UPS Technology

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Review

- UPS glossary
- protection devices
- UPS technology
- Choosing a right UPS
- UPS batteries
- UPS companies
  - APC
  - BestPower
  - PowerWare(Exide)

Review

- UPS parameters
- UPS interfacing with computer
- UPS software

UPS jargonomy

- Pronounciation :
  - A U.P.S.
  - An “ups”
- Uninterruptible Power Supply
- Uninterruptible Power System

UPS glossary : Outage

- Power Failure (blackout) : A total loss of utility power. (lasts for more than 2 cycles)
- Cause : lightning strikes, downed power lines, grid over demands, accidents and natural disasters.
- Causes : data damage, data loss, file corruption and hardware damage.

UPS glossary : Sag

- Power Sag : A short term low voltage. (80 to 85% below normal)
- Cause : heavy equipment being turned on, large electrical motors being stated, switching of power mains(internal or utility).
- Causes : memory loss, data errors, flickering lights and equipment shutoff.

UPS glossary : surge

- Power Surge : Short term high voltage. (voltages 110% of nominal)
- Cause : rapid reduction in power loads, heavy equipment being turned off, utility switching.
- Causes : memory loss, data errors, flickering lights and equipment shutoff.

UPS glossary : brownout

- Brownout : Reduced line voltage for extended periods of a few minutes to a few days.
- intentional utility voltage reduction to conserve power during peak demand periods (summer), or other heavy loads that exceeds supply capacity.
- Cause : data corruption, data loss and permanent hardware failure.

UPS glossary : noise

- Electrical Line Noise : high frequency waveform that piggyback on the line waveform.
- Cause : either RFI or EMI interference generated by transmitters, welding devices, SCR driven printers,electric motors, relays, motor control devices, broadcast transmissions, microwave radiation, lightning, etc.
- Causes : data error, data loss, storage loss, keyboard lockup and system lockup.

UPS glossary : HV spikes

- High voltage spikes : instant and dramatic increase in line voltage. can send line voltages to levels of 6,000 volts.
- Cause : nearby lighting strikes.
- Causes : A spike almost always results in data loss or hardware damage (burned circuit boards).

UPS glossary : frequency variation

- Frequency variation : A change in frequency stability.(50 or 60Hz)
- Cause : resulting from emergency generator or small cogeneration sites being loaded and unloaded or unstable frequency power sources.
- Causes : can cause erratic operation, data loss, hard drive crash, keyboard lockup and program failure, system crashes and equipment damage.

UPS glossary : switching transients

- Swtching transients : instantaneous high voltage increase.(20,000 v with a duration of 10 to 100 microsecounds).
- Cause : arcing faults and static discharge, major power system switchning disturbances initiated by the utilities to correct line problems.
- Causes : memory loss, data error, data loss and component stress.

UPS glossary : harmonic distortion

- Harmonic distortion : distortion of the normal waveform generally transmitted by nonlinear loads.
- Non-linear loads : SMPS, variable speed motors and drives, copiers, and fax machines.
- Cuases : communication errors, overheating and hardware damage.

UPS glossary : power factor

- Power is a measure of the delivery rate of energy and in DC circuits is expressed as

  Power = Volts x Amps

- In AC power system, some AC current (Amps) may flow into and back out of the load without delivering energy. This current, called reactive or harmonic current, gives rise to an apparent power (Volt x Amps) which is larger than the actual power.

UPS glossary : power factor

- The power factor is equal to the ratio of the actual power to the apparent power.
- The apparent power is expressed as the Volt-Amp or VA rating.
- Therefore, the actual power in any AC system is the VA rating multiplied by the power factor.

  W = VA * pf
- Note that KVA=1000VA.

Protection Devices

- Surge suppressors (surge protectors)
- line conditioner
- UPS

Surge Suppressors

- Passsive electronic devices that protect against transient high-level voltages.
- Limited protection against power surges, high-voltage spikes.
- When large equipment like AC motors are turned on and off, they create large, fast voltage changes (switching transients).
- Are often used to shield important, but not critical or highly sensitive office equipment, such as copiers & fax machines.

Power line Conditioner

- Offer regulation over a certain bandwidth of voltage fluctuations.
- Limited protection against power surges, high-voltage spikes and switching transients.
- Some protect against power sags and brownouts for up to two cycles.
- An adequate solution for electrical noise problems.

UPSs

- Uninterruptible Power Systems.
- Three primary types :
  - off-line (standby)
  - line interactive (hybrid)
  - online

UPS components

- Battery set
- Battery charger
- Inverter
- Filter

Battery Set

- A UPS must have a battery set in which to store an emergency source of power.
- Generally consists of more than one battery connected in series. Such a configuration is described as a battery string.
- Runtime normally measured in either minutes and/or hours.
- Is sized in terms of its Ampere hours (Ah) capacity.(the Amps to be supplied per Hour to the Inverter.)

