

FAST-PS- ANET-1050

Current- and
Voltage-Controlled Bipolar
Digital Power Supply Series



User's Manual



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User Manual – Models – Options – Custom Models

This manual covers the following Power Supply Module:

- **FAST-PS-ANET-1050**

Additional useful manuals are:

- Remote Control Manual - ANET



Table Of Contents

Safety information	7
1. INTRODUCTION.....	9
1.1 USER'S MANUAL CONTENT	9
1.2 FAST-PS-ANET OVERVIEW	9
1.3 FAST-PS-ANET AT A GLANCE	10
1.4 MODES OF OPERATION.....	11
1.4.1 Regulation Mode	11
1.4.2 Remote Control Modes	11
2. POWER SUPPLY MAIN FEATURES	12
2.1 CONNECTORS	12
2.1.1 Output Power Cables Connectors	12
2.1.2 Interlock Connector	12
2.1.3 Current and Voltage Monitors	13
2.2 FRONT AND REAR PANEL INDICATORS	14
2.3 INTERNAL PROTECTIONS.....	16
2.3.1 Earth Leakage Current	16
2.3.2 Earth Fuse.....	16
2.3.3 Regulation Fault	17
2.3.4 Input OVerCurrent - OVC	17
2.3.5 OVerPower - OVP	17
2.3.6 Crow-Bar	17
2.3.7 OVerTemperature - OVT	18
2.3.8 DC-Link Undervoltage.....	18
3. INSTALLATION.....	19
3.1 PREPARATION FOR USE.....	19
3.2 INITIAL INSPECTION	19
3.3 MOUNTING.....	20
3.3.1 Rack Mounting	20
3.3.2 Desktop use	20
3.4 AC INPUT POWER CONNECTION	21
3.4.1 AC Source requirement.....	21
4. MECHANICAL DIMENSIONS.....	22
5. TECHNICAL SPECIFICATIONS	23

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1.0	June 1 st , 2017	Official Release
1.1	June 25 th , 2017	Added information regarding the front panel LEDs. Review of all sections


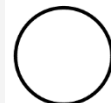





Safety information

The following table shows the general environmental requirements for a correct operation of referred instruments in this User's Manual:

Environmental Conditions	Requirements
Environment	Indore use
Operating Temperature	0°C to 50°C
Operating Humidity	20% to 80% RH (non-condensing)
Altitude	Up to 2000 m
Pollution degree	2
Overvoltage Category	II
Storage Temperature	-10°C to 60°C
Storage Humidity	5% to 90% RH (non-condensing)

The following symbols are used within this manual or are reported in the box and along this manual:

- 
 Caution: Documentation must be consulted in all cases where this symbol is marked
- 
 Off (Power)
- 
 On (Power)
- 
 The WARNING sign denotes a hazard. An attention to a procedure is called. Not following procedure correctly could result in personal injury. AWARNING sign should not be skipped and all indicated conditions must be fully understood and met.
- 
 The CAUTION sign denotes a hazard. An attention to a procedure is called. Not following procedure correctly could result in

damage to the equipment. Do not proceed beyond a CAUTION sign until all indicated conditions are fully understood and met.

CAEN ELS will repair or replace any product within the guarantee period if the Guarantor declares that the product is defective due to workmanship or materials and has not been caused by mishandling, negligence on behalf of the User, accident or any abnormal conditions or operations.

Please read carefully the manual before operating any part of the instrument

WARNING

Do NOT open the boxes

CAEN ELS s.r.l. declines all responsibility for damages or injuries caused by an improper use of the Modules due to negligence on behalf of the User. It is strongly recommended to read thoroughly this User's Manual before any kind of operation.

CAEN ELS s.r.l. reserves the right to change partially or entirely the contents of this Manual at any time and without giving any notice.

Disposal of the Product

The product must never be dumped in the Municipal Waste. Please check your local regulations for disposal of electronics products.



