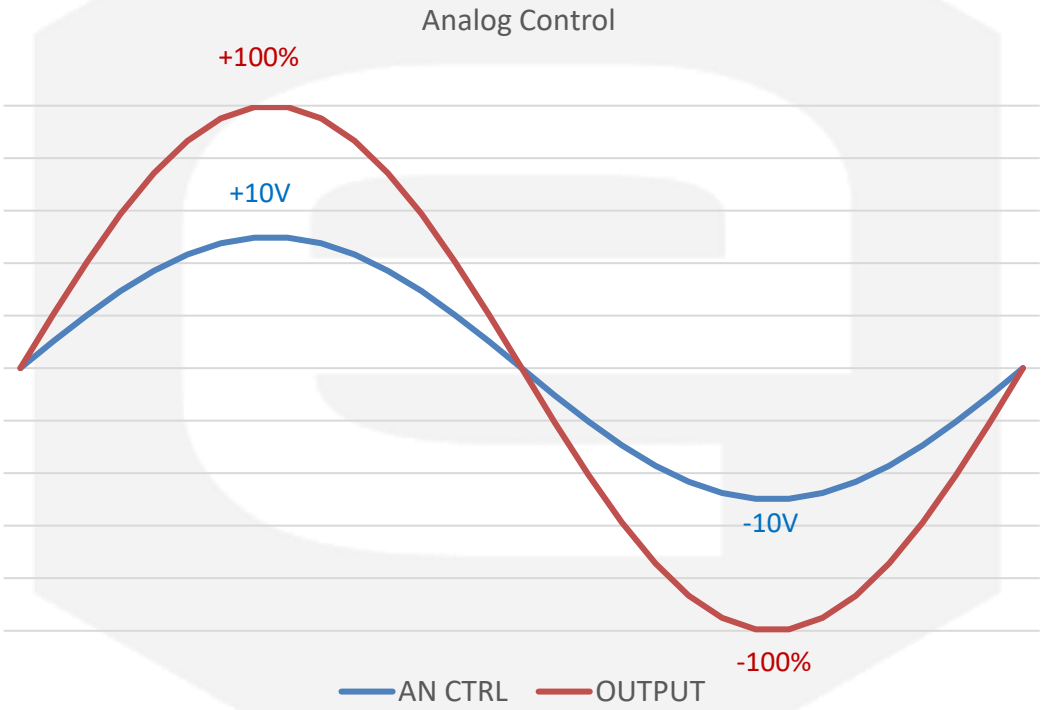


Figure 15: Analog Control – Output Relation

In order to avoid drifts, offset and external noise pick-up it is always suggested to use the digital interface – e.g. Ethernet – to control the power unit in order to get the best performance.

Please note that the bandwidth of the analog control input is internally limited to 1 kHz.

3.2 EPICS IOC

An on-board EPICS IOC server running on the power source is present and the main window is presented below. Protocols shows the current EPICS server settings:

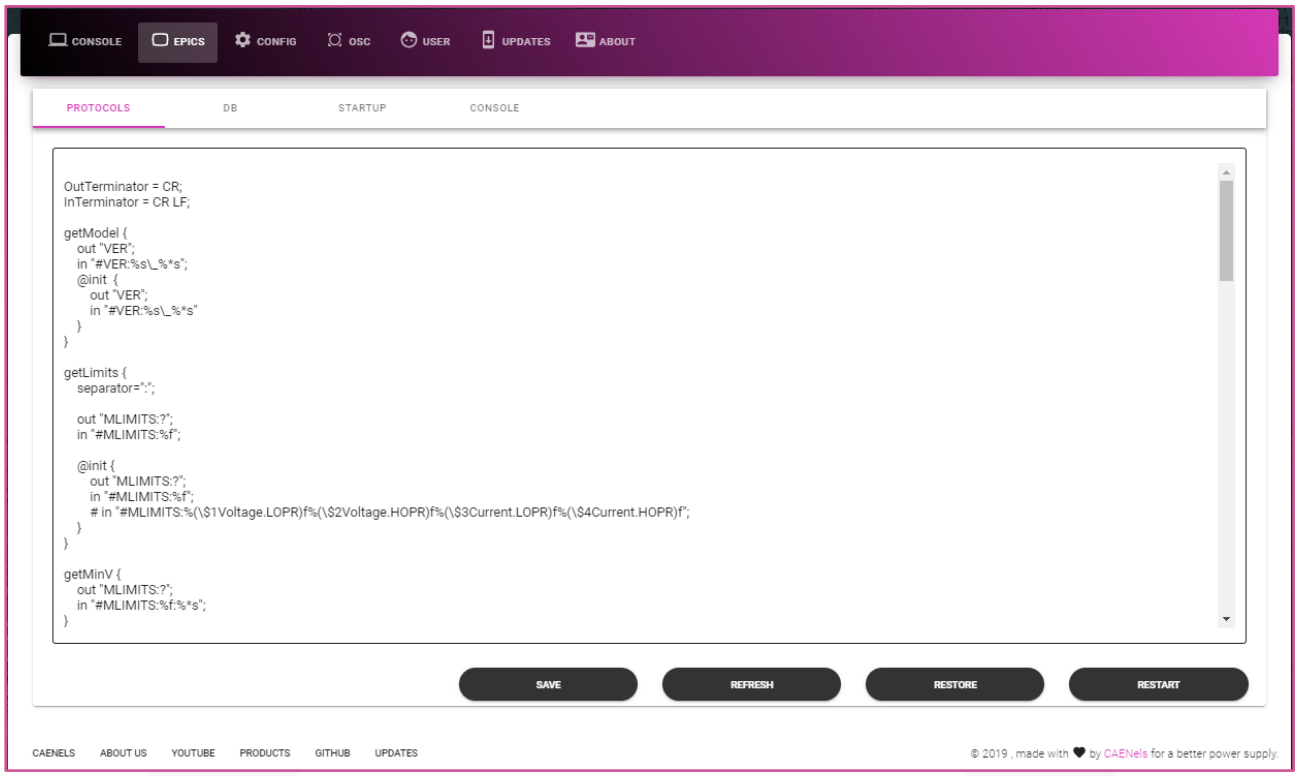


Figure 16: EPICS - Main Window

EPICS PV (Process Variables) can be changed in “DB” window:

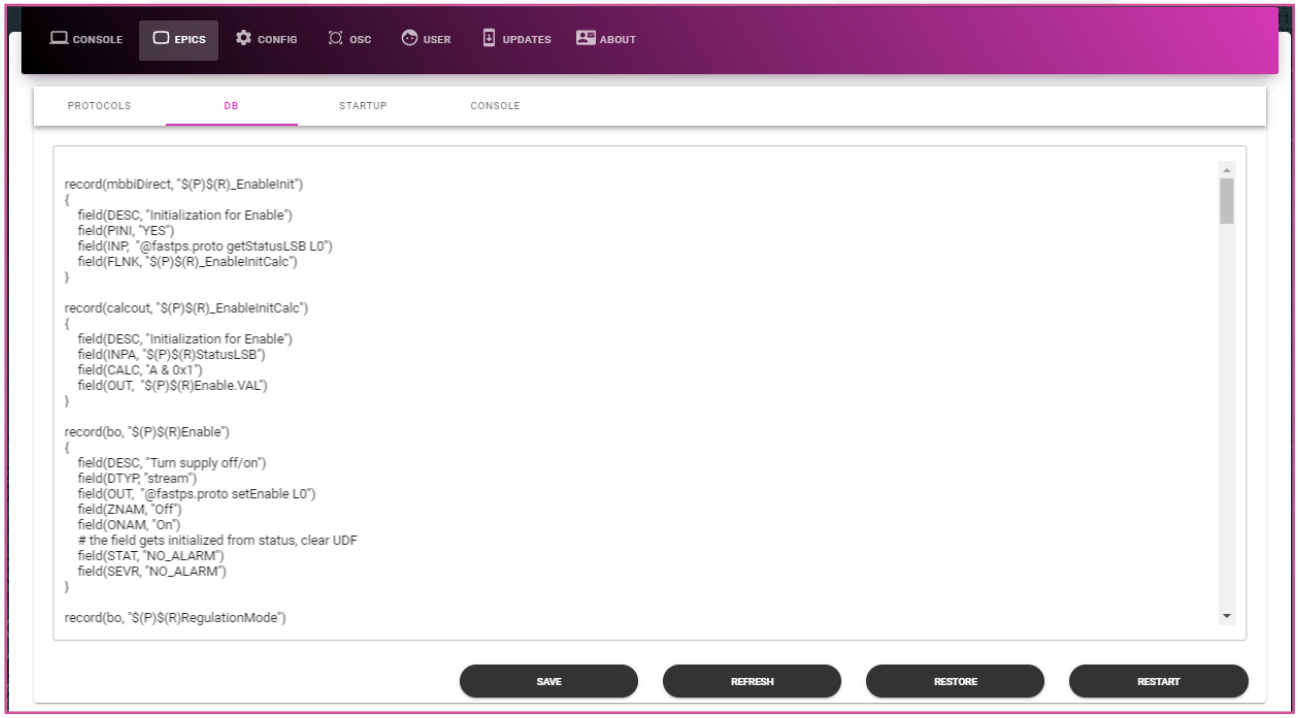


Figure 17: EPICS - DB

After the editing has been performed, click “SAVE” to store the current configuration.

EPICS records can be changed in “STARTUP” window:

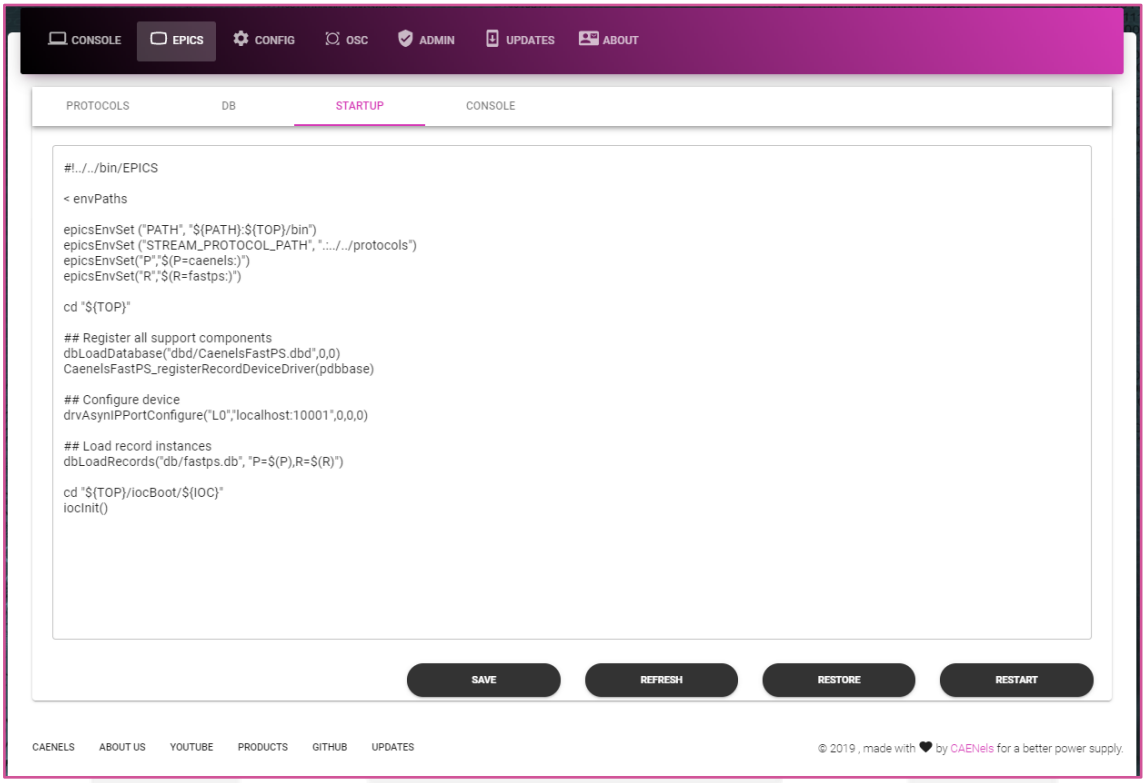


Figure 18: EPICS – STARTUP

In “CONSOLE” window EPICS-supported commands may be typed in order to get commands’ replies (e.g. by typing “dbl” the power source will reply with the current EPICS-IOC configuration of records and variables).

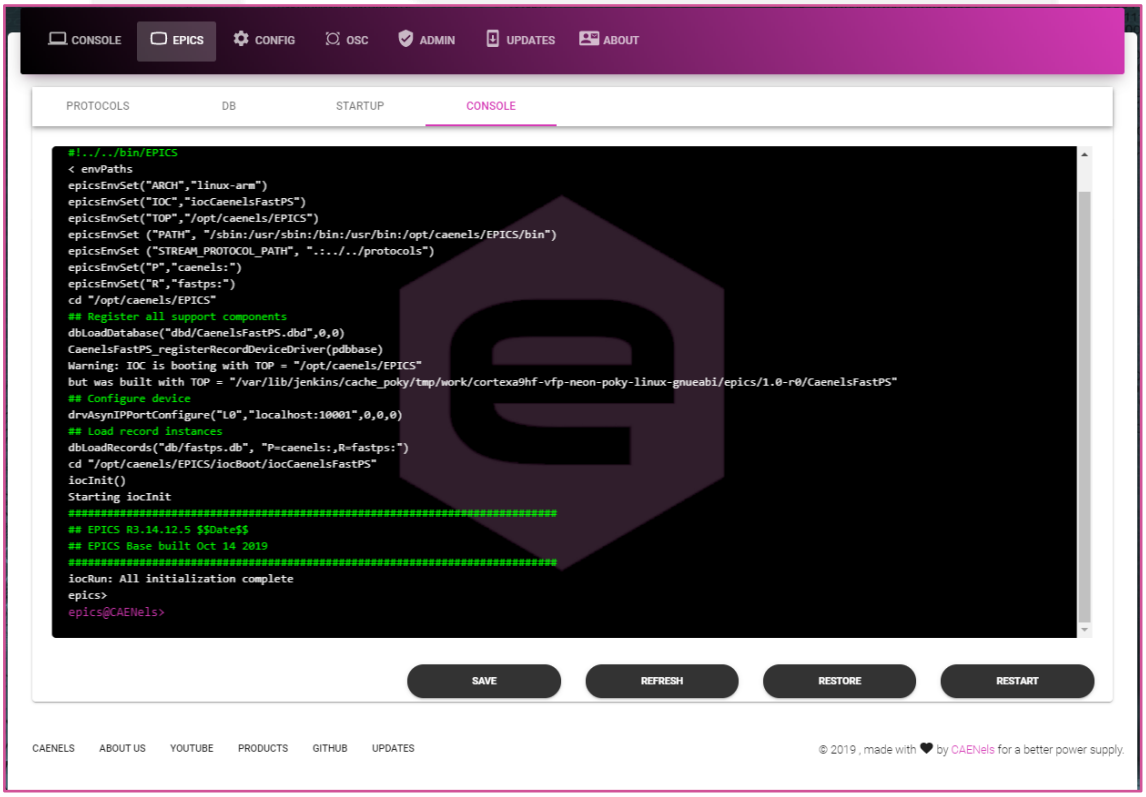


Figure 19: EPICS – CONSOLE

3.3 Unit Configuration

To display the configuration Window, click on the "CONFIG" button on the main Toolbar. From this window, it is possible to configure the unit. Several fields are password protected. Please remember to set "Ps-admin" as password at the login in order to have administrator privileges.

The "CONFIG" window is presented below:

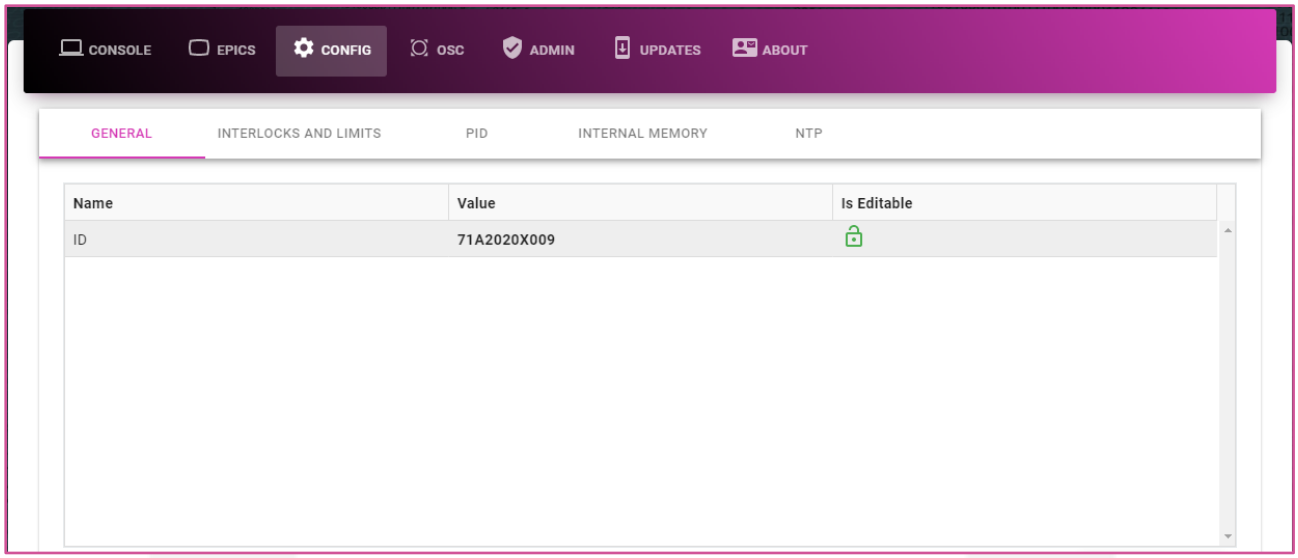


Figure 20: Web Server – General Section

- **General tab:** shows the serial number of the module.