Battery Set

- Published runtimes are normally calculated for the UPS at 100% full load.
- When a UPS is run at less than full load the UPS will provide a longer runtime.
- Some UPS have the capacity to increase the size of the battery set using battery extension packs.
- Are normally of the sealed lead acid maintenance free type.
- Are definitely not the same as the battery you use to start your car.

Battery Set

- Even though UPS systems may appear to use the same battery technology, wide variations in the lifetimes of UPS batteries are common between various UPS manufacturers.
- UPS battery replacement is expensive (as much as 30% of the original cost of the UPS).
- Failed batteries reduce system reliability and are a source of nuisance and downtime.
- The battery is the least reliable part of most well designed UPS systems.

Battery Set

- Battery temperature affects reliability
  - battery life is reduced by 10% for every additional 10 degrees F (5 degrees C).
- Battery charger design affects reliability
  - it is essential that the UPS charge the battery whenever it is plugged in, even if the UPS is switched off.

Battery Set

- Battery voltage affects reliability
  - magnitude of this aging problem is directly related to the number of cells in the string and therefore increases as the battery voltage increases.
  - For a given UPS capacity, the UPS design which will have the longest battery life is the unit with the lowest battery voltage. This preferred type of UPS uses a small number of large cells in series instead of a large number of small cells.

Battery Set

- Battery ripple current affects reliability
  - Ideally, a UPS battery should be permanently maintained in a float or constant voltage charging situation in order to maximize service life.
  - If an on-line UPS has the battery placed between the battery charger and the inverter, then the battery will be subject to ripple current. This is the classical double-conversion style UPS.

Battery Set .. So :

- The battery is the least reliable part of most well designed UPS systems.
- Operating a battery under continuous charge even when the UPS is off extends battery life.
- When choosing a UPS, avoid UPS topologies that use higher battery voltages. Beware of UPS designs that subject the battery to ripple current or unnecessarily high temperatures.

Battery Charger

- The battery within a UPS needs to be charged when the mains is present and within a reasonable recharge time.
- For standard UPS runtimes this is generally accepted to be 80% within 12 hours and care must be taken when adding battery extension packs to ensure that the charger is capable of recharging the battery.

Battery Charger

- The charging assembly draws its power from the mains supply as an alternating current (ac) and rectifies this to a direct current (dc) at the Amperage (A) and Voltage (V) required to charge the battery.
- The battery charger assembly is also known as a ‘rectifier’.

Inverter

- The purpose of the inverter is to ‘invert’ the dc supply of the battery set into an ac supply waveform sought by the SMPS.
- The inverter is normally sized in terms of the VA it can supply.
- This value is used to describe the overall size of the UPS in terms of the apparent power it can supply.
- Larger UPS may be sized in terms of the Watts (W) to be supplied.