WARNING

- Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in this manual.
- Do not use the device if it is damaged. Before you use the device, inspect the instrument for possible cracks or breaks before each use.
- Do not operate the device around explosives gas, vapor or dust.
- Always use the device with the cables provided.
- Turn off the device before establishing any connection.
- Do not operate the device with the cover removed or loosened.
- Do not install substitute parts or perform any unauthorized modification to the product.
- Return the product to the manufacturer for service and repair to ensure that safety features are maintained

1. Introduction

1.1 User’s Manual Content

This manual contains basic operating instructions and installation instructions for the FAST-PS-ANET bipolar power supplies.

In this manual only the local control of the power supply is covered, while for the remote control interface the “VISUAL ARCNET manual” is the reference. The expert user can then refer to the “Remote Control Manual” in order to use the dedicated programming language of the power supplies.

1.2 FAST-PS-ANET Overview

High performances, high efficiency, high stability, easiness of configuration and maintenance are the key features of the FAST-PS power supply series.

The FAST-PS module is compact and fits in a single 19-inch 1U standard crate. The power unit implements a completely digital control loop with a Pulse Width Modulation (PWM) generation technique that allows to adapt the system to any load condition.

The control board houses a dedicated FPGA with integrated dual-core ARM CPU. The loop regulation task is performed directly by the FPGA logic, in order to have high performance and deterministic loop control. On the ARM CPU an embedded Linux OS is installed, with the task to supervise all process as communication, diagnostics and local interface handling.

Remote communication is guaranteed by means of an Ethernet 10/100/1000 autosensing socket present on the rear panel of the power unit.

In addition to the standard Ethernet interface it is possible to communicate with the unit using the SFP-ports on the rear panel. This interface allows to communicate with the unit using a proprietary packet structure with a very high update rate (more than 10 kHz). These ports are connected directly to the FPGA logic and so the given packet is elaborated directly by the hardware logic.

This approach eliminates the software stratification that manages the packet and the computational time is smaller and deterministic, allowing a very high update rate of the setpoint, giving the user more flexibility and excellent rates for the digital control of the power supply.

In addition to these features, the FAST-PS-ANET hosts a dedicated slot for being interfaced with the ARCNET control protocol in use in KEK, Japan.

1.3 FAST-PS-ANET at a glance

The FAST-PS-ANET system is composed by a single 19-inch 1U crate. The FAST-PS-ANET unit and its I/O connections can be easily seen in **Figure 1** (front view) and **Figure 2** (rear view).



Figure 1: FAST-PS-ANET front view

On the front side of the FAST-PS-ANET unit are placed: a power switch, a DIP switch location array, two monitors for current and voltage output, 6 status LEDs and the slot for the ARCNET board.



Figure 2: FAST-PS-ANET rear view

On the rear side of the unit are placed: AC three phase power line input, three fuse holders (one per phase), the output connector, the earth fuse holder, an output current monitor, the Ethernet port as well as the SFP ports, four status LEDs and the External Interlock BNC connector.

The current rating of the earth fuse is 1 A, fast acting (F1AL250V).

The current rating of the power line fuses is 6 A, time delay (T6AL250V).

1.4 Modes of Operation

The FAST-PS-ANET system has multiple features and multiple configurations that allow using the unit for a very widespread topology of applications.

A brief summary of the basic configurations that the unit is able to handle are hereafter presented.

1.4.1 Regulation Mode

The FAST-PS-ANET can be used as current-controlled or voltage-controlled bipolar units. The regulation types are:

- **C.C.** mode: it is the Constant Current regulation mode. The power supply regulates the output current set by the user;
- **C.V.** mode: it is the Constant Voltage regulation mode. The power supply regulates the output voltage set by the user.

1.4.2 Remote Control Modes

The FAST-PS unit can be controlled in two different ways, hereafter listed:

- **ARCNET** control: the unit can be controlled directly via ARCNET protocol when the ARCNET board is hosted in the dedicated slot. In order to do so, the module needs to be put in ARCnet control on the front panel (Ethernet – – ARCnet switch). The ARCnet board needs to be hosted and the location key must be configured before turning the module ON.
The setting and control of the unit can be performed exclusively via this interface while monitoring is still possible from the Ethernet port.
- **REMOTE** control: the unit is controlled via the TCP-IP Ethernet interface. The setting and control of the unit can be performed exclusively via this interface while monitoring is still possible from the ARCNET board. Please refer to “Remote Control Manual” and “VISUAL Manual” for this feature. In order to do so, the module needs to be put in Ethernet control on the front panel (Ethernet – or – ARCnet switch).