- **Interlock and Limit tab:** from this tab the user can:
  - display and edit the names, direction, status (enabled or disabled) and intervention time of the available external interlocks,
  - visualize and edit the module limits (which generate a fault condition) as: the maximum allowable temperature, min DC-link voltage, Leakage current limit etc.

- **PID tab:** from this tab it is possible to edit the PID regulators parameters – i.e. proportional, derivative and integral terms.

- **File tab:** in this tab the user can display, edit and save the content of the unit memory.

3.3.1 Interlocks and limits

The “INTERLOCK AND LIMITS” window is divided into 3 sub-windows:

- External Interlock Setup
- Limits
- Regulation Fault

In the following 3 paragraphs each of these 3 sub-windows is explained.

3.3.1.1 *External Interlock Setup*

To set interlocks levels, at first click on the “External Interlock Setup” window:

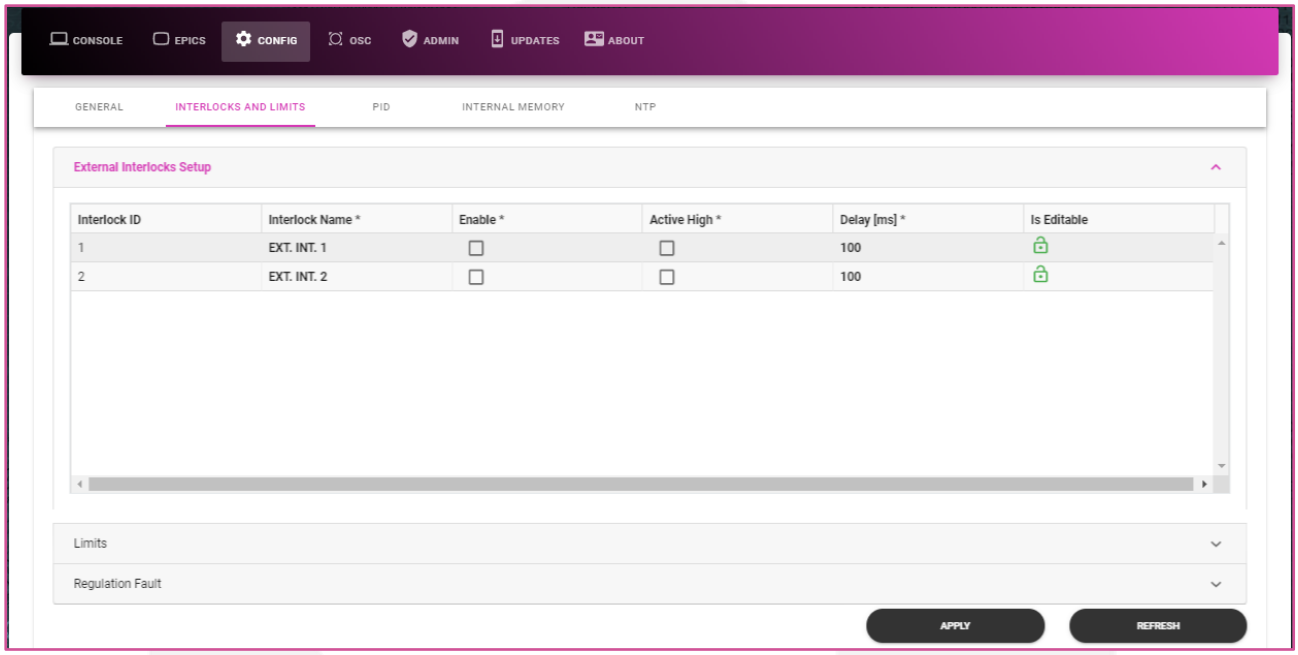


Figure 21: Web Server – External Interlock Setup

Administrator privileges are needed for interlocks editing, please refer to login instructions at page 11 of this Manual.

It is now possible to enable interlocks (checking the “Enable” box), to set the high or low level and the intervention time (delay).

For interlocks enabled at high level, fault will appear when the interlock pin is shorted with the common pin, for the ones enabled at low level, fault will appear when the interlock pin and the common pin are in open loop.

More information regarding the number of interlocks available on the power supply and the interlock pinout are available in the specific power source Manual.

When the interlock configuration has been changed, click “APPLY” in order to save it.

3.3.1.2 *Limits*

Under “Limits” section, different important parameters are listed, and it is recommended to not change such values:

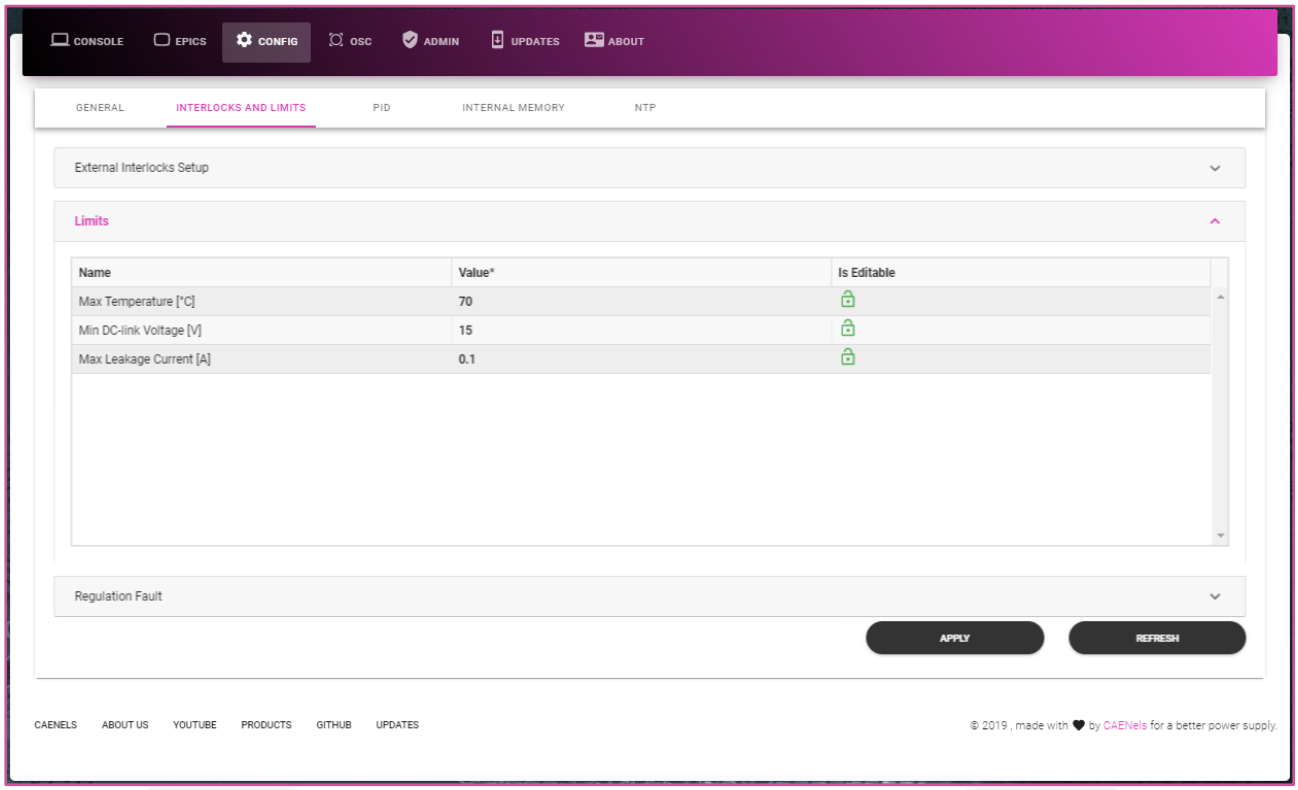


Figure 22: Web Server – Limits Section

The meaning of these limits is:

- Max Temperature: max temperature allowed for the MOSFETs on the H (or half H) -Bridge
- Min DC-link Voltage: min voltage allowed on the output of the AC-DC converter
- Max Leakage Current: max earth-leakage current allowed

If the machine reads a value which is not within these limits, a fault will be generated.

3.3.1.3 *Regulation Fault*

Whenever a power converter is not able to reach a set point, either a voltage one or a current one, a “Regulation Fault” will appear.

E.g., if the user sets a 15A set-point on a 2 Ohm load and the maximum voltage output is 20V, a “Regulation Fault” will appear as soon as the power source senses that it is impossible to reach the set-point.

Under “Regulation Fault” section the following limits are listed:

- Current Regulation Fault Limit: maximum difference between the current set-point and the current which can be reached
- Voltage Regulation Fault Limit: maximum difference between the voltage set-point and the voltage which can be reached
- Regulation Fault Intervention Time: maximum time allowed to reach the set-point

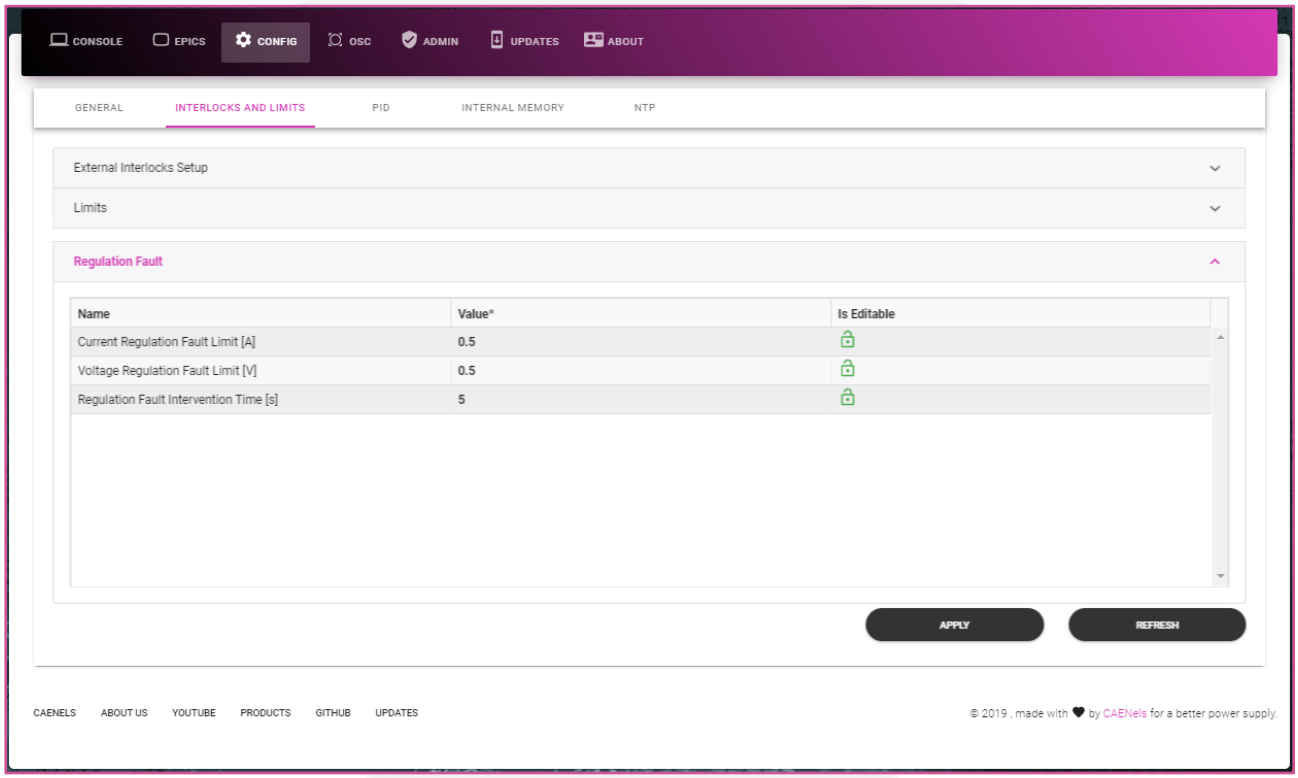


Figure 23: Web Server – Regulation Fault Section

In this case also it is recommended to not change the factory values. However, this may be useful in specific applications (e.g., high inductive loads with high time constants).

3.3.2 PID

CAEN ELS power supplies run a digital control loop instead of the more commons analog ones based on hardware components.

The PID loops run on FPGA logic, this allowing very fast dynamics, while the possibility of changing the P,I,D parameters give infinite possibilities of use.

PID parameters are found on the “CONFIG” Window under “PID” section:

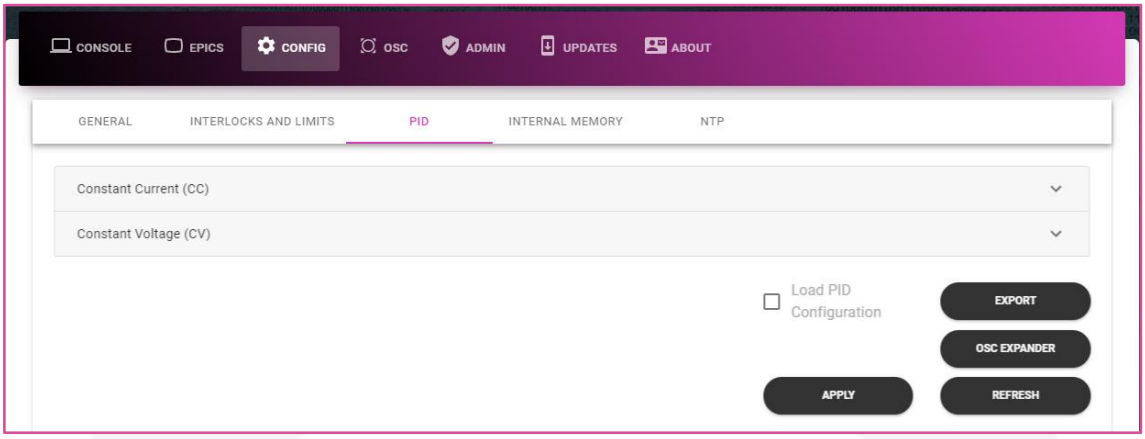


Figure 24: Web Server – PID section

PID parameters must be set separately for current control (Constant Current, CC) mode or for voltage control (Constant Voltage, CV) mode, the PID architecture is shown in **Figure 25**. Please note that for CC control, both current and voltage loops are involved, while for CV control only the voltage loop is.

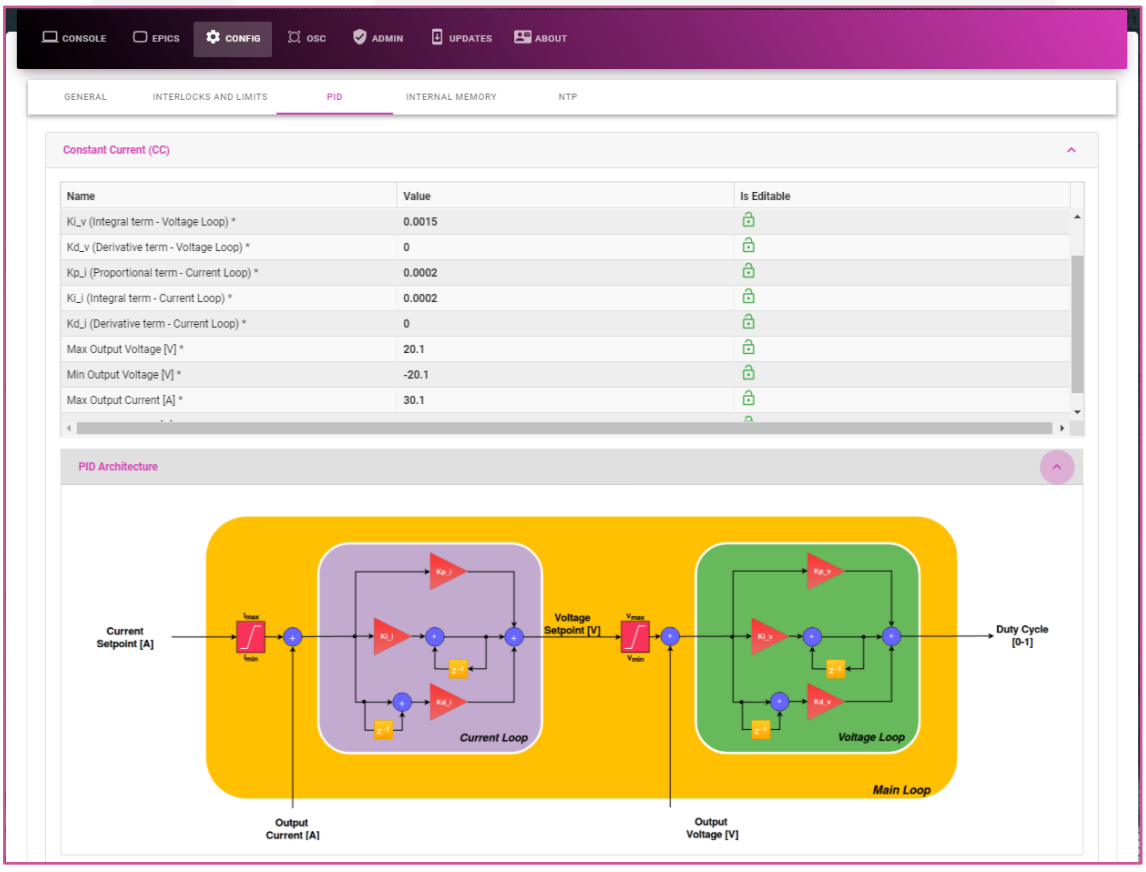


Figure 25: Web Server – PID section (CC) and PID architecture

3.3.2.1 *Save and use pre-set PID configurations*

In order to save and load pre-set configurations, a folder on the PC in use must be created.