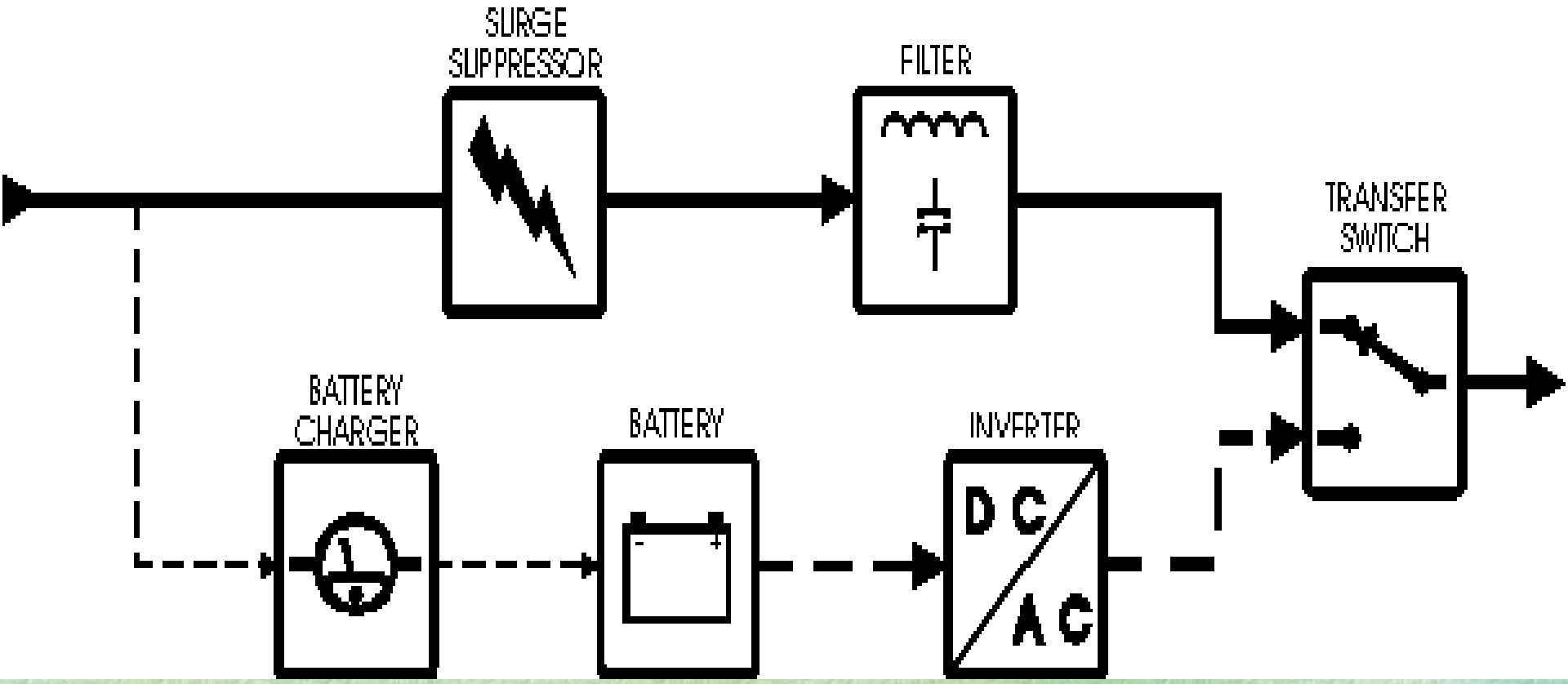
Filters

- Range from transformers providing a physical barrier to spikes and electrical noise (known as Galvanic Isolation) to basic ‘clipping’ circuits which allow some ‘pollution’ to pass directly through to the load.

UPSs

- According to APC :
  - Standby Line Interactive
  - Standby on-line hybrid
  - Standby-ferro
  - Double Conversion On-Line
  - Delta Conversion On-Line
- The commonly used terms "on-line" and "standby" do not correctly describe the majority of UPS systems available.

