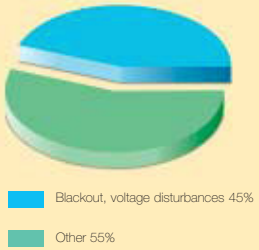
Power problems

BLACKOUT, VOLTAGE DISTURBANCES



Why an Uninterruptible Power Supply?

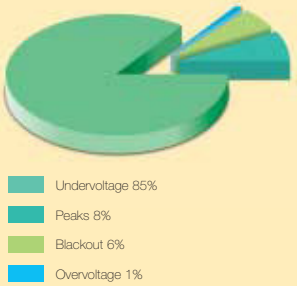
Data centres, servers, LAN nodes and telecommunication systems must always be protected against possible problems in the power supply. Sudden blackouts and variations in the mains supply may lead to system malfunctions and severe data losses. But even other electrical equipment can cause damage or inconvenience if there is a breakdown in the mains. Just think of the check-out systems in a supermarket, lighting systems and industrial production units, not to mention safety systems, pumping systems and automatic devices in general.

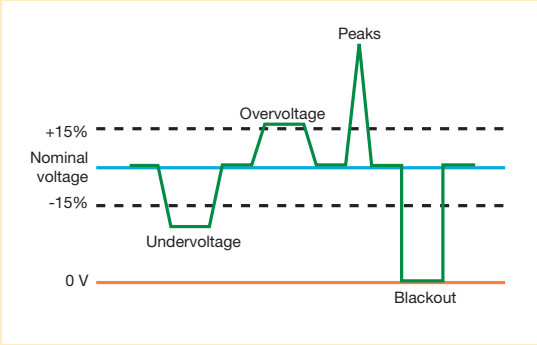
Power problems are caused by various sources such as distribution network faults, system switching, weather and environmental conditions, heavy equipment or simply just faulty maintenance.

The simplest and most effective way of coping with these disturbances is to install a UPS unit (UPS stands for Uninterruptible Power Supply). Acting as an interface between the mains and the loads, the UPS guarantees the continuity and the quality of the electrical power supplied to the loads, whatever the condition of the mains may be. In fact these systems stabilise the voltage perfectly, eliminating all disturbances.
They even supply voltage when the mains fails, by means of a series of batteries which give a back up time that is generally sufficient to guarantee the safety of persons and of the system.

In order to decide which type of appliance is able to guarantee the best level of protection, you must know the types of mains problems that can disturb your systems.

TYPE OF MAINS DISTURBANCES





CEI, CENELEC and IEC are the recognized standardization bodies respectively at national, European and international level. Such standardization guarantees the compliance with CE Directives.

Technical Standards

Safety
EN 62040-1-1 is the reference standards regulating the basic safety requirements for UPS used in operator access areas.
EN 62040-1-2 is the reference standards regulating general and safety requirements for UPS used in restricted access locations.

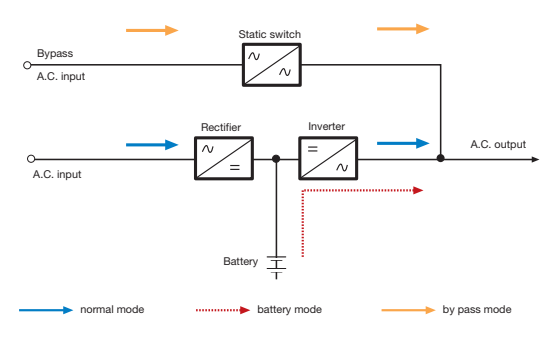
Electromagnetic Compatibility
This is the capacity of equipment to work without being disturbed (immunity) and without disturbing (emission) other equipment due to electromagnetic disturbances on electric wires and irradiated.
EN 50091-2 and IEC 62040-2 are the reference standards which also defines the testing procedures.

Performances
The reference document is the Performance Requirements EN 62040-3. It is a guide for a better understanding between manufacturer and user since it defines which performance must be declared as well as the relevant testing methods.
All AROS UPS's have been designed and built in accordance with all the above standards and therefore bear the CE mark.

Types of Uninterruptible Power Supply (UPS)

On-Line Uninterruptible Power Supply (VFI)

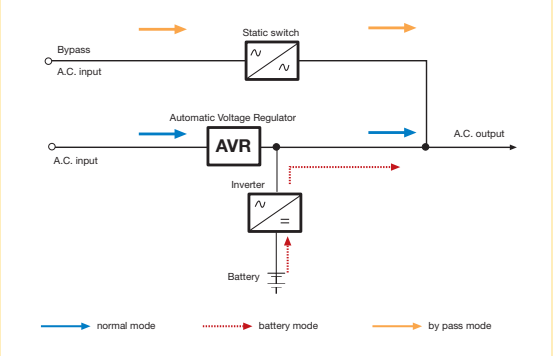
On this type of UPS, also known as a double conversion UPS, the inverter draws its power continuously from the rectifier (converter). The current is completely regenerated by its transformation from AC to DC and back to AC, guaranteeing a constant level of quality, regardless of disturbance on the mains power source.
By carrying out continuous double conversion, an On-Line UPS significantly attenuates electrical noise, which might otherwise damage a computer. When the AC input supply is not within the voltage and frequency tolerances, the battery is used to power the inverter. The inverter continually supplies the critical load with a true sinewave current.
If a converter/inverter failure occurs, the continuity of the load power can be improved by activating the bypass source using a transfer switch.



