# 4Q AC-DC POWER AMPLIFIER
# 3x10kVA - 270V - 37A - HP

SPHEREA
PUISSANCE PLUS

## APPLICATIONS

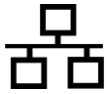
- AC or DC network simulation (industrial, grid, avionics)
- Motor emulation / AC-AC AC-DC or DC-DC converters
- Harmonics generation

*Non-contractual picture*

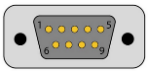
## PERFORMANCES

- Three insulated outputs:
  - From mains
  - From each other
  - From analog inputs
- Generation and absorption AC, AC+DC, DC
- Fast transients < 10 µs
- Quadrant changes without transition
- High inrush current facilities (4 x In)
- Includes an AF synthetizer from DC to 10 kHz
- Wide bandwidth 50 kHz at -3dB
- Very low distortion < 0.3%
- Very low output impedance
- Low noise S/B > 70 dB
- High accuracy < 0.2%
- High stability < 0.1%

**TOUCHSCREEN**



**ETHERNET**



**RS232**

## DESCRIPTION

- PA-10k is a « 4 quadrants » power amplifiers, AC+DC, single-phase or three-phase, operating in voltage regulation:
  - For each phase, an analog input receives its « pilot » signal, amplitude is 0~±10 V peak,
  - Insulated analog outputs, two per phase, return images of voltage and current at the output of the equipment, with an amplitude of 0~±10 V peak.
- Built in linear technology, this amplifier has high dynamics, a very low distortion over a wide frequency band and bandwidth. This technology also allows them to provide power up to 4 times its rated power.
- Linear technology allows a quick and easy integration for "Real time" or "Power Hardware In the Loop" applications in combination with simulators such as Opal-RT, Typhoon, Speedgoat...
- Entirely self-sufficient with local control on touch screen, it can be controlled remotely from a supervisor system via an Ethernet or RS232 link for an easy integration in a complex test system.
- The addition of a "resistive load" allows increasing from 30% to 100% its absorption capacity for use as alternative or continuous load.

CE

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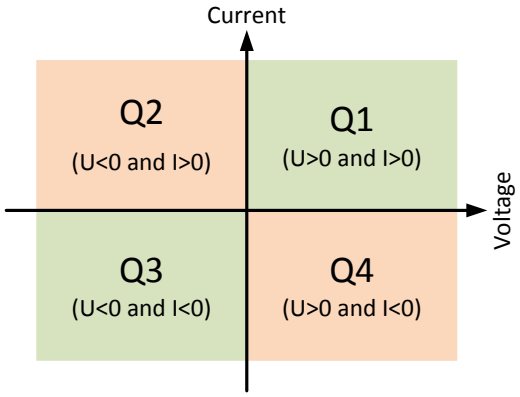
## 4 QUADRANTS OPERATION

Amplifiers operate in voltage regulation with current limitation: in case of temporary overload the voltage decreases to limit the current.

In "Q1" and "Q3" areas, the amplifier behaves in “GENERATOR or SOURCE”: the instantaneous power is positive.

In "Q2" and "Q4" areas, the amplifier behaves in “ABSORBER or SINK”: the instantaneous power is negative.



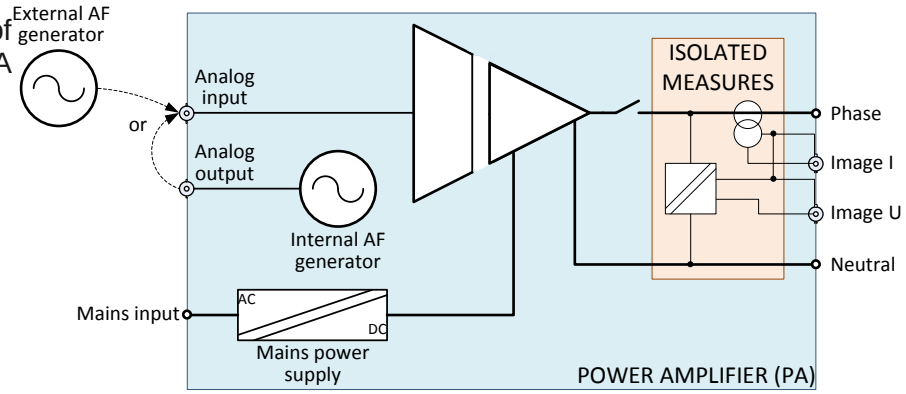

## INTERNAL CONSTITUTION

PA-3x10k amplifier is composed of three identical amplifiers of 10 kVA each.