Indeed, at the next run of the Visual Software, configurations will be searched in the last folder used to store the PID configurations.

PID configurations are stored as .json files (readable by mean of any text editor).

To export a configuration, under "Configuration Window" open "PID"; in the bottom, click "Export":

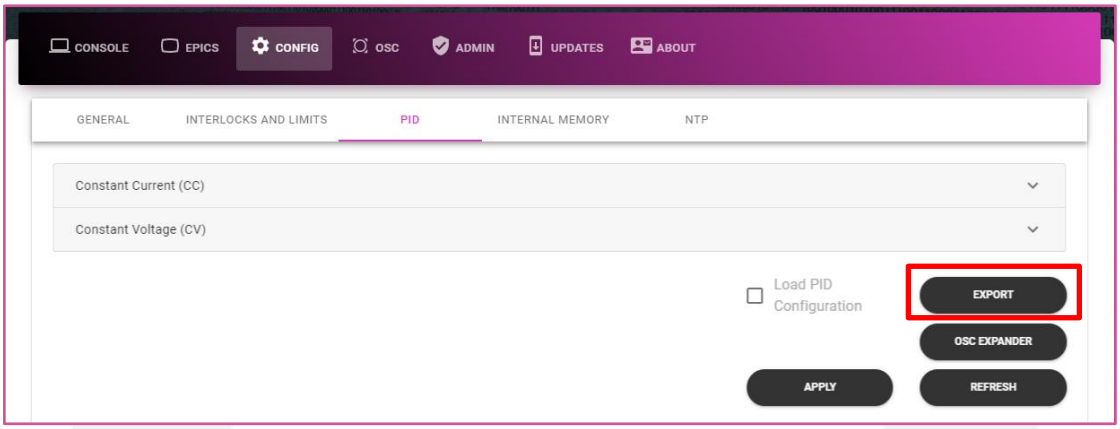


Figure 26: Web Server – export PID settings

The configuration can now be saved and easily accessed in the future. It is recommended to save the file using a name which refers to the load in use and/or to the dynamic achieved.

To use a stored configuration, drag and drop the .json file in the window under "Use preload PID's parameters" (the box needs to be set):

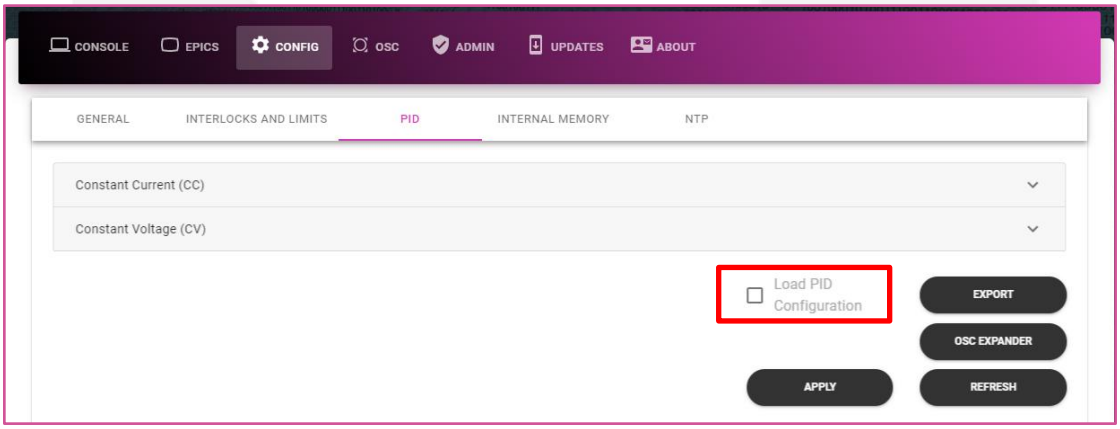


Figure 27: Web Server – import PID settings

Once the configuration is selected, it is automatically stored and saved into the module by clicking "APPLY".

3.3.3 Internal memory

As the name suggests, in this window the internal memory cells are listed:

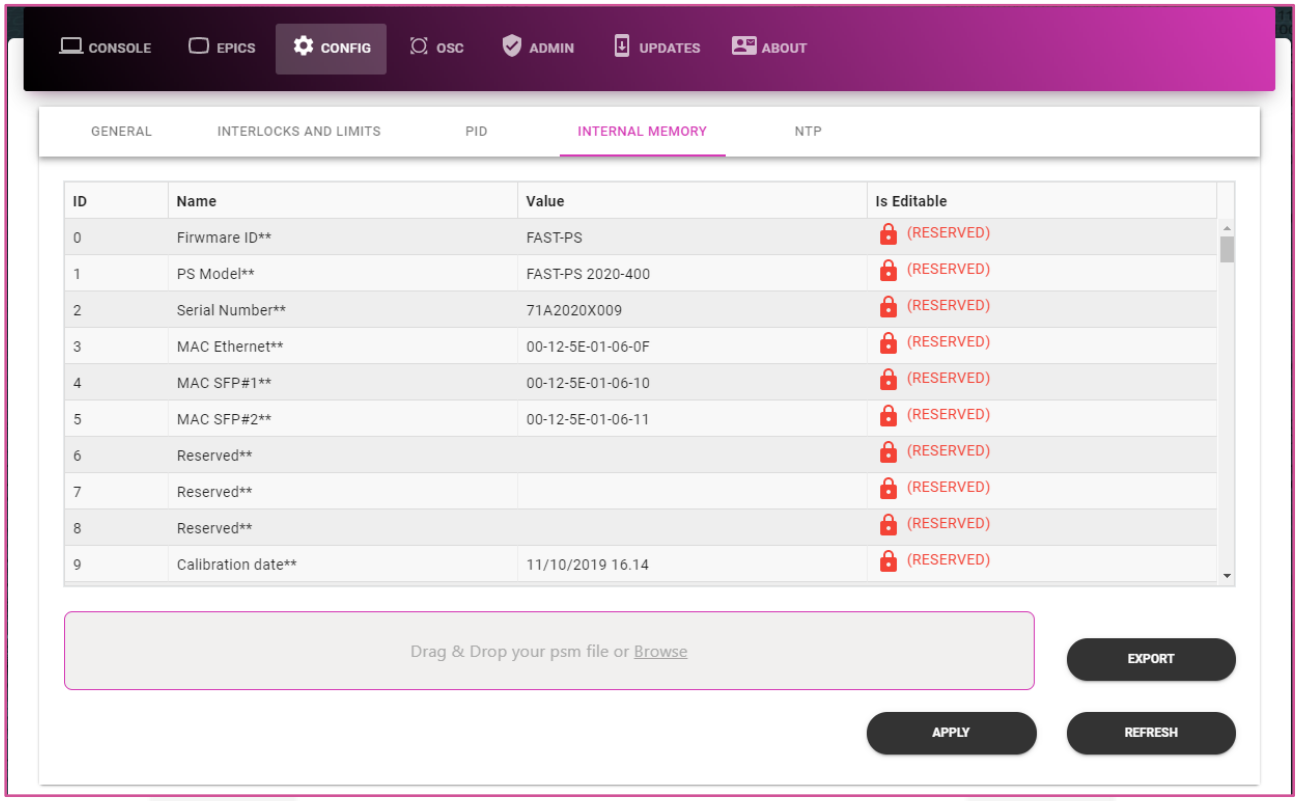


Figure 28: Web Server – internal memory

The internal memory is mapped differently depending on the power source family; in the following pages the mapping is reported into 3 different tables, one per each family.

Once in the “INTERNAL MEMORY” window, the user is allowed to change the memory cells; in order to do so, it is required to overwrite the values and to click “APPLY”.

By clicking “EXPORT”, a .psm file listing the memory mapping can be exported, and later re-imported by dragging and dropping it in the purple framed rectangle in **Figure 28**: Web Server – internal memory **Figure 28**

Parameter #	Access Privileges	Parameter Name
#0	Read Only	Firmware ID
#1	Read Only	PS Model
#2	Read Only	Serial Number
#3	Read Only	MAC Ethernet
#4	Read Only	MAC SFP #1
#5	Read Only	MAC SFP #2
#6 - #8	/	Reserved
#9	Read Only	Calibration date
#10	Read Only	Current Calibration Parameter a
#11	Read Only	Current Calibration Parameter b
#12	Read Only	Current Calibration Parameter c
#13	Read Only	Current Calibration Parameter d
#14	Read Only	Voltage Calibration Parameter a
#15	Read Only	Voltage Calibration Parameter b
#16	Read Only	Voltage Calibration Parameter c
#17	Read Only	Voltage Calibration Parameter d
#18	Read Only	DC Link Calibration Parameter a
#19	Read Only	DC Link Calibration Parameter b
#20	Read Only	AC Link Calibration Parameter a
#21	Read Only	AC Link Calibration Parameter b
#22	Read Only	Current Leakage Calibration Parameter a
#23	Read Only	Current Leakage Calibration Parameter b
#24	Read Only	Analog Input Calibration Parameter a
#25	Read Only	Analog Input Calibration Parameter b
#26	Read Only	Analog Input Calibration Parameter c
#27	Read Only	Analog Input Calibration Parameter d
#28 - #29	/	Reserved
#30	User	Module Identification
#31	User	Default Current Slew Rate [A/s]
#32	User	Default Voltage Slew Rate V [V/s]
#33 - #34	/	Reserved
#35	User	Turning off time of Display [minutes] – 0 to disable
#36 - #39	/	Reserved
#40	User	PID I: Kp_v
#41	User	PID I: Ki_v
#42	User	PID I: Kd_v
#43	User	PID I: Kp_i
#44	User	PID I: Ki_i
#45	User	PID I: Kd_i
#46	User	PID I: Upper Limit Acc_v

Parameter #	Access Privileges	Parameter Name
#47	User	PID I: Lower Limit Acc_v
#48 - #59	/	Reserved
#60	User	PID V: Kp_i
#61	User	PID V: Ki_i
#62	User	PID V: Kd_i
#63	User	PID V: Kp_v
#64	User	PID V: Ki_v
#65	User	PID V: Kd_v
#66	User	PID V: Upper Limit Acc_i
#67	User	PID V: Lower Limit Acc_i
#68 - #77	/	Reserved
#78	Admin	Min Current Setpoint [A]
#79	Admin	Min Voltage Setpoint [V]
#80	Admin	Max Current Setpoint [A]
#81	Admin	Max Voltage Setpoint [V]
#82	Admin	Max Mosfet Temperature
#83	Admin	Min DC-link Threshold
#84	Admin	Earth Leakage Limit
#85	/	Reserved
#86	Admin	Current Regulation Fault Limit [A]
#87	Admin	Voltage Regulation Fault Limit [A]
#88	Admin	Regulation Fault Intervention Time [s]
#89	/	Reserved
#90	Admin	Interlock Enable Mask
#91	Admin	Interlock Activation State
#92	Admin	Interlock #1 intervention time [ms]
#93	Admin	Interlock #1 name
#94	Admin	Interlock #2 intervention time [ms]
#95	Admin	Interlock #2 name
#96 - #99	/	Reserved

Table 1: Parameters table for FAST-PS / FAST-PS-M

Parameter #	Access Privileges	Parameter Name
#0	Read Only	Firmware ID
#1	Read Only	PS Model
#2	Read Only	Serial Number
#3	Read Only	MAC Ethernet
#4	Read Only	MAC SFP #1
#5	Read Only	MAC SFP #2

Parameter #	Access Privileges	Parameter Name
#6 - #8	/	Reserved
#9	Read Only	Calibration date
#10	Read Only	Current Calibration Parameter a
#11	Read Only	Current Calibration Parameter b
#12	Read Only	Current Calibration Parameter c
#13	Read Only	Current Calibration Parameter d
#14	Read Only	Voltage Calibration Parameter a
#15	Read Only	Voltage Calibration Parameter b
#16	Read Only	Voltage Calibration Parameter c
#17	Read Only	Voltage Calibration Parameter d
#18	Read Only	DC Link Calibration Parameter a
#19	Read Only	DC Link Calibration Parameter b
#20	Read Only	AC Link Calibration Parameter a
#21	Read Only	AC Link Calibration Parameter b
#22	Read Only	Current Leakage Calibration Parameter a
#23	Read Only	Current Leakage Calibration Parameter b
#24	Read Only	Analog Input Calibration Parameter a
#25	Read Only	Analog Input Calibration Parameter b
#26	Read Only	Analog AUX Calibration Parameter a
#27	Read Only	Analog AUX Calibration Parameter b
#28 - #29	/	Reserved
#30	User	Module Identification
#31	User	Default Current Slew Rate [A/s]
#32	User	Default Voltage Slew Rate V [V/s]
#33 - #39	/	Reserved
#40	User	PID I: Kp_v
#41	User	PID I: Ki_v
#42	User	PID I: Kd_v
#43	User	PID I: Kp_i
#44	User	PID I: Ki_i
#45	User	PID I: Kd_i
#46	User	PID I: Upper Limit Acc_v
#47	User	PID I: Lower Limit Acc_v
#48 - #59	/	Reserved
#60	User	PID V: Kp_i
#61	User	PID V: Ki_i
#62	User	PID V: Kd_i
#63	User	PID V: Kp_v
#64	User	PID V: Ki_v
#65	User	PID V: Kd_v

Parameter #	Access Privileges	Parameter Name
#66	User	PID V: Upper Limit Acc_i
#67	User	PID V: Lower Limit Acc_i
#68 - #77	/	Reserved
#78	Admin	Min Current Setpoint [A]
#79	Admin	Min Voltage Setpoint [V]
#80	Admin	Max Current Setpoint [A]
#81	Admin	Max Voltage Setpoint [V]
#82	Admin	Max Mosfet Temperature
#83	Admin	Min DC-link Threshold
#84	Admin	Earth Leakage Limit
#85	/	Reserved
#86	Admin	Current Regulation Fault Limit [A]
#87	Admin	Voltage Regulation Fault Limit [A]
#88	Admin	Regulation Fault Intervention Time [s]
#89	/	Reserved
#90	Admin	Interlock Enable Mask
#91	Admin	Interlock Activation State
#92	Admin	Interlock #1 intervention time [ms]
#93	Admin	Interlock #1 name
#94	Admin	Interlock #2 intervention time [ms]
#95	Admin	Interlock #2 name
#96	Admin	Interlock #3 intervention time [ms]
#97	Admin	Interlock #3 name
#98	Admin	Interlock #4 intervention time [ms]
#99	Admin	Interlock #4 name
#100	Admin	Maximum Load resistance [Ω]
#101	Admin	Minimum Load resistance [Ω]
#102	Admin	Minimum Current for Quench detector [A]
#103	Admin	Quench intervention Time [s]

Table 2: Parameters table for FAST-PS-1K5

Parameter #	Access Privileges	Parameter Name
#0	Read Only	Firmware ID
#1	Read Only	PS Model
#2	Read Only	Serial Number
#3	Read Only	MAC Ethernet
#4	Read Only	MAC SFP #1
#5	Read Only	MAC SFP #2
#6 - #8	/	Reserved

Parameter #	Access Privileges	Parameter Name
#9	Read Only	Calibration date
#10	Read Only	Current Calibration Parameter a
#11	Read Only	Current Calibration Parameter b
#12	Read Only	Current Calibration Parameter c
#13	Read Only	Current Calibration Parameter d
#14	Read Only	Voltage Calibration Parameter a
#15	Read Only	Voltage Calibration Parameter b
#16	Read Only	Voltage Calibration Parameter c
#17	Read Only	Voltage Calibration Parameter d
#18	Read Only	DC Link Calibration Parameter a
#19	Read Only	DC Link Calibration Parameter b
#20	Read Only	AC Link Calibration Parameter a
#21	Read Only	AC Link Calibration Parameter b
#22	Read Only	Current Leakage Calibration Parameter a
#23	Read Only	Current Leakage Calibration Parameter b
#24	Read Only	Analog Input Calibration Parameter a
#25	Read Only	Analog Input Calibration Parameter b
#26	Read Only	Primary Current Calibration Parameter a
#27	Read Only	Primary Current Calibration Parameter b
#28 - #29	/	Reserved
#30	User	Module Identification
#31	User	Default Current Slew Rate [A/s]
#32	User	Default Voltage Slew Rate V [V/s]
#33 - #39	/	Reserved
#40	User	PID I: Kp_v
#41	User	PID I: Ki_v
#42	User	PID I: Kd_v
#43	User	PID I: Kp_i
#44	User	PID I: Ki_i
#45	User	PID I: Kd_i
#46	User	PID I: Upper Limit Acc_v
#47	User	PID I: Lower Limit Acc_v
#48 - #59	/	Reserved
#60	User	PID V: Kp_i
#61	User	PID V: Ki_i
#62	User	PID V: Kd_i
#63	User	PID V: Kp_v
#64	User	PID V: Ki_v
#65	User	PID V: Kd_v
#66	User	PID V: Upper Limit Acc_i

Parameter #	Access Privileges	Parameter Name
#67	User	PID V: Lower Limit Acc_i
#68 - #74	/	Reserved
#75	Admin	Max Transformer Temperature
#76	Admin	Min DCCT Shunt Temperature
#77	Admin	Max DCCT Shunt Temperature
#78 - #79	/	Reserved
#80	Admin	Max Current Setpoint [A]
#81	Admin	Max Voltage Setpoint [V]
#82	Admin	Max Heatsink Temperature
#83	Admin	Min DC-link Threshold
#84	Admin	Earth Leakage Limit
#85	/	Reserved
#86	Admin	Current Regulation Fault Limit [A]
#87	Admin	Voltage Regulation Fault Limit [A]
#88	Admin	Regulation Fault Intervention Time [s]
#89	Admin	Primary Current Limit
#90	Admin	Interlock Enable Mask
#91	Admin	Interlock Activation State
#92	Admin	Interlock #1 intervention time [ms]
#93	Admin	Interlock #1 name
#94	Admin	Interlock #2 intervention time [ms]
#95	Admin	Interlock #2 name
#96	Admin	Interlock #3 intervention time [ms]
#97	Admin	Interlock #3 name
#98	Admin	Interlock #4 intervention time [ms]
#99	Admin	Interlock #4 name

Table 3: Parameters table for NGPS

3.3.4 NTP – Network Time Protocol

The Network Time Protocol (NTP) is an internet protocol intended for the synchronization (under Coordinated Universal Time - UTC) of several clients in a client-server architecture.