Types of Uninterruptible Power Supply (UPS)

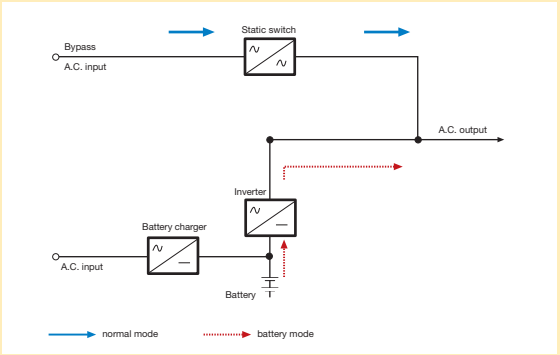
Line Interactive Uninterruptible Power Supply (VI)

On this type of UPS the inverter is connected in parallel to the AC input and also charges the battery (interactive operation in reversible mode).
When the AC input supply is not within strict amplitude and frequency tolerances, the load is powered by the inverter through the battery.
The normal inverter output waveform is a stepwave or squarewave.
This technique is rarely used for high power ratings as frequency regulation is not possible. Active Standby (or Line Interactive) technology is a recent development made possible by the advent of microprocessors. The UPS is fully controlled by a microprocessor which monitors the quality of the mains power supply and reacts to any variations. In the event of a power problem, the UPS transfers the load to the batteries to supply stabilised power. It is increasingly frequent to add a voltage compensation circuit, called a "booster", that is enabled in the event of prolonged voltage drops.



Passive Standby Uninterruptible Power Supply (Off-line) (VFD)

This type of UPS, also called Off-line UPS, is connected in parallel to the normal AC source. The current is filtered in order to attenuate the most frequent forms of disturbance. In the event of a power problem the UPS transfers the load to the batteries to supply stabilised power: the inverter only switches on when the mains fails or fluctuates outside the input voltage tolerances of the EMI filter or if it is fitted with Automatic Voltage Stabiliser (AVS).



Evaluation parameters

Apparent power (in VA or kVA)
It is defined as:

$P_{APP} = V \times I$
for single-phase load

$P_{APP} = V \times I \times \sqrt{3}$
for three-phase loads

where **V** is the load voltage supply and **I** is the current absorbed by the load in normal load conditions.
This information is normally shown on documents and/or load nameplates though it may be shown as an oversized value.

Active power (in W or kW)
It is defined as:

$kW = kVA \times \cos\varphi$
(where $\cos\varphi$ means power factor PF).

The $\cos\varphi$ value of loads is very seldom indicated, therefore a correct UPS sizing requires measurements of **kVA** absorbed by loads.
Experience, anyway, shows that typical loads of computer feature a PF between 0,65 and 0,8.

Considerations on the misleading concept of "computer power"
In the definition of the UPS rated power, the parameter values, defined as "computer power", "switching power", "actual power", power a particular temperature value, etc. are sometimes indicated.
Such arbitrary parameter values have no relation with apparent power and active power; they can be neither quantified nor defined and therefore must not be used for the correct sizing of the UPS.

Crest Factor
A linear load absorbs a sinewave current that shows an effective value (I_{EFF} usually measured and declared) and a peak value (I_{PK}). The Crest Factor value is defined as:

$$CF = \frac{I_{PK}}{I_{EFF}}$$

The nominal value for a linear load is CF = 1,41. Most loads applied to UPS's are non- linear load: they absorb distorted current with a CF value greater than 1,41 and require therefore higher peak currents thus resulting in an increased distortion of the output voltage than equivalent linear loads. Directive EN62040-3, indicates a typical non-linear load as CF=3, used for UPS testing, which may be used in the absence of other data.

Overload
Overloads are temporary requests from electrical equipment which exceed regular operation absorption. They are caused by current peaks which may occur when one or more users are switched on. In case the overload exceeds the admissible limits the UPS guarantees the energy supply via the automatic bypass line. For "On line" UPS's the transfer is effected without any break in power (transfer time = 0 ms). The "bypass" is a safety device with independent protection and auxiliary supply able to supply the load independently from the UPS also when the UPS is switched off or broken.

