POWER SUPPLY PROBLEMS AND UPS SELECTION

1.1 POWER SUPPLY PROBLEMS

Electricity consists of a single phase or three phase waveform (normally a sinewave with little if any distortion) characterised by:

- Voltage
- Current
- Frequency
- Symmetry (only for three phase supplies)

From the source to the connected loads, the sinewave can be polluted with various types of electrical disturbance:

- Spikes and Electrical Noise (Common and normal mode)
- Sags and Brownouts
- Frequency fluctuations
- Voltage harmonics
- Momentary interruptions and mains failures
- Transient Voltage Surges

These disturbances are caused by a variety of sources including failures and switching problems within the electrical transmission and distribution system, extreme weather conditions and the operation of heavy industrial and/or faulty hardware. Mains interruptions are the only immediately evident disturbances. Spikes, transients, sags and brownouts are far more common and can stress the power supplies within computer and telecoms applications to the point where hardware damage, data processing errors and costly downtime result. Harmonics can cause unexpected heating damage to electronic switching.

1.2 EFFECTS OF POWER SUPPLY PROBLEMS ON EQUIPMENT

Many computer and telecoms manufacturers have sourced power supplies that meet global requirements and balance cost against electrical performance. Typical power supplies work within an input voltage window to 10-20% of the nominal mains voltage, and can withstand mains interruptions up to 5ms. They are ideal for non-critical office based applications within stable electrical environments, where recovery from a sudden system loss can be easily achieved and damaged hardware replaced. However, the increasing interconnectivity and complexity of many computer, telecoms and industrial applications, and their requirement to operate continuously dramatically raises the demand for the correct power solution to be implemented. Power disturbances can result in productivity losses, product quality deterioration, health and safety risks, and may even undermine the very existence of the organisation. Voice and data processing systems within critical environments must be protected to avoid hardware damage, data processing errors and sudden system failures.

2.1 UPS': FOUR GOOD REASONS FOR INSTALLING THEM

1. To provide power to critical loads when the mains fails: this is the classical function of a UPS but not the most important today.
2. To provide a high quality electrical supply that is filtered and stabilised from a mains supply or generator source.
3. To provide independent power management. When the mains fails or fluctuates the UPS will automatically safeguard its connected loads, and can even provide remote indication of its status, including alarms.
4. To considerably improve power system reliability, in the form of redundant and parallel solutions that can cater for system faults and still deliver a high quality electrical supply.

2.1.1 UPS

A UPS consists of three main assemblies:

1. A rectifier-battery charger (converter): changes the mains supply ac voltage and current into the levels of dc voltage and current required to charge the battery and power the inverter.
2. A set of batteries (usually of the sealed lead-acid type) to store dc electrical energy and power an inverter for periods from several minutes to many hours. For large three phase UPS a DC flywheel can provide this function for a limited time.
3. A static converter (inverter) to convert the stored dc supply into an ac voltage waveform, stabilised, filtered and regulated to supply the connected load(s).

These assemblies can be enhanced with additional fetures an automatic bypass for overloads or UPS fault conditions, a manual bypass to permit complete isolation of the UPS for maintenance, and various local and remote monitoring options.

figure A: UPS in VFI configuration

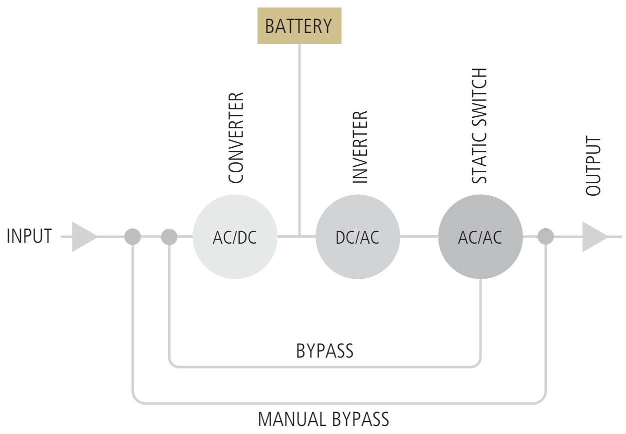
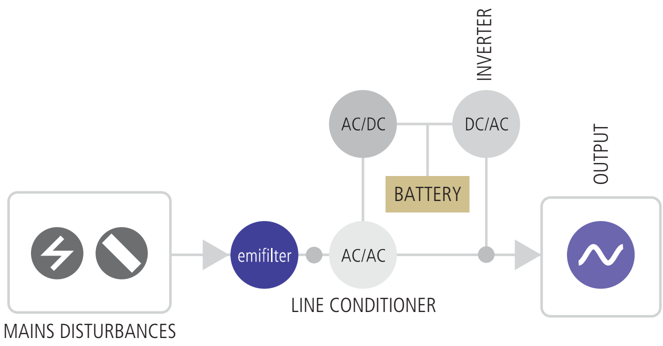