Each amplifier is electrically insulated from the two others.

Each amplifier includes:

- one AF generator,
- one analog input,
- one power output,
- two outputs « image »




The outputs “Voltage image” and “Current image” are isolated from power outputs. They are used for amplifier used in PHIL system.

## BANDWIDTH “small signals”

**Blue trace:**

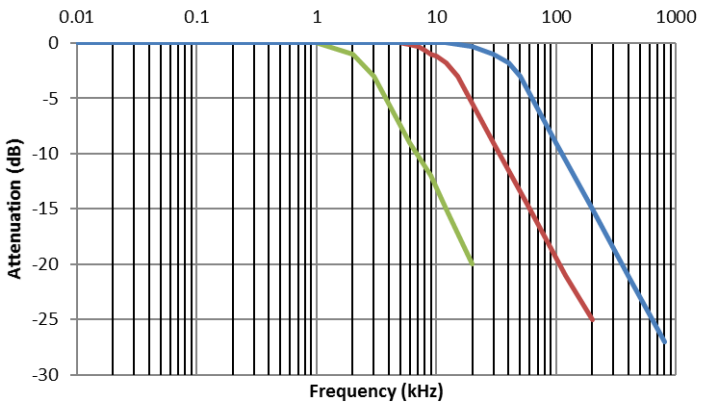
In voltage regulation bandwidth at -3dB is 50 kHz.

**Red trace:**

In current regulation bandwidth at -3dB is 15 kHz.

**Green trace:**

When equipment is used as a one-phase amplifier, the three outputs are connected in parallel and the bandwidth at -3dB is reduced to 2.5 kHz.

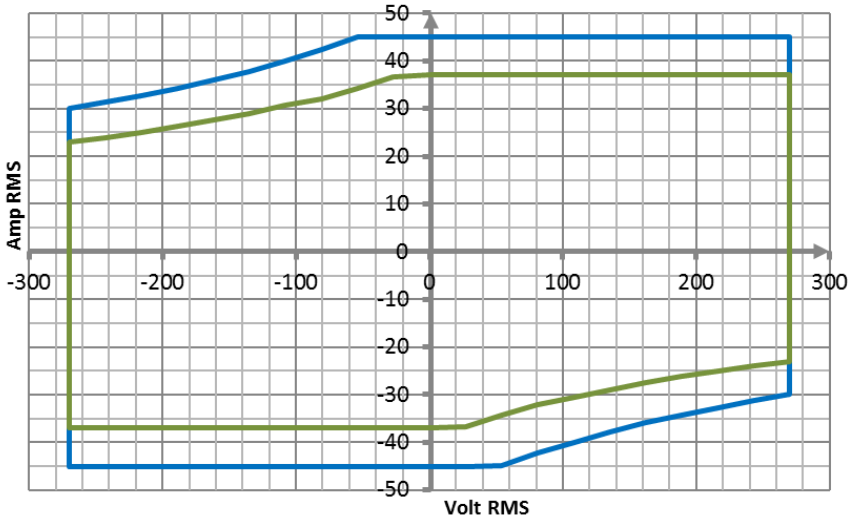


## PERMANENT OPERATION IN AC

These diagrams explain relation between current and voltage for a power factor of 1 (SOURCE) and -1 (SINK).