In such architecture the power source acts as client, and an NTP server must be available in order to achieve synchronization.

The NTP server can run in local on the PC in use (in this case several guides online can be found, depending on the OS in use) or the NTP server can be reached by Internet (e.g. refer to pool.ntp.org).

Once the IP of the NTP server is known, insert it in the NTP window in the CAEN ELS web server:

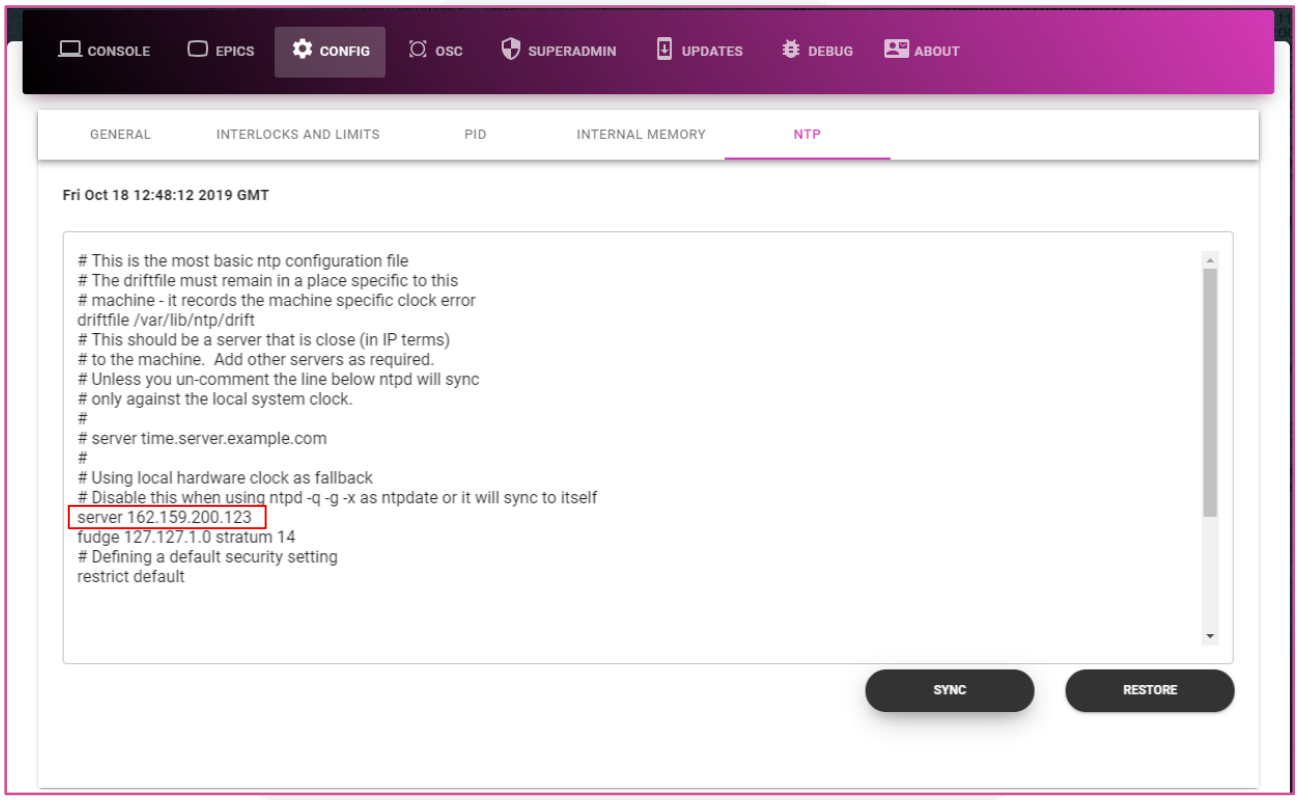


Figure 29: Web Server – NTP server

When the configuration has been set, click “SYNC” in order to synchronize the power module to the NTP server.

3.4 Oscilloscope

The web server also provides access to the on-board oscilloscope, enabling real-time plotting of relevant information, via DMA (Direct Memory Access), at a 100 kHz sampling frequency for FAST-PS, FAST-PS-M, and FAST-PS-1K5, instead of 40 kHz (specifically 39.0625 kHz) for NGPS.

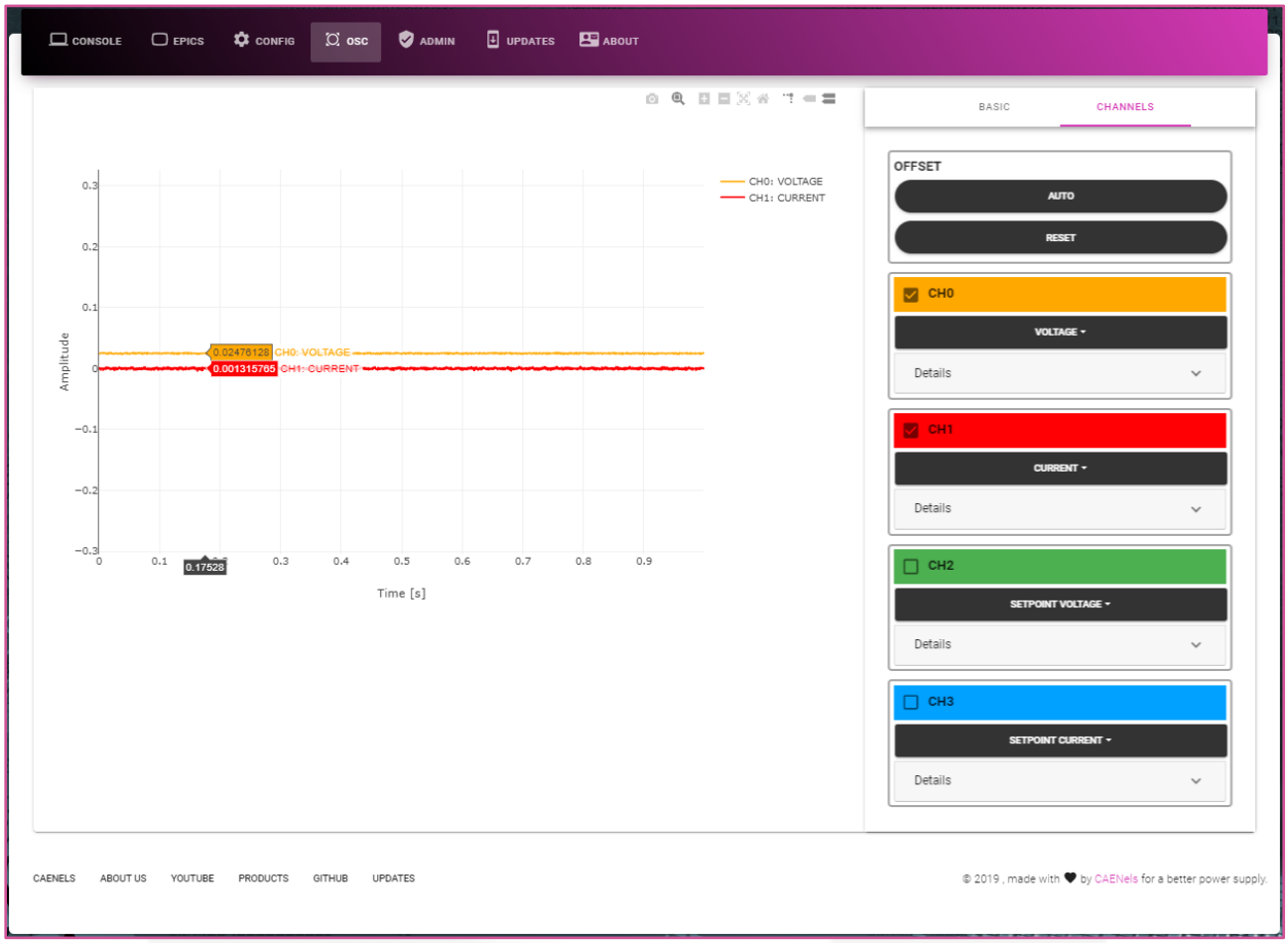


Figure 30: Web Server – Embedded Oscilloscope

Above the oscilloscope plotting several icons are present:

Figure 31: Web Server – Embedded Oscilloscope – zooming features

These icons provide different features, from left to right:

- Save plot as .png file
- Zoom (creating a zoom region with mouse cursor)
- Zoom in
- Zoom out
- Autoscale
- Reset axes
- Toggle spike lines (it correlates X and Y points for easier oscilloscope reading)
- Show closest data (shows time,value per each channel when passing on the channels plotting with mouse cursor)

- Compare data (shows valueCH1,…,valueCHn,time when passing on the channels plotting with mouse cursor)

On the upright corner in **Figure 30** two windows are present: “BASIC” and “CHANNELS”, here below discussed.

3.4.1 Channels

The embedded Oscilloscope allows to plot up to 4 values, to be decided within:

- Current set-point
- Voltage set-point
- Current actual values
- Voltage actual values

In addition, two offset functions are available by clicking on the related widgets:

- AUTO: Sets all the channels to zero
- RESET: Re set the real values for each channel

3.4.2 Basic

Here the user can set different values and parameters related to the oscilloscope operation and triggering options:

Figure 32: Web Server – Embedded Oscilloscope – BASIC window

Four different operation modes are available from the “MODE” window:

- AUTO: continuous real time plotting
- NORM: used in trigger mode, oscilloscope waits for trigger signal. It plots each trigger.

- SINGLE: used in trigger mode, oscilloscope waits for trigger signal. It plots only the first trigger.
- STOP: stops plotting

"HORIZONTAL" window allows to change the time-width of the oscilloscope plotting.

"TRIGGER"* window is used to edit all the values related to trigger modes (NORM and SINGLE):

- SOURCE (CH1, CH2, CH3 or CH4)
- EDGE (POS, NEG, BOTH)
- Level
- Position

* The trigger must be hardware installed (it is optional on FAST PS and FAST PS M families). If installed, it will be present as "TRIG" in General Information - Capabilities (**Figure 5**).

3.5 Firmware Update & Support

"UPDATES" and "ABOUT" windows provide additional support and information to end-users such as firmware update and connection to CAEN ELS website as well as contacts for maintenance of power sources when required.

In order to update the unit's firmware, follow the simple instructions reported in **Figure 33**. Once the .updt file has been dropped, the power source will automatically start the upgrade procedure.

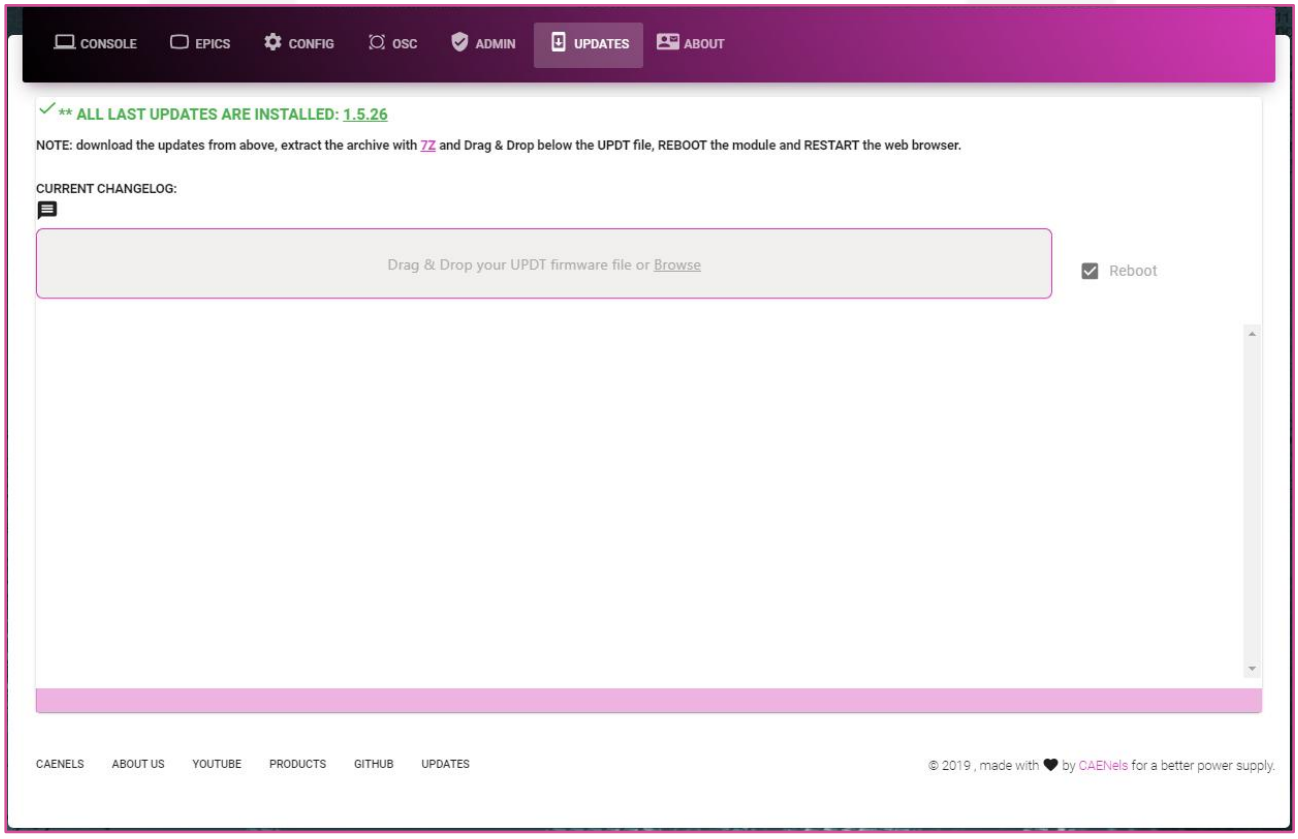


Figure 33: Web Server – "UPDATES"

4. Software Commands

This chapter describes the base TCP/IP software commands used for the control and configuration of the power module.

4.1 Ethernet Interface

The device is shipped with default IP address, subnet mask, and gateway and TCP-IP communication port:

Parameter	Factory Value
IP address	192.168.0.10
Subnet mask	255.255.255.0
Gateway	192.168.0.1
TCP/IP port	10001

Table 4: Default Ethernet Settings

4.2 Command Syntax

The command syntax used by the protocol is described in the following sections.

Commands must be sent in ASCII format and are composed by a *"command field"* and one, two or none *"parameter field"*, separated by a colon (*":"* or *"0x3A"* in hexadecimal notation). The number of *"parameter fields"* depends on the specific command. Commands are **NOT case sensitive** and therefore the command string can be sent either using uppercase or lowercase characters (conversion to uppercase characters is performed internally). Each command must be terminated with the termination sequence. The protocol supports two termination sequences:

- *"carriage return"* termination char "\r" (*"0x0D"* in hexadecimal notation or commonly CR) or
- "*carriage return\line feed*" sequence "\r\n" (*"0x0D 0x0A"* in hexadecimal notation or commonly CRLF).

Command Example:

MWI:20.5580\r or ***MWI:20.5580\r\n***

- ***"MWI"*** is the command field;
- ***":"*** is the parameter's separation character;
- ***"20.5580"*** is the first parameter field;
- ***"\r"*** or ***"\r\n"*** are the termination sequences of the command.

In the following command description the ***"\r"*** termination char is used, but it can be always replaced with the termination sequence ***"\r\n"***.

Commands are processed one at a time; therefore, **user must wait for a response from the unit before sending the next command**.

All the responses from the FAST-PS module are in upper case and are terminated with the same *"carriage return\line feed"* sequence ("\r\n"), *"0x0D 0x0A"* in hexadecimal notation or commonly CRLF.