figure B: UPS in VI configuration



2.1.2 UPS TYPES

Many different types of UPS have been developed to meet specific customer requirements for power quality, mains failure protection and price. The current method for classifying the three main UPS types is described in BS EN 62040-3:2001:

VFI (Voltage and Frequency Independent) - More generally known as ON LINE or DOUBLE CONVERSION where the output of the UPS is independent of any fluctuations in the power voltage (mains) and frequency variations are maintained within the limits prescribed ENV 61000-2-2 (CEI 110-10). This type of UPS can operate as a frequency converter (see fig. A).

VFD (Voltage and Frequency Dependent) - More commonly known as OFF LINE where the output of the UPS tracks the mains power supply in terms of voltage and frequency variations.

VI (Voltage Independent) - Usually known as LINE INTERACTIVE where voltage fluctuations are stabilised and regulated to within an output specification by built-in passive/electronic regulation devices (see fig. B).

2.1.3 UPS SIZING

When calculating the size of a UPS, it is important to take into account the following:

- Apparent power (VA or kVA) - This is defined as S=VxI for single-phase loads, S=(VLI x ILI)+(VL2xIL2)+(VL3xIL3) for three-phase loads where V is the voltage, and I is the current absorbed by the load under normal operating conditions (EN50091-1-1). This information can usually be found on rating hardware labels, and in the documents and information supplied with the system(s) to be protected. It is generally over estimated.
- Active power (W or kW) - Is defined as P=Sxpf where pf is the power factor. If the value of P and pf of the load(s) are not specified, the power absorbed must be precisely measured in order to correctly size the right UPS. The typical load of a computer is associated with a pf of between 0.65 and 0.8. Active power is particularly relevant when sizing batteries.
- Overloads - Are voltage and current demands on the UPS in excess of its specification. They may be temporary during initial energising of a system or constant where too much steady state load is connected to the UPS output.
- System Expansion - When sizing a UPS two factors are important. The reliability of any electronic device is improved when run at less than 100% of capacity. For UPS the load should be around 90% of the system size to guarantee long-term reliability. A factor should also be added for future expansion of the protected load(s). This is typically taken as 25%.
- High switch on current demands - At power-on, some loads have a high initial switch on current demand lasting for a short time period (50 to 100ms).
  For example laser printers, some types of lights, isolation transformers and pumps. For these types of load it is good practice to oversize the UPS by a factor of at least 3 or remove them from the protected system, especially when they can be allowed to power down on mains failure.

2.1.4 UPS IN PARALLEL AND REDUNDANT CONFIGURATIONS

In network, enterprise wide and industrial installations, UPS may be connected in parallel or redundant configurations:

- Parallel - To obtain a kVA/kW output higher than that of any single UPS. For example 2 x 200kVA modules may be connected in parallel to achieve a 400kVA output.
- Redundancy - To improve the overall UPS system resilience by applying the principle of N+1. Here 2 x 200kVA modules may be connected in a redundant configuration to supply up to 200kVA. Should one module fail or be taken out of service for maintenance the remaining module is sufficiently sized to power the load(s).