Continuous operation is allowed “inside” diagrams. In generation or absorption limitations are due to the heating of the power transistors.
Operation “outside” diagrams will result in:

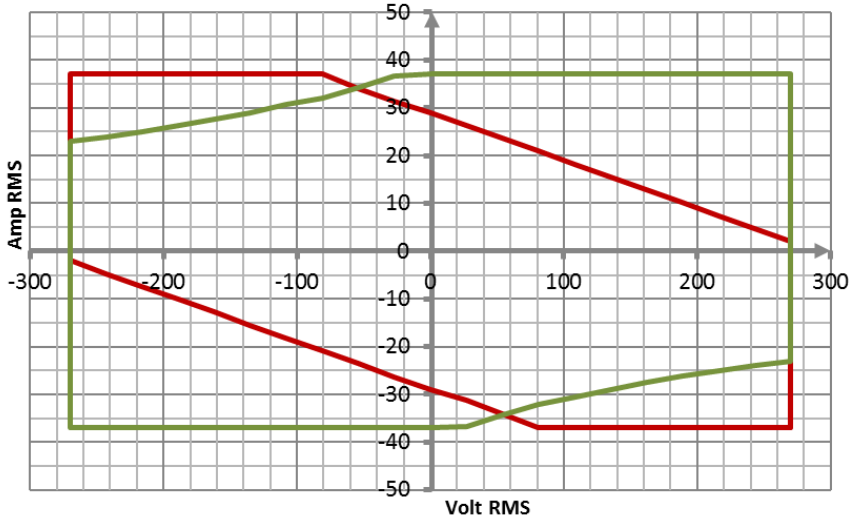
- an immediate switch-off by over-current protection if current is above the limits
- a break after a delay by thermal protection in case of overheating of the power parts.




**Green trace:** permanent operation on each phase on LVAC 270V range
**Blue trace:** over-power operation limited to 2 minutes on LVAC 270V range

In quandrants “Q2” and “Q4”, absorption is limited to 60% of rated power.

It is possible to add a resistive pack, option “PA-3X10K-L100”.
In this case, absorption is increased to 100% between 80 and 270 VRMS in quadrants “Q2” and “Q4” as shown by red trace.



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## LOCAL OR REMOTE CONTROL

Managed by a Control board, the amplifiers have two operating modes:

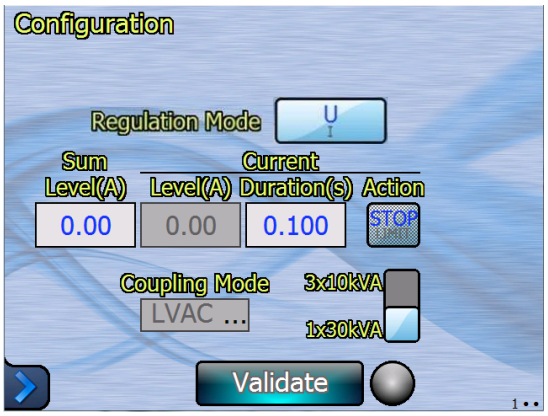
- **Local control:** The control device equipped with a graphical touch screen disposed in front panel gives access to all the control functions and the display of the measures.

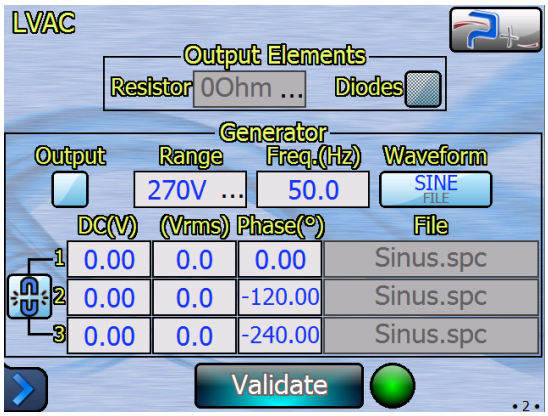
- **Remote control:** The control device has one TCP/IP Ethernet link and one serial link RS232 for a control through a remote PC.

### LOCAL CONTROL

This amplifier can be configured in “3x10kVA” configuration or in “1x30kVA” configuration.