2. Power Supply Main Features

2.1 Connectors

Different types of connections are present in FAST-PS power supplies: connectors for three phase power cables, interlock connector, output connectors, BNC connectors for current and voltage monitoring.

2.1.1 Output Power Cables Connectors

The load needs to be connected to the output connector placed on the rear panel of the unit as shown in **Figure 3** using the NJC-243-RF connector:



Figure 3: Output Connector

Pin Number 1 is the positive terminal.
Pin Number 2 is the negative terminal.
Pin Number 3 is not connected.

2.1.2 Interlock Connector

The FAST-PS module has one configurable input interlock on the rear panel (**Figure 4**):



Figure 4: I/O Connector

The interlock pin is galvanically isolated from ground and outputs terminal, and it trips when 24V are applied (or NOT applied, refer to the table below):

Interlock Level	Trip in case of
Low	24V are applied
High	24V are NOT applied

2.1.3 Current and Voltage Monitors

The FAST-PS-ANET hosts three different BNC connectors for current and voltage monitoring. One of the two connectors for current monitoring is a special kind of BNC connector (BNC twinax), placed on the rear panel (**Figure 6**). On the front panel one current monitor and one voltage monitor are present:



Figure 5: Front Connectors

The 2 monitors are presented in **Figure 5**; the current monitor is labelled CURR MON, while the voltage one is labelled VOLT MON.



Figure 6: Rear Connector

In the BNC twinax connector for current monitoring the male connection is grounded, while the female one refers to the “+” output.

2.2 Front and rear Panel Indicators

The FAST-PS-ANET has six (6) LED indicators placed on the front panel as shown in **Figure 7**.



Figure 7: front panel indicators

The front panel indicators and their behaviour are hereafter listed (from left to right):

- **STATUS (green)**: it informs about the correct operation of the module diagnostics. If it blinks one time per second, PS is ready to communicate and operate.
- **OUT ON (green)**: it signals if the output is enabled or not. The green LED is lit if the output is enabled and it is correctly regulating;
- **ARCnet (green)**: it signals the working of the module via ARCnet board. The green LED is lit if the module is correctly operating via ARCnet;
- **DC-Link (green)**: the green LED is lit if the DC-link voltage is within specifications and it ensures the correct operation of the module.
- **ALARM (red)**: if turned ON signals that the power unit has experienced a fault condition. It is necessary to perform a “fault reset” command in order to turn OFF this LED and turn ON the output again (only if the fault condition/cause has been removed).
- **EXT. INT (red)**: if turned ON signals that the power unit has experienced a fault condition related to the External Interlock. It is necessary to perform a “fault reset” command in order to turn OFF this LED and turn ON the output again (only if the External Interlock condition/cause has been removed).

The FAST-PS-ANET also has four (4) LED indicators placed on the rear panel as shown in **Figure 8**.

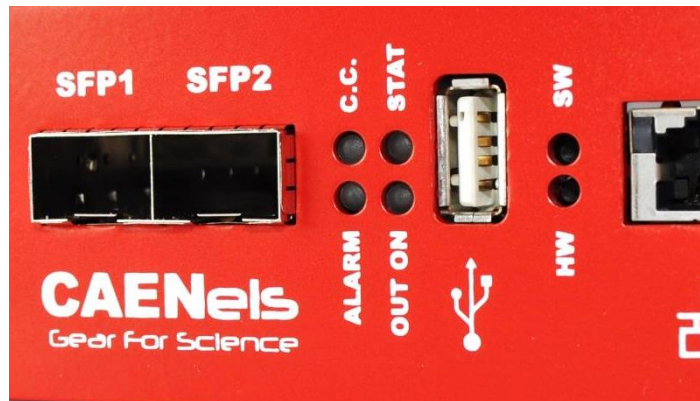


Figure 8: rear panel indicators

The front panel indicators and their behaviour are hereafter listed (clockwise starting from top-left):

- **C.C.:** Constant Current mode (**blue**). If turned on, the FAST-PS is working in constant-current mode. When OFF, it is regulating the output voltage;
- **STAT** (**green**): informs about the correct operation of the module diagnostics. The blinking signaling the correct operation has a 1-second period;
- **OUT ON** (**blue**): informs if the output is enabled or not. The blue LED is ON if the output is enabled and it is regulating output current or voltage;
- **ALARM** (**red**): if turned on signals that the power unit has experienced a fault condition. It is necessary to perform a “reset fault” command in order to turn off this LED and to turn to module output again (only if the fault condition/cause has been removed).