MWI:10.5875\r\n →

← **#ACK\r\n**

or:

MWI:10.5875\r →

← **#ACK\r\n**

4.3 Command Replies

The reply from the module depends on the given command. In general, the command can be grouped in two categories: Write commands and Read commands.

For **write commands** there are two specific replies that indicate that the command has been correctly elaborated or not. Those replies are hereafter presented:

- **Ac**Knowledge (“***#AK***”) indicates that the command is valid and it was correctly elaborated by the device:

#AK\r\n

  - ***“#AK”*** is the **Ac**Knowledged response to a valid command;
  - ***“\r\n”*** is the termination sequence of the reply.

- **N**ot **Ac**Knowledge (*“**#NAK**”*) indicates that the command is either not valid or that it was not accepted by the device; the *“NAK”* reply is followed by an *“error code”* field, which can be used to determine the cause of the error (see the List of the Error Codes appendix, section 4.4, for a detailed list of all possible error codes):

#NAK:01\r\n

  - ***“#NAK”*** is the **N**ot **Ac**Knowledged response to an invalid command;
  - ***“:”*** is the parameter’s separation character;
  - ***“01”*** is the error code,
  - ***“\r\n”*** is the termination sequence of the reply.

For **read commands**, the replies are generally formed by an echo string, followed by the corresponding read value. The echo string is preceded by the hash character (“#”) and the echo is separated from the “**:**” separation character.

Some examples are hereafter shown:

MRI\r →

← **#MRI:12.8875\r\n**

or:

MWI:?\r →

← **#MWI:10.9850\r\n**

or:

MRG:90\r →

← **#MRG:90:0x2\r\n**

- the read commands are highlighted in **blue**;
- the echo string is highlighted in **green**;
- the read value is in **purple**;
- the termination char is highlighted in **red**.

For more detailed information about the single command please refer to the specific command section.

4.4 Error Table

The list of error codes returned with the ***#NAK*** reply and their description are hereafter shown:

Error Code #	*Description*
01	Unknown command
02	Unknown Parameter
03	Index out of range
04	Not Enough Arguments
05	Privilege Level Requirement not met
06	Save Error on device
07	Invalid password
08	Module in fault
09	Module already ON
10	Setpoint is out of hardware limits
11	Setpoint is out of software limits
12	Setpoint is not a number
13	Module is OFF
14	Slew Rate out of limits
15	Device is set in local mode
16	Module is not in waveform mode
17	Module is in waveform mode
18	Device is set in remote mode
19	Module is already in the selected loop mode
20	Module is not in the selected loop mode
21	Module is not in normal update mode
22	Float mode is already selected

Error Code #	Description
23	Unknown sub-command for SFP communication
24	Unknown feature or feature not available (AIN,TRIG)
25	Parallel Fault
26	Waveform error
27	Cannot open the required file
28	Module is currently inverting the polarity
29	Cannot write waveform data
30	Polarity switch not allowed
31	Cannot set options for socket used by oscilloscope
32	Cannot change settings while in parallel slave mode
33	MASTER and SLAVES have different FW version
34	MASTER and SLAVES are different models
35	MASTER and SLAVES have different ratings
36	The required feature is not available
37	UDP buffer overflow
38	Module is in “Wait for OFF”
39	This field is read only
40	Cannot parse input name for debug field
41	Cannot parse input value for debug field
42	Cannot parse type for debug field
43	DHCP is enabled
44	This command is disabled
99	Unknown error

Table 5: NAK Error code table

4.5 Command Table

The list of commands used within the communication protocol and the corresponding syntax is hereafter presented as well as a description of each command purpose and any special requirements related to the specific command. The base commands (common to all modules) are summarized in Table 6. The commands for the FAST-PS 1K5 are listed in Table 7.

Command	Read/ Write	Parameter #1	Parameter #2	Detailed description	Reply value
VER	R	/	/	Return the module model and installed firmware versions	ASCII indicating the module model and firmware version
MON	W	/	/	Turn on the module	“AK” or “NAK”
MOFF	W	/	/	Turn the module OFF	“AK”
LOOP	W R	“I” or “V” “?”	/ /	Set the power module loop mode Query for the power supply loop mode	“AK” or “NAK” Loop mode (“I” or “V”)
UPMODE	W R	Update mode “?”	/ /	Set the new update mode (ASCII) Query for the current update mode	“AK” or “NAK” ASCII indicating the current setpoint
SETFLOAT	W R	“F” or “N” “?”	/ /	Set if the output is floating or not	“AK” or “NAK” Float mode if “F” or not “N”
MST	R	/	/	Read module internal status register	Internal status register (Hex representation)
MRESET	W	/	/	Reset the module status register	“AK” or “NAK”
MRI	R	/	/	Read output current value	ASCII indicating the output read current
MRV	R	/	/	Read output voltage value	ASCII indicating the output read voltage
MRW	R	/	/	Read output power	ASCII indicating the output read power
MRIA	R	/	/	Read instantaneous output current value	ASCII indicating the output read current

Command	Read/ Write	Parameter #1	Parameter #2	Detailed description	Reply value
MRVA	R	/	/	Read instantaneous output voltage value	ASCII indicating the output read voltage
MRWA	R	/	/	Read instantaneous output power	ASCII indicating the output read power
MRIO	R	/	/	Read output current offset	ASCII indicating the output read current
MRVO	R	/	/	Read output voltage offset	ASCII indicating the output read voltage
MRT	R	/	/	Read MOSFET Heatsink Temperature [°C]	ASCII indicating the temperature value
MRP	R	/	/	Read DC-Link Voltage	ASCII indicating the DC-Link voltage
MGC	R	/	/	Read Earth Leakage current	ASCII indicating the Earth leakage current
MWV	W R	V Setpoint "?"	/ /	Set the new voltage setpoint (ASCII) Query for the last applied setpoint	"AK" or "NAK" ASCII indicating the voltage setpoint
MWVR	W R	V Setpoint "?"	/ /	Go to the given setpoint with a ramp (ASCII) Query for the last accepted final ramp setpoint	"AK" or "NAK" ASCII indicating the voltage setpoint
MWI	W R	I Setpoint "?"	/ /	Set the new current setpoint (ASCII) Query for the last applied current setpoint	"AK" or "NAK" ASCII indicating the current setpoint
MWIR	W R	I Setpoint "?"	/ /	Go to the given setpoint with a ramp (ASCII) Query for the last accepted final ramp setpoint	"AK" or "NAK" ASCII indicating the current setpoint

Command	Read/ Write	Parameter #1	Parameter #2	Detailed description	Reply value
MSRI	W R	I Ramp Slew rate "?"	/ /	Set the I ramp slew rate [A/s] (ASCII) Query for the I ramp slew-rate	"AK" or "NAK" ASCII indicating the I ramp slew-rate
MSRV	W R	V Ramp Slew rate "?"	/ /	Set the I ramp slew rate [V/s] (ASCII) Query for the I ramp slew-rate	"AK" or "NAK" ASCII indicating the I ramp slew-rate
MRID	R	/	/	Read module identification	Module identification (ASCII)
HELP	R	/	/	Print this command List	Command List
HWRESET	W	/	/	Reboot power supply software	"AK" or "NAK"
PASSWORD	W R	Password word "?"	/	Set the password word (ASCII) Query for the actual user privileges	"AK" or "NAK" User privileges (ASCII representation)
MRG	R	Parameter field #	/	Read the given parameter field	Field content (ASCII)
MWG	W	Parameter field #	Cell content (ASCII)	Write to the given parameter field	"AK" or "NAK"
MSAVE	W	/	/	Save the used parameter in the non-volatile memory	"AK" or "NAK"
NETWORK	W R	DHCP IP NETMASK GATEWAY	1/0 IP NETMASK GATEWAY	Set the network configuration and/or enable/disable the DHCP	"AK" or "NAK" Network configuration

Table 6: Commands overview table

Command	Read/ Write	Parameter #1	Parameter #2	Detailed description	Reply value
MGPC	R	/	/	Read AUX Voltage	ASCII indicating voltage present in the AUX
MCRWF	W	/	/	Turn on Crowbar circuit (that shorts the output)	“AK” or “NAK”

Table 7: Commands for FAST-PS-1K5

Command	Read/ Write	Parameter #1	Parameter #2	Detailed description	Reply value
TRIG	W	"?" BOTH LEVEL NEG POS ON/OFF	/ / HIGH/LOW / / /	Set and monitor trigger options	"AK" or "NAK"
UPMODE	W R	"?" ANALOG NORMAL WAVEFORM	/ / / /	Set the new update mode (ASCII) Query for the current update mode	"AK" or "NAK" ASCII indicating the current setpoint
WAVE	W	KEEP_START N_PERIODS POINTS START STOP TRIGGER	/ Integer Floating array / / START/POINT	Set waveform generator	"AK" or "NAK"

Table 8: Advanced features commands – available with firmware version 1.4.0 or later

4.6 Basic Commands

In the following section are described the basic commands that allows to control the power unit and to monitor its status.

4.6.1 MON Command

The ***MON*** (Module ON) command is intended to turn ON the module output driver, thus enabling the output current terminals and allowing the power supply to regulate and feed current or voltage to the connected load.

After the reception of an "MON" command, the power supply automatically sets output current to 0A or 0V (depending if the module is set in constant current or constant voltage mode).

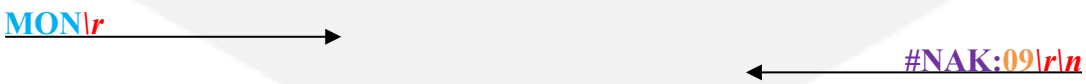
Replies from the power converter to a ***MON*** command are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed, with "***xx"*** indicating the error code. The complete list of the error codes is shown in the

Error Table. Sending a ***MON*** command when the module output is already enabled generates a non-acknowledgment response.

Examples:

MON command example:

MON command example when the module is already enabled (09 code):



4.6.2 MOFF Command

The ***MOFF*** (Module OFF) command is intended to turn OFF the module output driver, thus disabling the output terminals.

The ***MOFF*** command automatically sets output current to 0A or 0V with a ramp before disabling the output drivers. This is done in order to ovoid output overshoots (especially in constant current regulation mode). The slew-rate of the ramp is factory defined.

Replies from the unit to a ***MON*** command are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed, with "*xx*" indicating the error code.

Examples:

MOFF command example:

MOFF\r →

← **#AK\r\n**

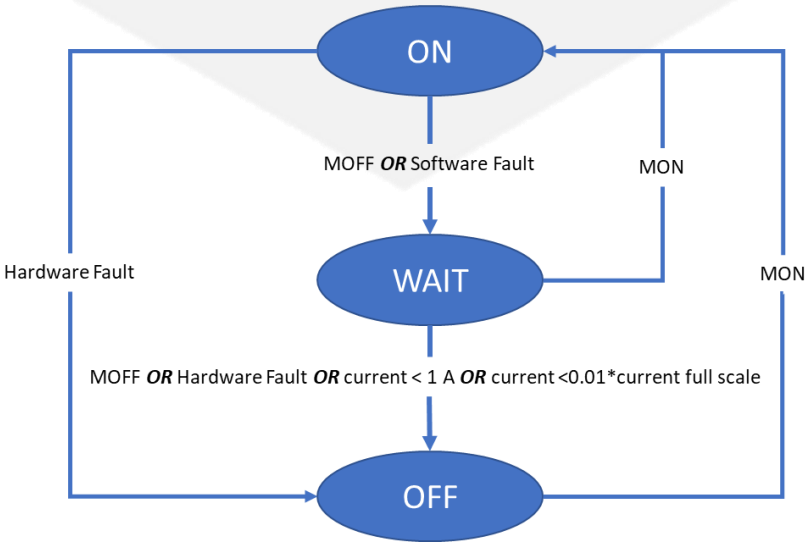
MOFF command example when the module is in local mode:

MOFF\r →

← **#NAK:15\r\n**

When the module receives an MOFF command, it will be driven to 0A setpoint carefully, in order to avoid any possible issue on highly-inductive loads.

Thus, the module operation is regulated as in the state machine shown below:



4.6.3 VER Command

The ***VER*** command returns the information regarding the model and the current installed firmware version.

The response to the ***VER*** command is in the following format:

#VER:ps_model:fw_version\r\n

where "***#VER***" is the echo string, "***ps_model***" is the power converter model and "***fw_version***" is the current firmware version. The echo, model and firmware information are separated by "**:**"character and the string is terminated with the standard "***\r\n***" character sequence.

Example:

VER command example:

4.7 Faults Monitoring and Reset

This section describes how to behave in the case of a fault (as described in the "User Manual"), and so how to reset the power supply (section 0), and how to monitor the fault presence (section 4.7.1).

4.7.1 MST Command

The ***MST*** command returns the value of the power supply internal status. The response to the ***MST*** command is in the following format:

#MST:status_reg\r\n

where "***#MST***" is the echo string and "***status_reg***" is the hexadecimal representation of the internal status register. The internal status register has 32 bits and so its representation is composed by 8 hexadecimal values.

The ***MST*** command, being a reading command, returns a response in any module condition.

Example:

MST command example:

MST\r →

← **#MST: 08000002\r\n**

In this example the value 08000002 (hex) has the binary representation:

0000 1000 0000 0000 0000 0000 0000 0010

Which means that the 2th bit and the 27th bit are set. One can refer to the status register (next pages) to see to what these bits are referred to. In the case of a FAST-PS this situation is referred to a fault condition (2nd bit), in particular due to the 2nd interlock (27th bit).

4.7.2 FAST-PS Status Register

The following table shows the FAST-PS internal status register structure:

Bit #	Bit name	Description
#31	/	*reserved*
#30	/	*reserved*
#29	OVP	Over Power condition
#28	/	*reserved*
#27	Ext. Interlock #2	External interlock 2 has tripped
#26	Ext. Interlock #1	External interlock 1 has tripped
#25	Excessive Ripple	Module is having excessive ripple
#24	Regulation Fault	Modules has experienced a regulation fault
#23	Earth Fuse	Earth fuse is blown
#22	Earth Leakage	Earth current leakage fault
#21	DC-Link Fault	DC-Link under-voltage condition
#20	OVT	Over Temperature condition
#19	/	*reserved*
#18	Crowbar	Crowbar protection intervention
#17	Input OVC	Input Over Current
#16	/	*reserved*
#15	/	*reserved*
#14	/	*reserved*
#13	Waveform	Waveform is in execution
#12	Ramping	Module is ramping current or voltage
#11	/	*reserved*
#10	/	*reserved*
#9	/	*reserved*
#8	/	*reserved*
#7 - #6	Update mode [2 bits]	Normal [00], Analog input [11]
#5	Regulation mode	C.C. [0] or C.V. [1] output regulation mode
#4	/	*reserved*
#3 - #2	Control Mode [2 bits]	Indicates the mode of operation of the unit (Remote [00], Local [01])
#1	Fault condition	This bit is set if the module has experienced a fault condition
#0	ON/OFF	This bit is set when the module is enabled and correctly regulating the output

Table 9: FAST-PS Status Register structure

4.7.3 FAST-PS-M Status Register

The following table shows the FAST-PS-M internal status register structure:

Bit #	Bit name	Description
#31	/	*reserved*
#30	/	*reserved*
#29	OVP	Over Power condition
#28	DCCT NOT OK	*Internal DCCT Fault*
#27	Ext. Interlock #2	External interlock 2 has tripped
#26	Ext. Interlock #1	External interlock 1 has tripped
#25	Excessive Ripple	Module is having excessive ripple
#24	Regulation Fault	Modules has experienced a regulation fault
#23	Earth Fuse	Earth fuse is blown
#22	Earth Leakage	Earth current leakage fault
#21	DC-Link Fault	DC-Link under-voltage condition
#20	OVT	Over Temperature condition
#19	DC-FUSE	*DC-Link Internal Fuse blow-up*
#18	/	*reserved*
#17	/	*reserved*
#16	/	*reserved*
#15	/	*reserved*
#14	/	*reserved*
#13	Waveform	Waveform is in execution
#12	Ramping	Module is ramping current or voltage
#11	/	*reserved*
#10	/	*reserved*
#9	/	*reserved*
#8	/	*reserved*
#7 - #6	Update mode [2 bits]	Normal [00], Analog input [11]
#5	Regulation mode	C.C. [0] or C.V. [1] output regulation mode
#4	/	*reserved*
#3 - #2	Control Mode [2 bits]	Indicates the mode of operation of the unit (Remote [00], Local [01])
#1	Fault condition	This bit is set if the module has experienced a fault condition
#0	ON/OFF	This bit is set when the module is enabled and correctly regulating the output

Table 10: FAST-PS-M Status Register structure

4.7.4 FAST-PS-1K5 Status Register

The following table shows the FAST-PS-1K5 internal status register structure:

Bit #	Bit name	Description
#31	OVP	Over Power condition
#30	DCCT Fault	*DCCT is not working*
#29	Ext. Interlock #4	External interlock 4 has tripped
#28	Ext. Interlock #3	External interlock 3 has tripped
#27	Ext. Interlock #2	External interlock 2 has tripped
#26	Ext. Interlock #1	External interlock 1 has tripped
#25	Excessive Ripple	Module is having excessive ripple
#24	Regulation Fault	Modules has experienced a regulation fault
#23	Earth Fuse	Earth fuse is blown
#22	Earth Leakage	Earth current leakage fault
#21	DC-Link Fault	DC-Link under-voltage condition
#20	OVT	Over Temperature condition
#19	Quench Fault	*Quench fault has been detected*
#18	Crowbar	Crowbar protection intervention
#17	Input OVC	Input Over Current
#16	/	*reserved*
#15	/	*reserved*
#14	/	*reserved*
#13	/	/
#12	Ramping	Module is ramping current or voltage
#11	Crowbar Force	*Crowbar has been forced by the user*
#10	/	*reserved*
#9	/	*reserved*
#8	/	*reserved*
#7 - #6	Update mode [2 bits]	Normal [00], Analog input [11]
#5	Regulation mode	C.C. [0] or C.V. [1] output regulation mode
#4	/	*reserved*
#3 - #2	Control Mode [2 bits]	Indicates the mode of operation of the unit (Remote [00], Local [01])
#1	Fault condition	This bit is set if the module has experienced a fault condition
#0	ON/OFF	This bit is set when the module is enabled and correctly regulating the output

Table 11: FAST-PS-1k5 Status Register structure

4.7.5 NGPS Status Register

The following table shows the NGPS internal status register structure:

Bit #	Bit name	Description
#31	OVP	Over Power condition
#30	DCCT FAULT	DCCT Not working properly
#29	Ext. Interlock #4	External interlock 4 has tripped
#28	Ext. Interlock #3	External interlock 3 has tripped
#27	Ext. Interlock #2	External interlock 2 has tripped
#26	Ext. Interlock #1	External interlock 1 has tripped
#25	/	*reserved*
#24	Regulation Fault	Modules has experienced a regulation fault
#23	Earth Fuse	Earth fuse is blown
#22	Earth Leakage	Earth current leakage fault
#21	Mains Fault	Mains fail condition
#20	OVT	Over Temperature condition
#19	/	*reserved*
#18	/	*reserved*
#17	Input OVC	*Input Over Current*
#16	/	*reserved*
#15	/	*reserved*
#14	/	*reserved*
#13	Waveform	Waveform is in execution
#12	Ramping	Module is ramping current or voltage
#11	/	*reserved*
#10	/	*reserved*
#9	/	*reserved*
#8	/	*reserved*
#7 - #6	Update mode [2 bits]	Normal [00], Analog input [11]
#5	Regulation mode	C.C. [0] or C.V. [1] output regulation mode
#4	/	*reserved*
#3 - #2	Control Mode [2 bits]	Indicates the mode of operation of the unit (Remote [00], Local [01])
#1	Fault condition	This bit is set if the module has experienced a fault condition
#0	ON/OFF	This bit is set when the module is enabled and correctly regulating the output

Table 12: NGPS Status Register structure

4.7.6 MRESET Command

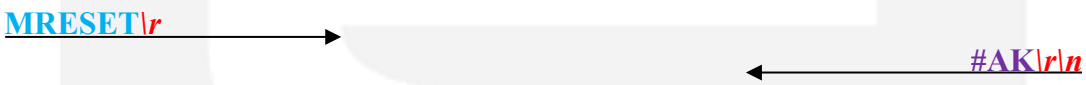
The ***MRESET*** command has to be used in order to perform a complete reset of the module status register. This is needed, for example, to enable the channel output again after a fault condition has been fixed.

Before sending the ***MRESET*** command to the power supply it is important to remove the fault presence, or the power supply will instantly get a new fault issue. After an ***MRESET*** command with reply in the form "***#AK\r\n***", the power supply can be turned on again.

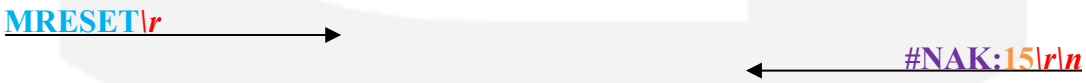
Replies from the unit to a ***MRESET*** command are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code). The complete list of the error codes is shown in the
Error Table**,** section 4.4**).**

Examples:

MRESET command example:



MRESET command example when the module is in local mode:



4.8 Current and Voltage Setting/Reading

In this section, specific commands to set or to read the value of the current and/or voltage are discussed.

4.8.1 UPMODE Command

First of all, in order to update the setpoint through remote control, the operation mode needs to be in ***NORMAL*** mode. ***UPMODE*** command can be used in order to select the update mode of the set-point. There are two possible modes of operation:

- **NORMAL** – in this mode of operation the power unit works in the standard update mode. The direct set-point or ramp commands are received using the standard Ethernet communication and they are applied immediately when the command is received. The analog input signal is ignored.
- **ANALOG –** in this mode of operation the power unit receives the set-point from its analog input. The analog inputs go from -10 V up to +10 V. The setting command from the local or remote interface are not accepted.
  Note: this update mode is available only on units that have the analog input. This option has to be communicated at the order of the unit.

To set the update mode of operation the following commands has to be used:

UPMODE:mode\r\n

where "***mode***" is a string indicating the mode of operation:

- "**NORMAL**" for normal update mode,
- "**ANALOG**" for analog input update mode.

Replies from the unit to a ***UPMODE*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code). The analog update mode of operation can be set only when the module is turned OFF.

To read the current used loop mode of operation the query command: "***UPMODE:?***" has to be used. The response to the "***UPMODE:?***" query command is in the following format:

#UPMODE:mode \r\n

where "***#UPMODE***" is the echo string, "***mode***" is a single character indicating the loop mode ("***normal***" for normal update mode and "***analog***" for analog input update mode).

The update mode is also visible in the status register (bits #7, #6). For further information, please see the MST command

Examples:

UPMODE example to set the update mode to analog:

UPMODE:ANALOG\r →

← **#AK\r\n**

UPMODE query example when the module is in normal mode:

UPMODE:?\r →

← **#UPDMODE: NORMAL\r\n**

4.8.2 MRI Command

The ***MRI*** command returns the readback value of the power supply actual output current.

The readback current value is represented with 6-digit precision. Replies from the power supply to this command are in the following format:

#MRI:current_value\r\n

where "***#MRI***" is the echo string, "***current_value***" is the output current value readback in Ampere [A].

Example:

MRI command example:

4.8.3 MRV Command

The ***MRV*** command returns the readback value of the power supply actual output voltage.

The voltage readback value is represented with 6-digit precision. Replies from the power supply to this command are in the following format:

#MRV:voltage_value\r\n

where "***#MRV***" is the echo string, "***voltage_value***" is the output voltage value readback in Volts [V].

Example:

MRV command example:

4.8.4 LOOP Command

The ***LOOP*** command can be used in order to select the mode of loop control of the FAST-PS unit. There are two possible modes of operation:

- Constant Current (c.c.),
- Constant Voltage (c.v.).

To set the mode of operation the following commands has to be used:

LOOP:mode\r\n

where "***mode***" is a single char indicating the mode of operation:

- "**I**" for Constant Current (c.c.) mode and
- "**V**" for Constant Voltage (c.v.) mode.

Replies from the unit to a ***LOOP*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code). The two modes of operation can be changed only when the module is turned OFF.

To read the current used loop mode of operation the query command: "***LOOP:?***" has to be used. The response to the "***LOOP:?***" query command is in the following format:

#LOOP:mode \r\n

where "***#LOOP***" is the echo string, "***mode***" is a single character indicating the loop mode ("***I***" for constant current mode and "***V***" for constant voltage mode).

Examples:

LOOP set example to set the constant current mode:

LOOP:I\r →

← **#AK\r\n**

LOOP set example when the module is ON:

LOOP:V\r →

← **#NAK:09\r\n**

LOOP query example when the module is in constant voltage (c.v.) mode:

LOOP:?\r →

← **#LOOP:V\r\n**

4.8.5 MWI Command

The ***MWI*** command can be used to set the output current value when the module is in the constant current mode (see ***LOOP*** Command). This command is usually needed when running feedback-related applications and for small changes in the output current.

The use of this command is alternative to the

MWIR Command (ramping current command), which is advised for regular use.

This command has the following format:

MWI:current_setpoint\r\n

where "***current_setpoint***" is the desired current set-point expressed in Ampere [A].

Replies from the module to a ***MWI*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

To read last applied current setpoint the query command: "***MWI:?***" has to be used. The response to this query command is in the following format:

#MWI:current_setpoint\r\n

where "***#MWI***" is the echo string, "***current_setpoint***" is the last applied current setpoint expressed in Ampere [A].

Examples:

MWI set example, with current setpoint +1.52 A:

MWI:1.52\r →

← **#AK\r\n**

MWI set example when the module is OFF:

MWI:1.52\r →

← **#NAK:13\r\n**

MWI query example:

MWI:?\r →

← **#MWI:1.52\r\n**

4.8.6 MWV Command

The ***MWV*** command can be used to set the output voltage value when the constant voltage mode is used (see ***LOOP*** Command). The use of this command is alternative to the ***MWVR*** Command (ramping voltage command).

This command has the following format:

MWV:voltage_setpoint\r\n

where "***voltage_setpoint***" is the desired voltage set-point expressed in Volts [V].

Replies from the unit to a ***MWV*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

To read last applied voltage setpoint the query command: "***MWV:?***" has to be used. The response to this query command is in the following format:

#MWV:voltage_setpoint \r\n

where "***#MWV***" is the echo string, "***voltage_setpoint***" is the last applied voltage setpoint expressed in Volts [V].

Examples:

MWV set example, with voltage setpoint +10.525 V:

MWV:10.525\r →

← **#AK\r\n**

MWV set example when the module is OFF:

MWV:10.525\r →

← **#NAK:13\r\n**

MWV query example:

MWV:?\r →

← **#MWV:10.525\r\n**

4.8.7 MWIR Command

The ***MWIR*** command can be used to perform a ramp to the given current setpoint. This command can be used when the constant current mode is selected (see ***LOOP*** Command).

The use of this command is alternative to the ***MWI*** Command**.** The difference between the ***MWI*** command and the ***MWIR*** command is that the first one generates a direct change in output current characterized by the PID regulator parameters (the command is ideally suited for small output current changes and feedback purposes) while the second one makes the power supply go from the previous to the actual current value performing a ramp, defined by a slew-rate in [A/s].

The default value of the slew-rate is stored in the parameter table and it can be read and modified using the ***MSRI*** command (section 4.8.8).

To dynamically change the current slew-rate value it is possible using the ***MSRI*** Command. This command has the following format:

MWIR:final_ramp_setpoint\r\n

where "***final_ramp_setpoint***" is the final current value expressed in Ampere [A] to which the power unit will ramp with the defined slew-rate.

Replies from the power unit to a ***MWIR*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("*xx*" is the error code).

To read the selected final ramp setpoint, the query command: "***MWIR:?***" has to be used. The response to this query command is in the following format:

#MWIR:final_ramp_setpoint\r\n

where "***#MWIR***" is the echo string and "***final_ramp_setpoint***" is the final ramp setpoint expressed in Ampere [A].

Examples:

MWIR set example, with final ramp setpoint +10.5 A:

MWIR:10.5\r →

← **#AK\r\n**

MWIR set example when the module is OFF:

MWIR:10.5\r →

← **#NAK:13\r\n**

MWIR query example:

MWIR:?\r →

#MWIR:10.5\r\n ←

4.8.8 MSRI Command

The ***MSRI*** command can be used to dynamically change the value of the current ramp slew-rate. The default slew-rate, used at start-up of the unit, is the value stored in the parameters table.

This command has the following format:

MSRI:slew_rate\r\n

where "***slew_rate***" is slew-rate for the current ramp expressed in Ampere per second [A/s].

Replies from the power converter to a ***MSRI*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

To read the current used slew-rate for the current ramp, the query command: "***MSRI:?***" has to be used. The response to this query command is in the following format:

#MSRI:slew_rate\r\n

where "***#MSRI***" is the echo string and "***slew_rate***" is the slew-rate value used for the current ramp expressed in Ampere per second [A/s].

Examples:

MSRI example, to set the current slew-rate to 10 A/s:

MSRI:10\r →

← #AK\r\n

MSRI set example when the unit is in local mode:

MSRI:10\r →

← #NAK:15\r\n

MSRI query example:

MSRI:?\r →

← #MSRI:10\r\n

4.8.9 MWVR Command

The ***MWVR*** command can be used to perform a ramp to the given voltage setpoint. This command can be used, when the constant voltage mode is selected (see ***LOOP*** Command).

The use of this command is alternative to the ***MWV*** Command**.** The difference between the ***MWV*** command and the ***MWVR*** command is that the first one generates a direct change in output voltage characterized by the PID regulator parameters while the second one makes the power supply go from the previous to the actual current value performing a ramp, defined by a slew-rate in [V/s].

To dynamically change the slew-rate value it is possible to use the ***MSRV*** Command (section 4.8.10).

This command has the following format:

MWVR:final_ramp_setpoint\r\n

where "***final_ramp_setpoint***" is the final voltage value expressed in Volts [V] to which the power unit will ramp with the defined slew-rate.

Replies from the FAST-PS to a ***MWVR*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

To read the selected final ramp setpoint, the query command: "***MWVR:?***" has to be used. The response to this query command is in the following format:

#MWVR:final_ramp_setpoint\r\n

where "***#MWVR***" is the echo string and "***final_ramp_setpoint***" is the final ramp setpoint expressed in Volts [V].

Examples:

MWVR set example, with final ramp setpoint +15.2 A:

MWVR:15.2\r →

← **#AK\r\n**

MWVR set example when the module is OFF:

MWVR:15.2\r →

← **#NAK:13\r\n**

MWVR query example:

MWVR:?\r →

← **#MWIR:15.2\r\n**

4.8.10 MSRV Command

The ***MSRV*** command can be used to dynamically change the value of the voltage ramp slew-rate. The default slew-rate, used at start-up of the unit, is the value stored in the parameters table.

This command has the following format:

MSRV:slew_rate\r\n

where "***slew_rate***" is slew-rate for the voltage ramp expressed in Volts per second [V/s].

Replies from the unit to a ***MSRV*** set are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

To read the current used slew-rate for the voltage ramp, the query command: "***MSRV:?***" has to be used. The response to this query command is in the following format:

#MSRV:slew_rate\r\n

where "***#MSRV***" is the echo string and "***slew_rate***" is the slew-rate value used for the voltage ramp expressed in Volts per second [V/s].

Examples:

MSRV example, to set the current slew-rate to 10 V/s:

MSRV:10\r →

← **#AK\r\n**

MSRV set example when the unit is in local mode:

MSRV:10\r →

← **#NAK:15\r\n**

MSRV query example:

MSRV:?\r →

← **#MSRV:10\r\n**

4.9 Generic Monitoring Parameters

This section describes some generic parameters that can be monitored through dedicated instructions (e.g. MOSFET temperature, estimated active power applied to the connected load and so on).

4.9.1 MRT Command

The ***MRT*** command returns the value of the temperature directly measured on the output stage MOSFET heatsink.

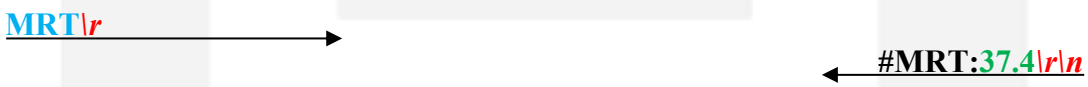
The response to the ***MRT*** command is in the following format:

#MRT:temperature\r\n

where "***#MRT***" is the echo string and "***temperature***" is the temperature value expressed in Celsius [°C]. The ***MRT*** command, being a reading command, returns a response in any module condition.

Example:

MRT command example:



4.9.2 MRW Command

The ***MRW*** command returns the actual value of the estimated active power applied to the connected load.

The response to the ***MRW*** command is in the following format:

#MRW:active_power\r\n

where "***#MRW***" is the echo string and "***active_power***" is the output active power readback expressed in Watts [W], estimated as the product of the output voltage and output current readbacks. The ***MRW*** command, being a reading command, returns a response in any module condition.

Example:

MRW command example:

4.9.3 MGC Command

The ***MGC*** command returns the readback value of the actual leakage current of the unit.

The response to the ***MGC*** command is in the following format:

#MGC:leakage_current\r\n

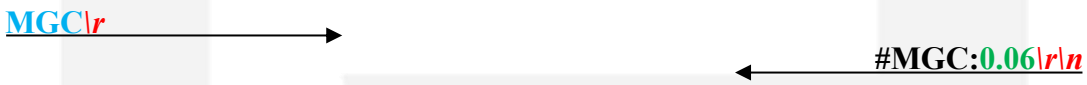
where "***#MGC***" is the echo string and "***leakage_current***" is the earth leakage current, expressed in Ampere [A].

When a leakage fault condition is tripped, the ***MGC*** command will return the value of the max leakage current that tripped the fault. To return to the normal behavior of the read command, the module status has to be reset (see MRESET command).

The ***MGC*** command, being a reading command, returns a response in any module condition.

Example:

MGC command example for a 60mA ground leakage current:



4.9.4 MRID Command

The ***MRID*** command returns the module identification name string. This description is useful in case that there are numerous units installed and it is possible to give a description for each unit (for example the name of the load on which the unit is connected). This information is also displayed on the local display.

The response to the ***MRID*** command is in the following format:

#MRID:fast_ps_identification\r\n

where "***#MRID***" is the echo string and "***fast_ps_identification***" is the module identification string. The identification string is stored in the parameters table and so it is possible to change it using the MWG command.

Example:

MRID example with the module identification "SkewMag1.3":

4.10 Special Commands

This section describes special commands that are specific for each different power supply.