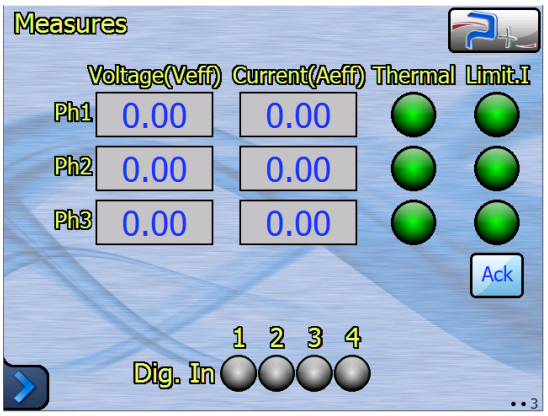
On the same screen are programmed the current limitation and its duration: at the end of this time, if the current on one phase is higher than the limit, the outputs are switched off.

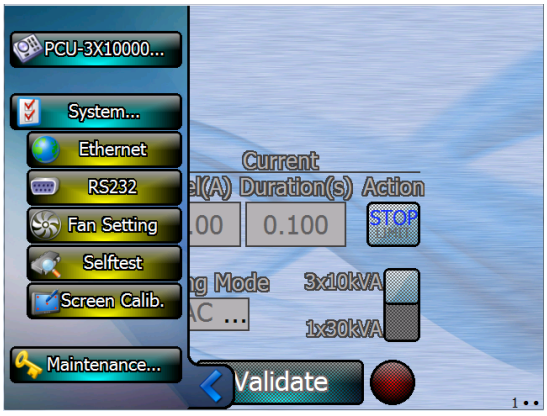



A second screen is for selection of range and activation of outputs. When internal synthetizer is used, other fields are used to program waveform, frequency, phase and amplitude.

A third screen displays instantaneous values of voltage, current and status on each phase.




Other screens are to set up communications links or for the management of variable speed fans.

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## FEATURES

| OUTPUTS: POWER | | | | |
|---|---|---|---|---|
| Power | | | | |
| Rated power per output (1) | 10.000VA | | | |
| AC ranges | LVAC: 35V / 270V – HVAC: 70V / 540V | | | |
| DC ranges | LVDC: 49V / 380V – HVDC: 98V / 760V | | | |
| Output type | Direct (without transformer) | | | |
| Voltage and current in AC (RMS) | Range 35V | Range 270V | Range 70V | Range 540V |
| AC voltage | 0-35 | 0-270 | 0-70 | 0-540 |
| Permanent AC current “In” | 0-37 | | | |
| Max peak current 3 x In < 5 s | 100 | | | |
| Voltage and current in DC | Range 49V | Range 380V | Range 98V | Range 760V |
| AC voltage | 0-49 | 0-±380V | 0-±98 | 0-±760 |
| Permanent AC current “In” | 0-37 | | | |
| Max peak current 3 x In < 5 s | 100 | | | |
| Voltage accuracy | | | | |
| Typical | 0,1% of range + 0,1% of programmed value | | | |
| Resolution | 12 bits | | | |
| Current accuracy | | | | |
| Typical | 0,1% of range + 0,1% of programmed value | | | |
| Resolution | 12 bits | | | |
| Voltage distortion at full output power | | | | |
| Typical | < 0,3% | | | |
| Max | < 0,7% | | | |
| Voltage regulation for a mains variation of +6% / -10% | | | | |
| Max | < 0,1% of rated voltage | | | |
| Voltage regulation for a current variation from 0 to 100% | | | | |
| Max | < 0,1% of rated voltage | | | |
| Noise | | | | |
| Max RMS | 0,02% of rated voltage | | | |
| Max peak to peak | 0,3% of rated voltage | | | |
| Variation according temperature | | | | |
| Typical | 50 ppm/°C | | | |
| Max | 100 ppm/°C | | | |
| Stability after 15 minutes of operation | | | | |
| Max | < 0,05% of rated voltage | | | |
| Insulation of the outputs versus case ground | | | | |
| Measurement at 500 VDC | > 100 MΩ | | | |

**Note:**

1) The output power of each phase is 10 kVA. To generate 30 kVA, output “Phase 1”, output “Phase 2” and “output Phase 3” are connected **IN PARALLEL** trough 0.2-ohm resistors.