2.3 Internal Protections

The FAST-PS-ANET is equipped with several internal protections that allow configuring the unit for optimal operation. These protections have the dual use of protecting the unit and the connected load/device from unwanted damages or undesired operation conditions.

A brief description of the FAST-PS internal protections is hereafter presented with some more basic considerations on their operation and use. It is highlighted that this section is a general overview on internal protections, which needs to be integrated with the “Remote Control Manual” to be mastered.

In the case of a fault condition the power supply needs to be reset by the user before turning the power supply output back ON again. Different values related to a fault condition can be set, and these procedures are explained in the “Remote Control Manual”, together with the commands to reset the power supply after a fault condition.

2.3.1 Earth Leakage Current

This protection continuously monitors the current flowing to earth and it has a settable threshold [A] that can be set by experienced users.

2.3.2 Earth Fuse

An earth fuse is present on the rear side of each FAST-PS-ANET and it is rated at 1A Fast Acting. The fuse housing is shown in **Figure 9**.



Figure 9: earth fuse housing

2.3.3 Regulation Fault

This fault is generated when the power supply is not able to correctly regulate the settled output current or output voltage (in CC and CV mode respectively).

Different thresholds for the differential current, differential voltage and the intervention time can be set by experienced users.

A typical example of a regulation fault is represented by a 10- Ω load on a FAST-PS-ANET 1050 for example where the maximum power supply output voltage is 48V. By setting a current of 10A to the load, the output voltage should reach a value of 100V which obviously is not feasible: once the power unit supplies 4.8A to the load it already reaches the maximum output voltage condition. The power unit recognizes this difference between the set-point – i.e. 10A – and the actual output current, thus generating a “regulation fault” condition.

2.3.4 Input OVerCurrent - OVC

The internal current drawn from the AC/DC power section of the unit is sensed by a hall transducer that, in conjunction with a comparator, generates a signal that turns off the device.

2.3.5 OVerPower - OVP

The FAST-PS-ANET can work continuously at a 5% over its power rating as expressed in the specifications.

The module is able to work at a power comprised between 5% and 10% over its rating – i.e. between 105% and 110% – for a 20-second period before turning off on an over-power fault.

If the actual output power drawn from the power supply is more than 10% above its nominal ratings the power unit will shut down after 1 second.

2.3.6 Crow-Bar

The energy stored in reactive loads – e.g. inductors – needs to be dissipated in order to protect the power supply from damages when, for example, the output stage gets suddenly disconnected.

A hardware circuit with some voltage suppressors triggering TRIACs is present on each FAST-PS-ANET mode. This circuit allows protecting the unit from unwanted and dangerous over-voltage conditions.

Being a hardware protection, the Crow-Bar is fixed for every model and the intervention threshold is of 120V.

2.3.7 OVerTemperature - OVT

Internal monitoring of temperature is performed in different places inside the FAST-PS-ANET power supply. If a pre-defined threshold is exceeded by any of these internal sensors, an OVT condition is generated, thus shutting off the power unit.

The threshold value [°C] can be set by experienced users. A reset fault operation needs to be executed on the status register of the FAST-PS-ANET before turning the output ON again.

2.3.8 DC-Link Undervoltage

The FAST-PS is composed internally by a power AC-DC section cascaded with a DC-DC stage. The voltage generated by the AC-DC section is also called DC-Link and it is proportional to the maximum rated voltage. Usually the DC-Link voltage is about 10% higher than the rated output.

A continuous monitoring of the DC-Link voltage is performed in order to always guarantee the capability of obtaining the maximum voltage from the power supply. If the DC-Link drops below a certain threshold, the power supply unit could not be able to regulate correctly or some faulty conditions have arisen so that a fault condition is generated.