4.10.1 MCRWF Command in FAST-PS-1K5

The ***MCRWF*** (Module Crowbar Force) command is intended to turn ON the Crowbar circuit allowing the load current to be flowing outside of the power supply.

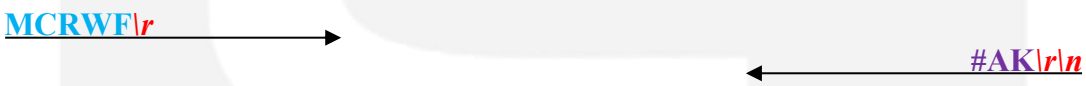
After the reception of an "MCRWF" command, the power supply automatically switches off the output and activates the crowbar circuit that is shorting the output bus bars.

Replies from the FAST-PS-1k5 to a ***MCRWF*** command are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed, with "***xx***" indicating the error code. The complete list of the error codes is shown in the Error Table.

Error TableSending an ***MCRWF*** command when the Crowbar is already enabled generates a non-acknowledgment response.

Examples:

MCRWF command example:



4.10.2 SETPS Command

The ***SETPS*** (Set Persistent Switch) command is intended to turn ON or OFF Persistent Switch output.

The command has the following format:

SETPS:state\r\n

where "***state***" is the state of the Persistent Switch output connector:

- "1": the Persistent Switch output is sourcing up to 500mA with a fixed output voltage of 24V;
- "0": the Persistent Switch output is at 0V.

Replies from the FAST-PS-1k5 to a ***SETPS*** command are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed, with "***xx***" indicating the error code. The complete list of the error codes is shown in the Error Table.

Examples:

SETPS command example:

SETPS:1\r →

← **#AK\r\n**

SETPS command example to set the 24 V to the Persistent Switch output

SETPS:0\r →

← **#AK\r\n**

SETPS command example to reset the 0 V to the Persistent Switch output

4.10.3 MSIGPU Command

This feature is available only with firmware version 1.2.4 or newer.

The ***MSIGPU*** (Module Solid State Signal – Power-Up) command is intended set the power up state of the solid switch relay placed on the I/O connector on the power units at the start-up. Please note that the memory cell is applied after a reboot for the "MSIGPU" command.

The command has the following format:

MSIGPU:powerup_status\r\n

where "***powerup_status***" is the desired power-up output status of the relay contacts that needs to be stored in the internal memory and it can be:

- "-1": the solid state switch cannot be SW controlled. The open/close configuration is handled by the power unit as described in the User's Manual;
- "0": open circuit;
- "1": short circuit.

Please note that the contacts of the solid state relay must be kept at a voltage lower than ±60 V respect to ground and that the maximum current that is allowed to flow is of 400 mA.

This state is indicated as "open" (i.e. 0) or "shorted" (i.e. 1) and its status can be check with a query.

A query for the command is also present to check the status of the stored solid state switch at power-up and can be performed by using the "***MSIGPU:?\r\n***" command.

Please note that if the power converter is not powered, the state of this solid state relay is always "open" (open circuit).

MSIGPU command example to set the solid state relay contacts open at power-up:

MSIGPU:0\r →

← **#AK\r\n**

MSIGPU command example to set the solid state relay contacts shorted at power-up:

MSIGPU:1\r →

← **#AK\r\n**

MSIGPU query example to check the status of the solid state relay contacts at power-up (closed/shorted in this case):

MSIGPU:?\r →

← **#MSIGPU:1\r\n**

4.10.4 MSIG Command

This feature is available only with firmware version 1.2.4 or newer.

The ***MSIG*** (Module Solid State Signal) command is intended to instantly switch the status of the solid state relay present on the I/O rear connector of the power units between open/close.

The command has the following format:

MSIG:status\r\n

where "***status***" is the desired output status of the relay contacts and it can be:

- "0": open circuit;
- "1": short circuit.

After the reception of an "MSIG" command, the power supply automatically switches the two contact between the states of "open" (i.e. 0) and closed/shorted (i.e. 1).

Please note that the contacts of the solid state relay must be kept at a voltage lower than ±60 V respect to ground and that the maximum current that is allowed to flow is of 400 mA.

Replies from the power supplies to a ***MSIG*** command are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command

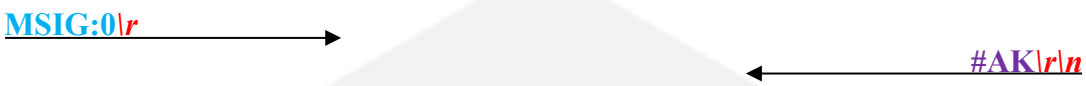
cannot be executed, with "***xx***" indicating the error code. The complete list of the error codes is shown in the Error Table.

A query for the command is also present to check the status of the solid state switch and can be performed by using the "***MSIG:?\r\n***" command.

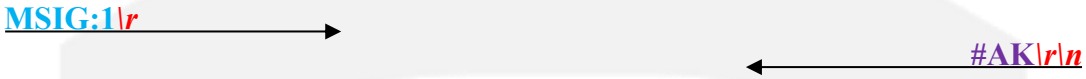
Error Table

Examples:

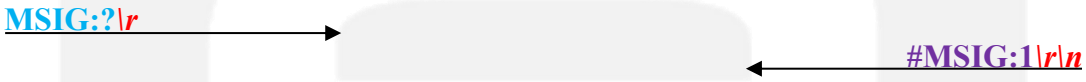
MSIG command example to open the solid state relay contacts:



MSIG command example to close/short the solid state relay contacts:



MSIG query example to check the status of the solid state relay contacts (closed):



4.11 Configuration Commands

In the following section are described the software commands that allow to read, set and store the working parameters of the power supply unit. **MRG** Command and***MWG*** Command allow reading or modifying the working parameters.

The write-access to several parameters is password protected and certain parameters are read only and so it is not possible to modify them. To change the password privileges, use the

PASSWORD Command.

In order to save the parameter on the on-board non-volatile memory, the ***MSAVE*** Command has to be used.

The complete list of the configuration parameters, their field index and the access privileges are hereafter shown:

Parameter #	*Access Privileges*	*Parameter Name*
#0	Read Only	Firmware ID
#1	Read Only	PS Model
#2	Read Only	Serial Number
#3	Read Only	MAC Ethernet
#4	Read Only	MAC SFP #1
#5	Read Only	MAC SFP #2
#6 - #8	/	Reserved
#9	Read Only	Calibration date
#10	Read Only	Current Calibration Parameter a
#11	Read Only	Current Calibration Parameter b
#12	Read Only	Current Calibration Parameter c
#13	Read Only	Current Calibration Parameter d
#14	Read Only	Voltage Calibration Parameter a
#15	Read Only	Voltage Calibration Parameter b
#16	Read Only	Voltage Calibration Parameter c
#17	Read Only	Voltage Calibration Parameter d
#18	Read Only	DC Link Calibration Parameter a
#19	Read Only	DC Link Calibration Parameter b
#20	Read Only	AC Link Calibration Parameter a
#21	Read Only	AC Link Calibration Parameter b
#22	Read Only	Current Leakage Calibration Parameter a
#23	Read Only	Current Leakage Calibration Parameter b
#24	Read Only	Analog Input Calibration Parameter a
#25	Read Only	Analog Input Calibration Parameter b
#26	Read Only	Analog Input Calibration Parameter c
#27	Read Only	Analog Input Calibration Parameter d
#28 - #29	/	Reserved

Parameter #	Access Privileges	Parameter Name
#30	User	Module Identification
#31	User	Default Current Slew Rate [A/s]
#32	User	Default Voltage Slew Rate V [V/s]
#33 - #34	/	Reserved
#35	User	Turning off time of Display [minutes] – 0 to disable
#36 - #39	/	Reserved
#40	User	PID I: Kp_v
#41	User	PID I: Ki_v
#42	User	PID I: Kd_v
#43	User	PID I: Kp_i
#44	User	PID I: Ki_i
#45	User	PID I: Kd_i
#46	User	PID I: Upper Limit Acc_v
#47	User	PID I: Lower Limit Acc_v
#48 - #59	/	Reserved
#60	User	PID V: Kp_i
#61	User	PID V: Ki_i
#62	User	PID V: Kd_i
#63	User	PID V: Kp_v
#64	User	PID V: Ki_v
#65	User	PID V: Kd_v
#66	User	PID V: Upper Limit Acc_i
#67	User	PID V: Lower Limit Acc_i
#68 - #77	/	Reserved
#78	Admin	Min Current Setpoint [A]
#79	Admin	Min Voltage Setpoint [V]
#80	Admin	Max Current Setpoint [A]
#81	Admin	Max Voltage Setpoint [V]
#82	Admin	Max Mosfet Temperature
#83	Admin	Min DC-link Threshold
#84	Admin	Earth Leakage Limit
#85	/	Reserved
#86	Admin	Current Regulation Fault Limit [A]
#87	Admin	Voltage Regulation Fault Limit [A]
#88	Admin	Regulation Fault Intervention Time [s]
#89	/	Reserved
#90	Admin	Interlock Enable Mask
#91	Admin	Interlock Activation State
#92	Admin	Interlock #1 intervention time [ms]

Parameter #	Access Privileges	Parameter Name
#93	Admin	Interlock #1 name
#94	Admin	Interlock #2 intervention time [ms]
#95	Admin	Interlock #2 name
#96 - #99	/	Reserved

Table 13: Parameters table for FAST-PS / FAST-PS-M

Parameter #	Access Privileges	Parameter Name
#0	Read Only	Firmware ID
#1	Read Only	PS Model
#2	Read Only	Serial Number
#3	Read Only	MAC Ethernet
#4	Read Only	MAC SFP #1
#5	Read Only	MAC SFP #2
#6 - #8	/	Reserved
#9	Read Only	Calibration date
#10	Read Only	Current Calibration Parameter a
#11	Read Only	Current Calibration Parameter b
#12	Read Only	Current Calibration Parameter c
#13	Read Only	Current Calibration Parameter d
#14	Read Only	Voltage Calibration Parameter a
#15	Read Only	Voltage Calibration Parameter b
#16	Read Only	Voltage Calibration Parameter c
#17	Read Only	Voltage Calibration Parameter d
#18	Read Only	DC Link Calibration Parameter a
#19	Read Only	DC Link Calibration Parameter b
#20	Read Only	AC Link Calibration Parameter a
#21	Read Only	AC Link Calibration Parameter b
#22	Read Only	Current Leakage Calibration Parameter a
#23	Read Only	Current Leakage Calibration Parameter b
#24	Read Only	Analog Input Calibration Parameter a
#25	Read Only	Analog Input Calibration Parameter b
#26	Read Only	Analog AUX Calibration Parameter a
#27	Read Only	Analog AUX Calibration Parameter b
#28 - #29	/	Reserved
#30	User	Module Identification
#31	User	Default Current Slew Rate [A/s]
#32	User	Default Voltage Slew Rate V [V/s]
#33 - #39	/	Reserved
#40	User	PID I: Kp_v

Parameter #	Access Privileges	Parameter Name
#41	User	PID I: Ki_v
#42	User	PID I: Kd_v
#43	User	PID I: Kp_i
#44	User	PID I: Ki_i
#45	User	PID I: Kd_i
#46	User	PID I: Upper Limit Acc_v
#47	User	PID I: Lower Limit Acc_v
#48 - #59	/	Reserved
#60	User	PID V: Kp_i
#61	User	PID V: Ki_i
#62	User	PID V: Kd_i
#63	User	PID V: Kp_v
#64	User	PID V: Ki_v
#65	User	PID V: Kd_v
#66	User	PID V: Upper Limit Acc_i
#67	User	PID V: Lower Limit Acc_i
#68 - #77	/	Reserved
#78	Admin	Min Current Setpoint [A]
#79	Admin	Min Voltage Setpoint [V]
#80	Admin	Max Current Setpoint [A]
#81	Admin	Max Voltage Setpoint [V]
#82	Admin	Max Mosfet Temperature
#83	Admin	Min DC-link Threshold
#84	Admin	Earth Leakage Limit
#85	/	Reserved
#86	Admin	Current Regulation Fault Limit [A]
#87	Admin	Voltage Regulation Fault Limit [A]
#88	Admin	Regulation Fault Intervention Time [s]
#89	/	Reserved
#90	Admin	Interlock Enable Mask
#91	Admin	Interlock Activation State
#92	Admin	Interlock #1 intervention time [ms]
#93	Admin	Interlock #1 name
#94	Admin	Interlock #2 intervention time [ms]
#95	Admin	Interlock #2 name
#96	Admin	Interlock #3 intervention time [ms]
#97	Admin	Interlock #3 name
#98	Admin	Interlock #4 intervention time [ms]
#99	Admin	Interlock #4 name

Parameter #	Access Privileges	Parameter Name
#100	Admin	Maximum Load resistance [Ω]
#101	Admin	Minimum Load resistance [Ω]
#102	Admin	Minimum Current for Quench detector [A]
#103	Admin	Quench intervention Time [s]

Table 14: Parameters table for FAST-PS-1K5

Parameter #	Access Privileges	Parameter Name
#0	Read Only	Firmware ID
#1	Read Only	PS Model
#2	Read Only	Serial Number
#3	Read Only	MAC Ethernet
#4	Read Only	MAC SFP #1
#5	Read Only	MAC SFP #2
#6 - #8	/	Reserved
#9	Read Only	Calibration date
#10	Read Only	Current Calibration Parameter a
#11	Read Only	Current Calibration Parameter b
#12	Read Only	Current Calibration Parameter c
#13	Read Only	Current Calibration Parameter d
#14	Read Only	Voltage Calibration Parameter a
#15	Read Only	Voltage Calibration Parameter b
#16	Read Only	Voltage Calibration Parameter c
#17	Read Only	Voltage Calibration Parameter d
#18	Read Only	DC Link Calibration Parameter a
#19	Read Only	DC Link Calibration Parameter b
#20	Read Only	AC Link Calibration Parameter a
#21	Read Only	AC Link Calibration Parameter b
#22	Read Only	Current Leakage Calibration Parameter a
#23	Read Only	Current Leakage Calibration Parameter b
#24	Read Only	Analog Input Calibration Parameter a
#25	Read Only	Analog Input Calibration Parameter b
#26	Read Only	Primary Current Calibration Parameter a
#27	Read Only	Primary Current Calibration Parameter b
#28 - #29	/	Reserved
#30	User	Module Identification
#31	User	Default Current Slew Rate [A/s]
#32	User	Default Voltage Slew Rate V [V/s]
#33 - #39	/	Reserved
#40	User	PID I: Kp_v

Parameter #	Access Privileges	Parameter Name
#41	User	PID I: Ki_v
#42	User	PID I: Kd_v
#43	User	PID I: Kp_i
#44	User	PID I: Ki_i
#45	User	PID I: Kd_i
#46	User	PID I: Upper Limit Acc_v
#47	User	PID I: Lower Limit Acc_v
#48 - #59	/	Reserved
#60	User	PID V: Kp_i
#61	User	PID V: Ki_i
#62	User	PID V: Kd_i
#63	User	PID V: Kp_v
#64	User	PID V: Ki_v
#65	User	PID V: Kd_v
#66	User	PID V: Upper Limit Acc_i
#67	User	PID V: Lower Limit Acc_i
#68 - #74	/	Reserved
#75	Admin	Max Transformer Temperature
#76	Admin	Min DCCT Shunt Temperature
#77	Admin	Max DCCT Shunt Temperature
#78 - #79	/	Reserved
#80	Admin	Max Current Setpoint [A]
#81	Admin	Max Voltage Setpoint [V]
#82	Admin	Max Heatsink Temperature
#83	Admin	Min DC-link Threshold
#84	Admin	Earth Leakage Limit
#85	/	Reserved
#86	Admin	Current Regulation Fault Limit [A]
#87	Admin	Voltage Regulation Fault Limit [A]
#88	Admin	Regulation Fault Intervention Time [s]
#89	Admin	Primary Current Limit
#90	Admin	Interlock Enable Mask
#91	Admin	Interlock Activation State
#92	Admin	Interlock #1 intervention time [ms]
#93	Admin	Interlock #1 name
#94	Admin	Interlock #2 intervention time [ms]
#95	Admin	Interlock #2 name
#96	Admin	Interlock #3 intervention time [ms]
#97	Admin	Interlock #3 name

Parameter #	Access Privileges	Parameter Name
#98	Admin	Interlock #4 intervention time [ms]
#99	Admin	Interlock #4 name

Table 15: Parameters table for NGPS

4.11.1 MRG Command

The ***MRG*** command returns the value stored in the given parameter number. The correct form for the reading request is as follow:

MRG:parameter_index\r\n

where "***parameter_index***" is the index of the parameter to be read. The response to the ***MRG*** command is in the following format:

#MRG:parameter_index:parameter_value\r\n

where "***#MRG***" is the echo string, "***parameter_index***" is the parameter's index and "***parameter_value***" is the parameter caption. The unit replies with "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code) – for example if the given parameter is out of the permitted range.

Examples:

MRG example of the FAST-PS Model (parameter #1):

MRG example of read a not valid parameter's index (parameter # -1):

4.11.2 MWG Command

The ***MWG*** command lets users write a desired value in the given parameters index.

MWG:parameter_index:parameter_value\r\n

where "***parameter_index***" is the parameter's index and "***parameter_value***" is the content to be written.

Replies from the power unit to a ***MWG*** write are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

After a ***MWG*** command the values are immediately applied, but they are not stored in the internal memory. To store the modified parameters in the non-volatile internal memory it is necessary to use the **MSAVE Command**.