| OUTPUTS: TIME AND FREQUENCY | |
|---|---|
| Bandwidth | |
| Full scale | DC – 5 kHz |
| Small signals at -3 dB | 50 kHz (voltage regulation)<br>15 kHz (current regulation) |
| Variation with a square signal pilot | |
| Rise time 10% / 90% | < 10 µs (voltage regulation)<br>< 100 µs (current regulation) |
| Fall time 10% / 90% | < 10 µs (voltage regulation)<br>< 100 µs (current regulation) |
| Transfer time | < 10 µs (voltage regulation)<br>< 100 µs (current regulation) |
| Transition from Q1 to Q4 | < 10µs |

| OUTPUTS: TIME AND FREQUENCY | |
|---|---|
| Images outputs (2) | |
| Voltage images | Ratio 56.2 (1 V for 56.2 V) |
| Current images | Ratio 7.9 (1V for 7.9 A) |
| Accuracy of the measurements displayed on the touch screen | |
| Voltage measurement | 0,3% of range + 0,3% of measure |
| Current measurement | 0,3% of range + 0,3% of measure |

**Note:**

2) The analog inputs are insulated from power outputs.

| INPUTS: AMPLITUDE AND FREQUENCY | |
|---|---|
| Input signal amplitude | |
| Insulation (3) | > 10 MΩ |
| Voltage for full output scale | 7,07 VRMS / ± 10V peak |
| Max. voltage | ± 15 V peak |
| Input impedance | 10 kΩ |
| Input signal frequency | |
| Fundamental | DC – 5kHz |
| Harmonics (small signals) | Max 50 kHz |

**Note:**

3) The power outputs are insulated from pilot inputs.

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| MAINS | |
|---|---|
| Mains network | |
| Number of phases | 3 Phases + Earth without Neutral |
| Voltage | 400 VRMS -10% +6% |
| Frequency | 45 - 65 Hz |
| Mains current at full output power | |
| Max | 45 ARMS per phase |
| Protection | Magneto thermal breaker |
| Inrush current | Limited to 2 x Max current |
| Dielectric strength of the mains input versus the output connected to the case ground | |
| Measurement at 2500VRMS / 50Hz | Current < 10 mA |

| MECHANICAL AND ENVIRONMENTAL | | |
|---|---|---|
| Metallic parts treatment | | |
| Frame | Aluminum painted RAL7021 | |
| Sides and panels | Aluminum painted RAL7021 | |
| Dimensions and weight | | |
| Width | 800 mm | |
| Depth (connectors excluded) | 800 mm | |
| Height | With Option “PA-3X10K-L100” | Without Option “PA-3X10K-L100” |
| | 2230 mm (43U) | 2010 mm (38U) |
| Weight | 650 kg | 550 kg |
| Temperature and humidity | | |
| Storage temperature | -10°C à +85°C | |
| Operating temperature | +0°C à +50°C | |
| Relative humidity | 10% - 90% non-condensing | |
| Sound level (fans at full speed) | | |
| Measured at 1 m of front panel | < 70 dBA | |
| Marking | | |
| Marking | CE | |
| Index of protection | IP20 | |

## PROTECTIONS

### Against overload: current limitation

Amplifiers in linear technology can generate up to four times their rated power during short time. They are using voltage regulation with current limitation: if current is higher than programmed value, a timer starts. At the end of a programmable time between 0.1 and 5 seconds, output voltage decreases to limit current to the programmed value.

### Against short-circuit on output: automatic output switch-off

Output is switched off on all phases et must be reactivated using touchscreen or an external command.

### Against overtemperature: automatic output switch-off

A temperature sensor is installed on each power part. It switches off outputs of the three phases in case of overheating. After cooling, output must be reactivated using touchscreen or an external command.

## SALES REFERENCES

### PA-3x10k-AC/DC-270V-37A-2G-HP

Amplifier 3x10 kVA: max voltage 270 VRMS, max current 37 ARMS
Two ranges, using Voltage regulation

## AVAILABLE OPTIONS (to order separately)

### PA-3X10K-L100

Resistive load to increase absorption capability up to 100% in 270V range

### PA-3X10K-RI

Add a current regulation selectable on configuration screen

## DELIVERIES

Amplifier is delivered with its mains cable, its user manual, its performances list (acceptance test report), its UE declaration.

Specification subject to change without notice.