It is necessary to reset the status register and to get rid of the fault cause before turning the power supply back on again.

3. Installation

This chapter contains instructions for initial inspection and preparation for use.

3.1 Preparation for use

In order to be operational, the power supply must be connected to an appropriate AC source. The AC source voltage should be within the power supply specification. Do not apply power before reading, Section 3.2 and 3.7. Table 1 below, describes the basic setup procedure. Follow the instructions in Table 1 in the sequence given to prepare the power supply for use.

Step	Checklist	Description
1	Initial inspection	Physical inspection of power supply
2	Mounting	Installing the power supply, ensuring proper ventilation
3	AC Input Power Connection	Connect the power supply to the AC source

Table 1: Installation checklist

3.2 Initial inspection

Prior to shipment this power supply was inspected and found free of mechanical or electrical defects. Upon unpacking of the power supply, inspect for any damage which may have occurred in transit.

The inspection should confirm that there is no exterior damage to the power supply such as broken switch or connectors and that the all panel and display are not scratched or cracked. Keep all packing material until the inspection has been completed. If damage is detected, compile the RMA form available to the CAEN ELS web site.

3.3 Mounting

The FAST-PS-ANET module can be used either as a desktop unit or as a rack-mount device since the unit form factor is designed to be installed in a standard 19-inch cabinet.

CAUTION

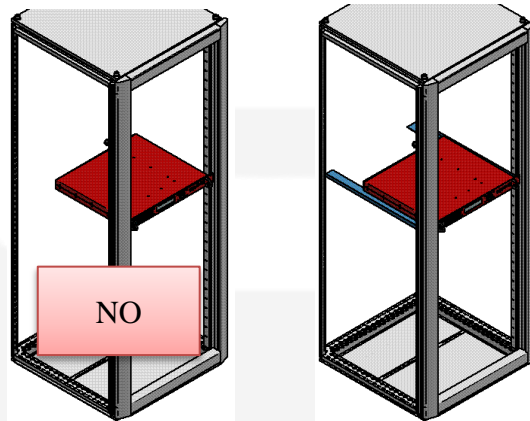
This power supply is fan cooled, the air intake is at the front panel and the exhaust is at the rear panel. Upon installation allow cooling air to reach the front panel ventilation inlets. Allow minimum 10 cm of unrestricted air space at the front and the rear of the unit.

3.3.1 Rack Mounting

The FAST-PS power supply series is designed to fit in a standard 19" equipment rack.

CAUTION

Use a support bar to provide adequate support for the power supply.



3.3.2 Desktop use

The FAST-PS-ANET power supply series can be used as a desktop unit as well.

3.4 AC Input Power Connection

The AC line input connector on the rear panel is a NJC-244-RM and it is represented in **Figure 10**.

The required fuses characteristics for all the models are (**T6AL250V**):

- Size: **20 x 5 mm**
- Current rating: **6 A**
- Blow characteristic: **Time Delay**
- Breaking Capacity: **35 A**
- AC Nominal Voltage: **3-Phase 200V_{AC}**



Figure 10: AC Power Line input socket

3.4.1 AC Source requirement

The FAST-PS power supplies are designed for AC three phase input; it can operate with voltage from 180V to 240V and input frequency ranging from 50 Hz to 60 Hz.

4. Mechanical Dimensions

The mechanical dimensions of the FAST-PS-ANET unit are hereafter presented (in units of mm) in **Figure 11**:

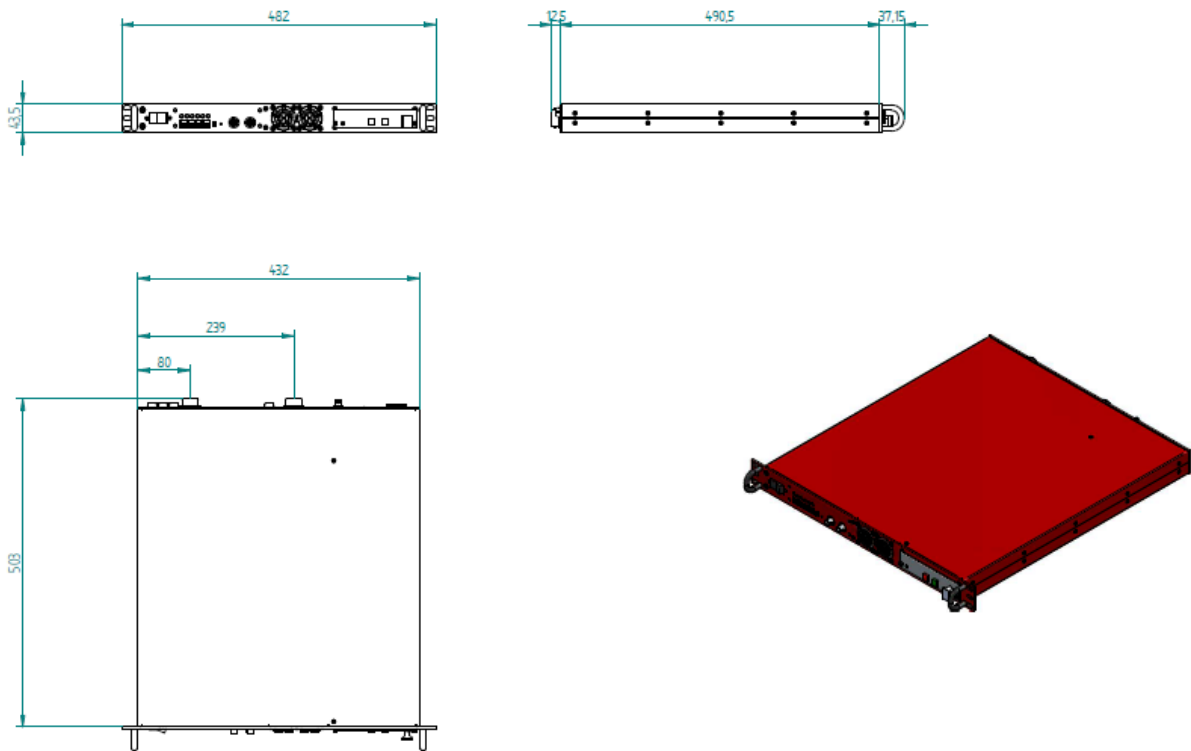


Figure 11: FAST-PS-ANET Mechanical Drawings

5. Technical Specifications

The main technical specifications for the FAST-PS models are hereafter presented:

Technical Specifications	FAST-PS-ANET-1050
Output current range	± 10 A
Output voltage range typ.	± 50 V (± 48 V guaranteed)
Maximum output power	Up to 500W
Regulation Type	Current- or Voltage- Control
Current setting resolution	18 bit
Voltage setting resolution	18 bit
Output current readback	20 bit
Output voltage readback	20 bit
Output current ripple*	30 ppm / FS
Output current stability	50 ppm / FS
Output voltage stability	50 ppm / FS
Switching Frequency	100 kHz
Max Current/Voltage update rate (SFP/SFP+)	10 kHz
Accuracy	< 0.05%
External Interlock/States	1 Input: user-configurable, 24 Voltage level
Internal Interlocks	DC Link Under-Voltage Over-Temperature Input Over-Current Crowbar Earth Leakage Current Regulation Fault
Hardware protections	Input fuses Earth fuse
Auxiliary ADC Read-Backs (16 bit resolution)	DC Link Voltage Ground Leakage Current Heatsink Temperature
Cooling	On-module self-regulated fans
Drivers	EPICS

Technical Specifications	FAST-PS-ANET-1050
Communication interfaces	1x Ethernet 10/100/1000 TCP-IP 2x SFP ports ARCnet protocol
Extra-features	User-definable interlock, active level and timing Firmware remote update
Dimensions	19" wide – 1U high rack – 503 mm deep
Input Voltage	3-Phase 180/240 V _{AC} (50-60 Hz)
Efficiency	up to 84%
Weight	10 kg
Local Monitor	Front and rear LEDs 2x current monitor (front, rear) 1x voltage monitor (front)

Table 2: Technical Specifications