Examples:

MWG example of the Module ID (parameter #30)

MWG:30:MAGNET A\r →

← **#AK \r\n**

MWG write example to the read-only field #1 (PS Model):

MWG:1:MAGNET A\r →

← **#NAK:05\r\n**

4.11.3 Interlock Setting

The power supply external interlock can be enabled or disabled by writing to the corresponding Interlock Enable/Disable Mask field of the advanced configuration parameters (field #90), using the MWG command. The value to be written is in ASCII format, representing the corresponding bit mask, as shown in the following table:

Bit Mask	Interlock number	ASCII string
0001	Interlock #1	0x1
0010	Interlock #2	0x2
0100	Interlock #3	0x4
1000	Interlock #4	0x8

Table 16: Interlock Mask Parameter

Only NGPS and FAST-PS-1K5 have four external interlocks; Interlock #3 and #4 have to be considered always disabled in FAST-PS and FAST-PS-M.

Example 1: if only Interlock #2 needs to be enabled, the following command has to be se sent to the power supply (after having un-locked the password protection): "MWG:90:0x2\r".

Example 2: if Interlock #2 and Interlock #4 needs to be enabled (0x2 + 0x8 = 0xA), the following command has to be se sent to the power supply (after having un-locked the password protection): "MWG:90:0xA\r".

Interlock Activation Level Mask

Each external interlock can be chosen to trip at high or low logic level. The high level means that the interlock trips when the interlock input signal is shorted, otherwise the low level that the interlock trips when the input is open. To configure the interlock state mask it is necessary to write on the advanced configuration parameters (field #91). The value to be written is an ASCII format representing the corresponding bit mask, as shown in the **Table 16**.

This setting has no effect if the interlock is not enabled. Only NGPS and FAST-PS-1K5 have four external interlocks; Interlock #3 and #4 have to be considered always disabled in FAST-PS and FAST-PS-M.

***Example 1*:** if interlock #1 needs to have a high activation level (trip when the interlock input signal is shorted), the following command has to be se sent to the power supply (after having un-locked the password protection): "MWG:91:0x1\r".

Example 2: if Interlock #1 and Interlock #4 (0x1 + 0x8 = 0x9) needs to have a high activation level (trip when the interlock input signal is shorted) the following command has to be se sent to the power supply (after having un-locked the password protection): "MWG:91:0x9\r".

Interlock Intervention Time

The module allows to set also the interlock intervention time (how long an interlock signal needs to be at its activation level before tripping and thus generating a fault condition). The Intervention time parameters are stored in:

- field #92 for Interlock #1;
- field #94 for Interlock #2;
- field #96 for Interlock #3;
- field #98 for Interlock #4.

The value to be set is in ASCII format, representing the intervention time in milliseconds. The minimum settable value is 0 (immediate generating of fault condition) and the maximum value is 10.000 ms (corresponding to 10 seconds).

***Example*:** if interlock #1 needs to have an interlock intervention time of 750 ms, the following command has to be se sent to the power unit: “MWG:92:750\r”. This setting has no effect if the interlock is disabled.

Interlock Identification Name

Units also allows associating a name to the interlocks in order to read form the remote interface or to display on the local display the interlock condition name. The Intervention names are stored in:

field #93 for Interlock #1;
field #95 for Interlock #2;
field #97 for Interlock #3;
field #99 for Interlock #4;
The value to be set is in ASCII format, representing the interlock name.

***Example*:** if the interlock #1 is associated to the cabinet door open, the following command can to be se sent to the power unit: “MWG:93:Cabinet door\r”. This setting has not effect if the interlock is disabled.

4.11.4 Quench Detector Setting – Only for FAST-PS-1K5

The FAST-PS-1K5 monitors the resistive part of the load (by measuring instantaneous output voltage and current) for detecting or preventing the quench condition on superconductive loads.

Four Quench detector parameters are required for the correct operation:

Parameter Field #	ASCII string
#100	Maximum Load resistance [Ω]
#101	Minimum Load resistance [Ω]
#102	Minimum Current for Quench detector [A]
#103	Quench Intervention Time [s]

Table 17: Quench detector parameters

The Maximum and Minimum Load resistance are the values of the expected resistive part of the load. If the load resistive part is changing during operation due to temperature variation the Quench protection will not trigger the fault. When the resistive part of the load increases over the Maximum value, after the Intervention Time the power supply switches Off the output triggering the Crowbar circuit, **Figure 34**.

For low current/voltage set points, it would be difficult to measure the resistance part of the load accurately so below the "Minimum Current for Quench detector" value, expressed in Amps, the Quench detector is disabled.

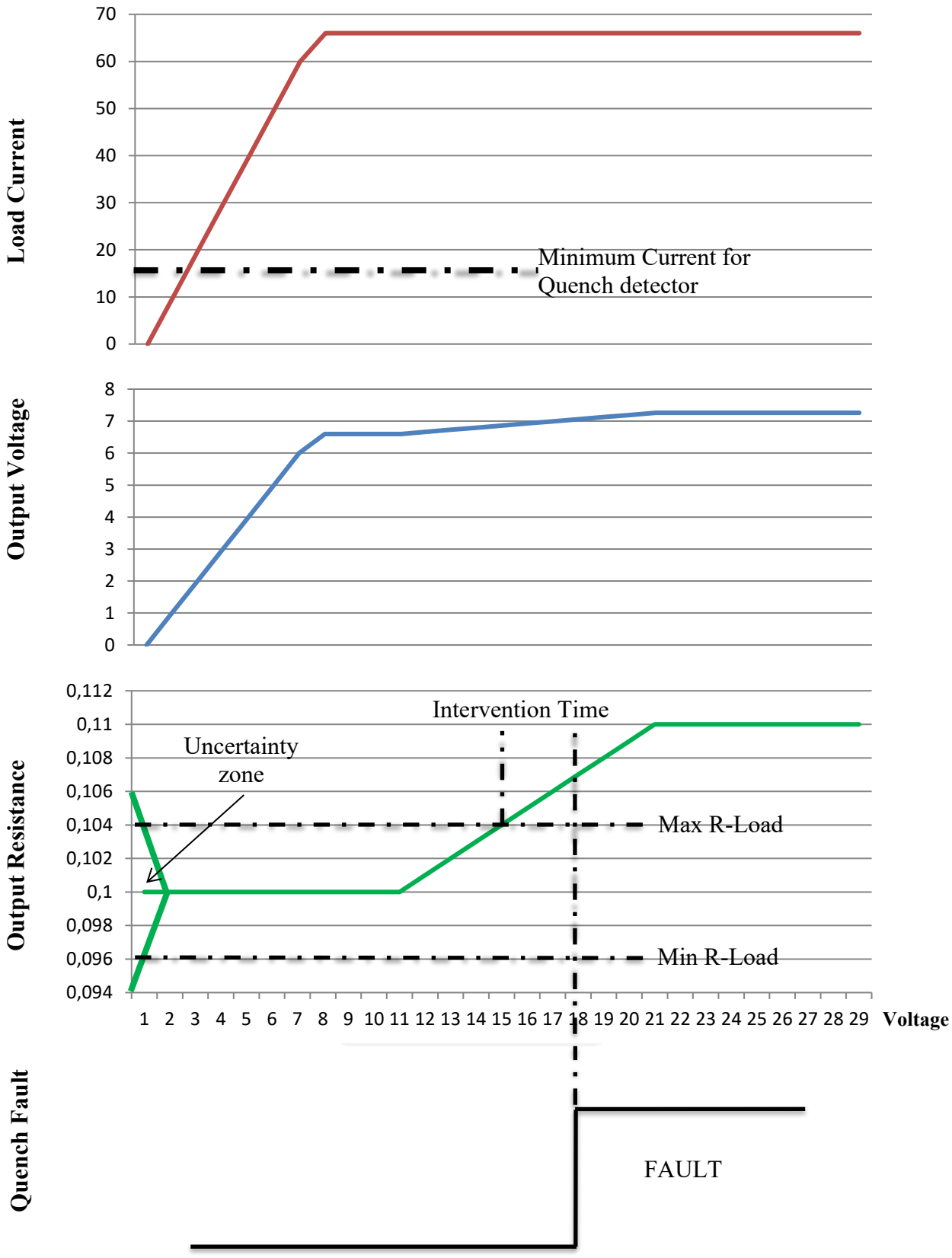


Figure 34: Quench detection Operation

4.11.5 PASSWORD Command

The ***PASSWORD*** command can be used to unlock or lock the access to the protected parameter fields.

Several parameters are protected in order not to let inexperienced users to change some power supply parameters that might compromise the correct operation of the module. See the **Parameters table** for further details regarding the password-protected cells (parameters with *User* access privileges are not password protected; parameters with *Admin* access privileges are password protected; parameters with *Read Only* access privileges cannot be modified).

The correct format for this command is as follows:

PASSWORD:password_word\r\n

where "***password_word***" is the password to lock or unlock the protected parameter fields, that can be:

- "***PS-ADMIN***" to receive the *Admin* access privileges and unlock the protected parameter fields;
- "***LOCK***" to return to *User* access privileges and lock the protected parameters fields.

Replies from the unit to a ***PASSWORD*** command are in the form "***#AK\r\n***" – when the command is accepted - or "***#NAK:xx\r\n***", when the command is not accepted ("***xx***" is the error code). When a wrong password word is received, the unit replies with a "***#NAK:07\r\n***" (error code 07 – invalid password) and locks the protected parameter fields.

To read the current privileges level the following query command can be used: "***PASSWORD:?***". The response to this query command is in the following format:

#PASSWORD:privileges_level\r\n

where "***#PASSWORD***" is the echo string and "***privileges_level***" is the string indicating the privileges level.

The privileges level "***ADMIN***" indicates that the user is able to modify the protected parameter fields, otherwise "***USER***" indicates that the uses is able to modify only the not protected parameter fields.

The password to unlock password-protected cells is:

PS-ADMIN

Examples:

PASSWORD example of correct password word (unlock the protected cells):

PASSWORD:PS-ADMIN\r →

← **#AK \r\n**

PASSWORD example of correct password word (lock the protected cells):

PASSWORD:LOCK\r →

← **#AK \r\n**

PASSWORD example of wrong password word:

PASSWORD:CAENELS\r →

← **#NAK:07 \r\n**

PASSWORD access level query:

PASSWORD:?\r →

← **#PASSWORD:ADMIN\r\n**

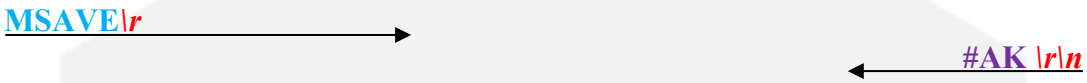
4.11.6 MSAVE Command

The ***MSAVE*** command can be used store the parameter fields in the non-volatile internal memory. If the parameter fields are not saved, they will be lost at power-off of the power supply.

Replies from the power modules to a ***MSAVE*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

MSAVE example:



4.12 Advanced Features Commands

The trigger related commands listed hereafter is available with firmware version 1.4.0 or later.

4.12.1 TRIG:? Command

The ***TRIG:?*** command is used to inquiry the power module about the current setting of the trigger options.

Replies from the power modules to a ***TRIG:?*** are in the form "***OFF/BOTH/POS/NEG\r\n***" – depending on the current settings.

Example:

TRIG:? example:

TRIG:?\r →

← **TRIG:POS \r\n**

4.12.1 TRIG:BOTH Command

The ***TRIG:BOTH*** command is used to set the power module in trigger mode (BOTH as explained at section **3.1.3**).

Replies from the power modules to a ***TRIG:BOTH*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

TRIG:BOTH example:

TRIG:BOTH\r →

← **#AK \r\n**

4.12.1 TRIG:LEVEL Command

The ***TRIG:LEVEL*** command is used to acquire the level read by the module (at the moment of setting the command).

Replies from the power modules to a ***TRIG:LEVEL***are in the form "**HIGH\r\n**" – when the level is high - or "**LOW\r\n**", when the level is low.

Example:

TRIG:LEVEL example:

TRIG:LEVEL\r →

← **HIGH \r\n**

4.12.1 TRIG:NEG Command

The ***TRIG:NEG*** command is used to set the power module in trigger mode (NEG as explained at section **3.1.3**).

Replies from the power modules to a ***TRIG:NEG*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

TRIG:NEG example:

TRIG:NEG\r →

← **#AK \r\n**

4.12.1 TRIG: OFF Command

The ***TRIG: OFF*** command is used to disable the trigger (TRIG:OFF).

Replies from the power modules to a ***TRIG: OFF*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

TRIG:OFF example:

TRIG:OFF\r →

← **#AK \r\n**

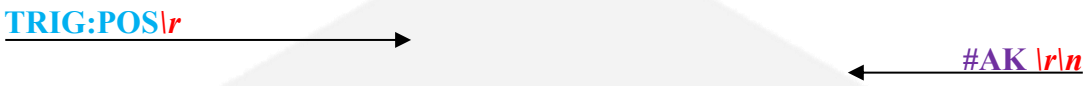
4.12.1 TRIG:POS Command

The ***TRIG:POS*** command is used to set the power module in trigger mode.

Replies from the power modules to a ***TRIG:POS*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

TRIG:POS example:



The upmode command listed hereafter is available with firmware version 1.4.0 or later.

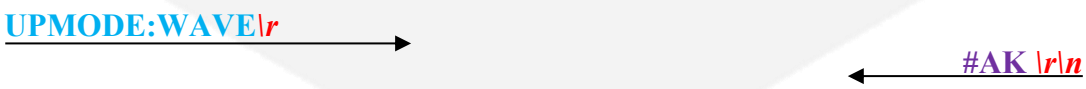
4.12.2 UPMODE: WAVE Command

The ***UPMODE:WAVE*** command is used to set the power module in analog control.

Replies from the power modules to a ***UPMODE:WAVE*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

UPMODE:WAVE example:



The waveform related commands are available with firmware version 1.4.0 or later.

4.12.3 WAVE:KEEP_START Command

The ***WAVE:KEEP_START*** command is used to start the waveform generation when the module is in trigger mode (the module waits the trigger signal).

Replies from the power modules to a ***WAVE:KEEP_START*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

WAVE:KEEP_START example:

WAVE:KEEP_START\r →

← **#AK \r\n**

4.12.1 WAVE:N_PERIODS: Command

The ***WAVE:N_PERIODS:*** command is used to set the number of periods the waveform needs to be reproduced. The maximum number that can be set is 2^{32} -1 (32 bit integer). By setting "0", the waveform is reproduced with an infinite number of periods.

Replies from the power modules to a ***WAVE:N_PERIODS:*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

WAVE:N_PERIODS example:

WAVE:N_PERIODS:5\r →

← **#AK \r\n**

4.12.1 WAVE:POINTS: Command

The ***WAVE:POINTS:*** command is used to store the waveform points into the module. The minimum number of points is 100 and the maximum 500'000. The time resolution, point by point, is 10 us.

Replies from the power modules to a ***WAVE:POINTS:*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

WAVE:POINTS example:

WAVE:POINTS: 1.1:0.543:…:3.42\r →

← **#AK \r\n**

4.12.1 WAVE:START Command

The ***WAVE:START*** command is used to start the waveform generation when the module is not in trigger mode.

Replies from the power modules to a ***WAVE: START*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

WAVE:START example:

WAVE:START\r →

← **#AK \r\n**

4.12.1 WAVE:STOP Command

The ***WAVE:STOP*** command is used to stop the waveform generation.

Replies from the power modules to a ***WAVE: STOP*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

WAVE:STOP example:

WAVE:STOP\r →

← **#AK \r\n**

4.12.2 WAVE:TRIGGER: Command

The ***WAVE:TRIGGER:*** command is used to select the mode of operation of the waveform when in trigger mode. The possible commands are ***WAVE:TRIGGER:START*** (when the waveform needs to be reproduced entirely) and ***WAVE:TRIGGER:POINTS*** (when the waveform needs to be reproduced point by point).

Replies from the power modules to a ***WAVE: TRIGGER*** are in the form "***#AK\r\n***" – when the command is correctly executed - or "***#NAK:xx\r\n***", when the command cannot be executed ("***xx***" is the error code).

Example:

WAVE:TRIGGER example:

WAVE:TRIGGER:START\r

#AK \r\n

4.13 Additional Features

This section is intended to collect different and peculiar features of CAEN ELS power supplies.

4.13.1 Auto Shut Down of Display

CAEN ELS power supplies, by default, have an automatic turning off time of 30 minutes, contained in Cell 35 of the power supply memory.

This time can be changed by changing the content of Cell 35 (User privilege needed).

The user is free to change the content of this cell or to disable the turning off time completely. In order to do so, cell 35 must be set to "0".

4.13.2 DHCP (Dynamic Host Configuration Protocol) Configuration

The ***NETWORK:DHCP*** command is used to enable or disable the DHCP:

NETWORK:DHCP:0 (disabled)
NETWORK:DHCP:1 (enabled)

When the DHCP is enabled the network configuration is automatically set on the module, and any change performed by the user will have no effect (e.g. sending the "NETWORK:IP" command).

When the DHCP is disabled, the user may configure the network parameters as below:

NETWORK:IP:IP
NETWORK:NETMASK:NETMASK
NETWORK:GATEWAY:GATEWAY

The DHCP is disabled by default.

The user may require to the module the current Network configuration sending the command:

NETWORK:?