2.1.5 TYPICAL UPS OPTIONS

Some of the following are built-into specific UPS as standard. Others may be options available on request:

A) GALVANIC ISOLATION

Not all Off-line, Line Interactive and transformerless On-line UPS provide Galvanic isolation. This is a separation of the mains and output supply of the system, principally disconnecting the input and output neutral. Without Galvanic isolation on sites with high levels of spikes, transients and electrical noise, the neutral can act as a direct path for the electrical pollution to reach the load(s). Galvanic isolation can be achieved using a transformer (normally housed in a separate cabinet).

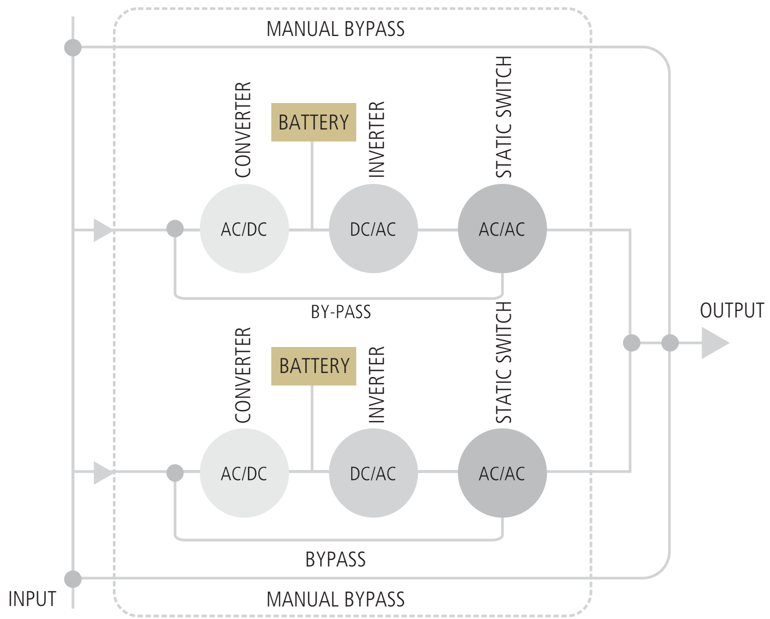


figure C: Connection of UPS in parallel.

The transformer will also prevent interference from the load(s) and UPS being injected back into the mains supply, and if configured can provide an isolated bypass supply during UPS maintenance.

B) HARMONIC FILTERS and 12-PULSE RECTIFIERS

Smaller UPS, within the single/single phase category up to 10kVA, typically have a sinusoidal input current wave-form and do not generate harmonics into the local mains supply. Harmonics can pollute downstream hardware and prevent synchronisation of the UPS to a generator supply. The problem is typically found with larger single and three phase UPS having a 6-pulse rectifier. The solution is to install a harmonic filter in a separate cabinet or change the 6-pulse rectifier for a 12-pulse system.

2.2 MONITORING OPTIONS

2.2.1 LOCAL COMMUNICATION

- FRONT PANEL LEDs
  Coloured LEDs provide immediate status indication and are usually sufficient for small single phase UPS.
- ALPHANUMERIC DISPLAY
  A front panel LCD can provide additional information on UPS, battery and mains operating conditions such as Load %, Battery Charge %, Mains Voltage and Runtime available. Such a facility normally provides access to stored historical logs and operating parameters for on-site customisation.

2.2.2 REMOTE COMMUNICATION

- REMOTE COMMUNICATION USING SIGNAL CONTACTS
  If the UPS front panel is not readily accessible, remote signalling may provide operational, historical and diagnostic information, either as simple mains failure and battery low alarms, or as RS232 information to a signal panel, management system or UPS management package.
- UPS/USER COMMUNICATION
  Using opto-isolators or volt-free contacts, a UPS can be interfaced with the protected voice and data processing system so that system users are notified of changes in UPS operating status, and to achieve an orderly system shutdown on mains failure.
- SERIAL COMMUNICATION
  For more detailed remote information, RS232 transmitted data can be displayed on an alphanumeric panel, terminal or network PC. Communication can be achieved using a standard RS232, RS422 or RS485 serial line (twin pair connection).
- NETWORK COMMUNICATION
  For network wide management, a UPS can be managed using the SNMP – Simple Network Management Protocol. SNMP can be achieved using software or hardware solutions.

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