Input current harmonics
The UPS battery charger rectifier absorbs a distorted current containing harmonics that are multiples to the reference 50Hz frequency. These harmonics may cause voltage distortion which may affect the normal operation of non privileged user's.

The harmonics level of AROS UPS's complies with the present directive. However, in order to further reduce the presence of these harmonics variuos solutions are available such as the installation of Active Filetrs (Power Factor Controlled) or different Rectifier designs.

Runtime
The batteries supplied with the UPS's are valve regulated batteries (VRLA) known as sealed batteries with no electrolyte top-up, very low gas emission, suitable for installations in offices and public places with no need for special precautions. Batteries are normally supplied with the UPS and can either be installed in the same cabinet or in additional ones. AROS guarantees the power supply runtimes specifying the apparent load power and the power factor.

Remarks about the misleading concept of "typycal autonomy"
In defing the runtime it is often used the concept "typical autonomy (or runtime)" which has nothing to do with the real runtime based on the 100% load value expressed in W or kW (active power). The runtime that AROS shows on all its documentation have been calculaterd at 100% of the load.

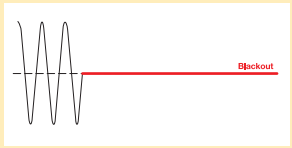
Power quality and mains disturbance

Electronic equipment functions properly as long as the utility is available and with high quality. Unfortunately not always this is possible because most of the power quality events are caused by factors beyond the control of the Distribution Company. These factors may occur either externally (in the network distribution system) or internally (in the facility when the system is located). External causes may be for example storm, lightning, high wind, tree limb contact, construction activities etc, while the internal causes may be switching of the machine, capacitor banks, fault or maintenance activities.

Depending on the events the power quality disturbances may vary in type, duration and intensity.

Typical power supply disturbances that cause major bad effects on your load are listen below.

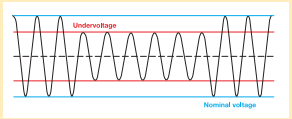
Power outage
Power interruption for a time of more than 3s is called an outage or commonly "blackout". This is normally caused by atmospheric accidents to the high voltage distribution network or a failure in the power supply equipment.



Blackout

Consequences:
- **Computer applications**
  Complete system shutdown with loss of data, possible hardware damage and long periods of employee inactivity.
- **Industrial applications**
  Huge impact in the production activity with consequent production loss and/or unexpected safety consequence.

Undervoltage
It is a voltage reduction in amplitude for a time between 10 ms to 1 s. expressed as a percentage from 10 and 100% of the rated voltage. This is caused for example by short circuits in the resident distribution systems or the large inrush current of the transformers.

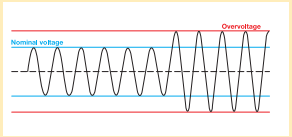


Undervoltage

Consequences:
- **Computer applications**
  Overheating of the electronic components with consequent operational breakdown.

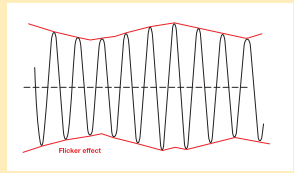
- **Industrial applications**
  Instability of asynchronous motors and loss of synchronization of synchronous motors, opening of contactors (voltage drop > 30%), power-off discharge lamps (voltage drop > 50% for 20-40 ms) with subsequent return of power after several minutes and consequent operational breakdown.

Overvoltages
Overvoltage is an increase in voltage for a time of more than 10 ms. Overvoltages may be caused by the disconnection of major loads (interruption in manufacturing processes of industrial companies, reduction in the speed of electric motors, arc furnaces, rolling mills, etc.) or natural events such as lightning.



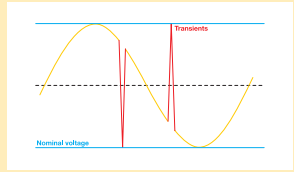
Consequences:
Faults in all electric/electronic equipment (100%<overvoltage<150%); e.g. damage to boards, power supplies, computers/servers, faults in lighting systems, etc.

Sag and Swell
Any short term voltage decrease (sags) or increase (swell) for a time from half cycle to 3 seconds. It is normally caused by the equipment shutdown, circuit breaker operations, high peak current absorbed by the equipments, or short-circuit.



Consequences:
The major effects may be the loss of data or the lights flicker, very unpleasant for the people exposed to these effects.

Transients
Transients are rapid, very high overvoltages of up to 20 kV. They are caused mainly by lightning (which is random in its location, duration and amplitude) but also by faults on the high-voltage network, the switching of inductive loads or the powering of highly capacitive loads.



Consequences:
Transients destroy inadequately protected equipment (melting of wires, perforation of isolation in motors, badly-timed release of protection devices, etc.).