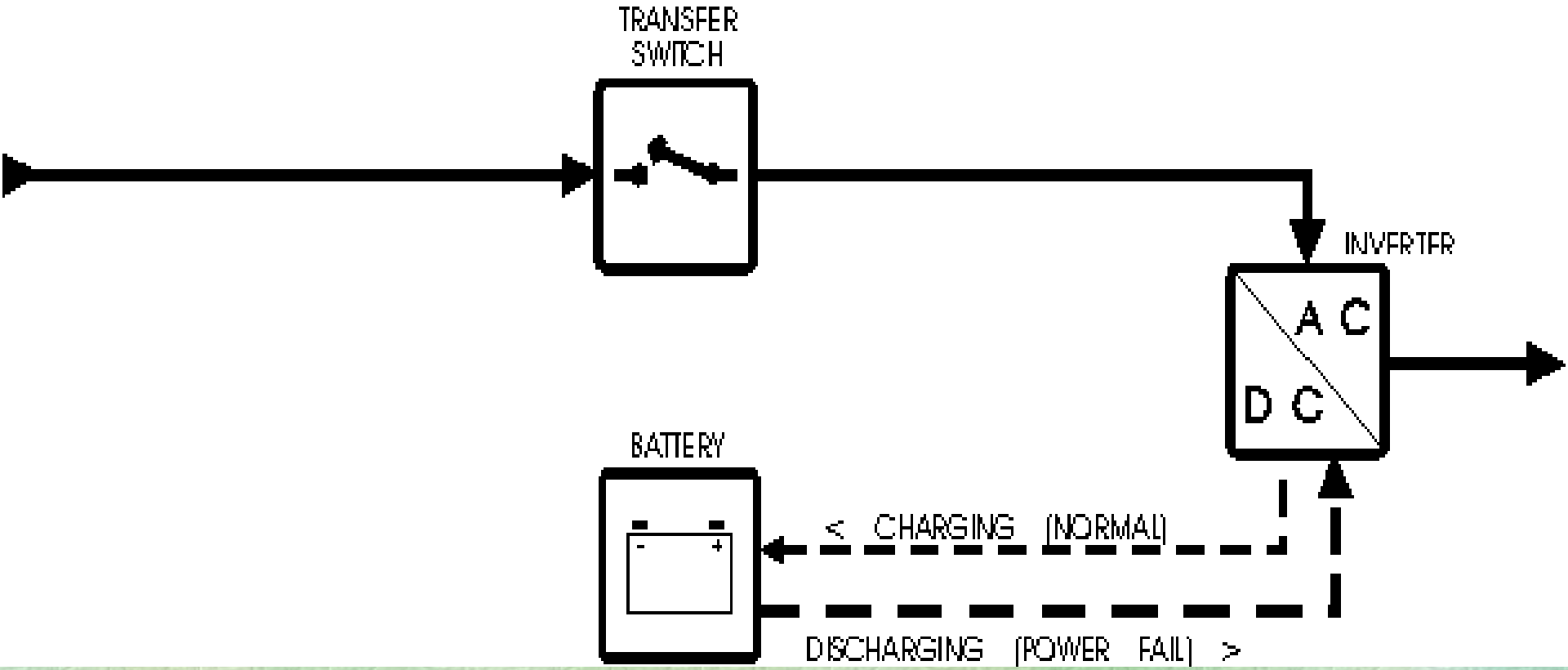
Standby


SURGE
SUPPRESSOR
FILTER
TRANSFER
SWITCH
BATTERY
CHARGER
BATTERY
INVERTER
DC
AC

Standby

- most common UPS type used for Personal Computers
- main benefits
  - High efficiency
  - Small size
  - Low cost

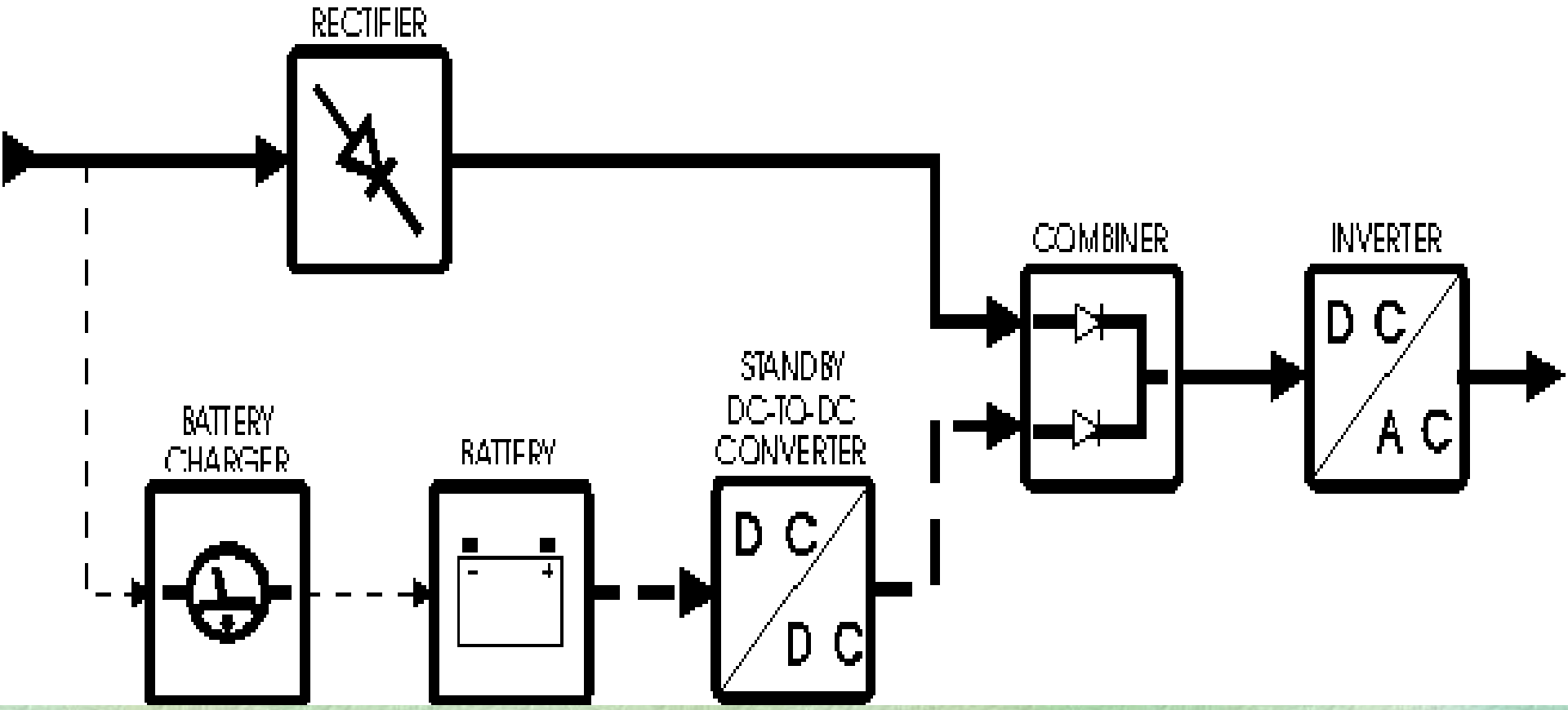
Line-interactive



Line-interactive

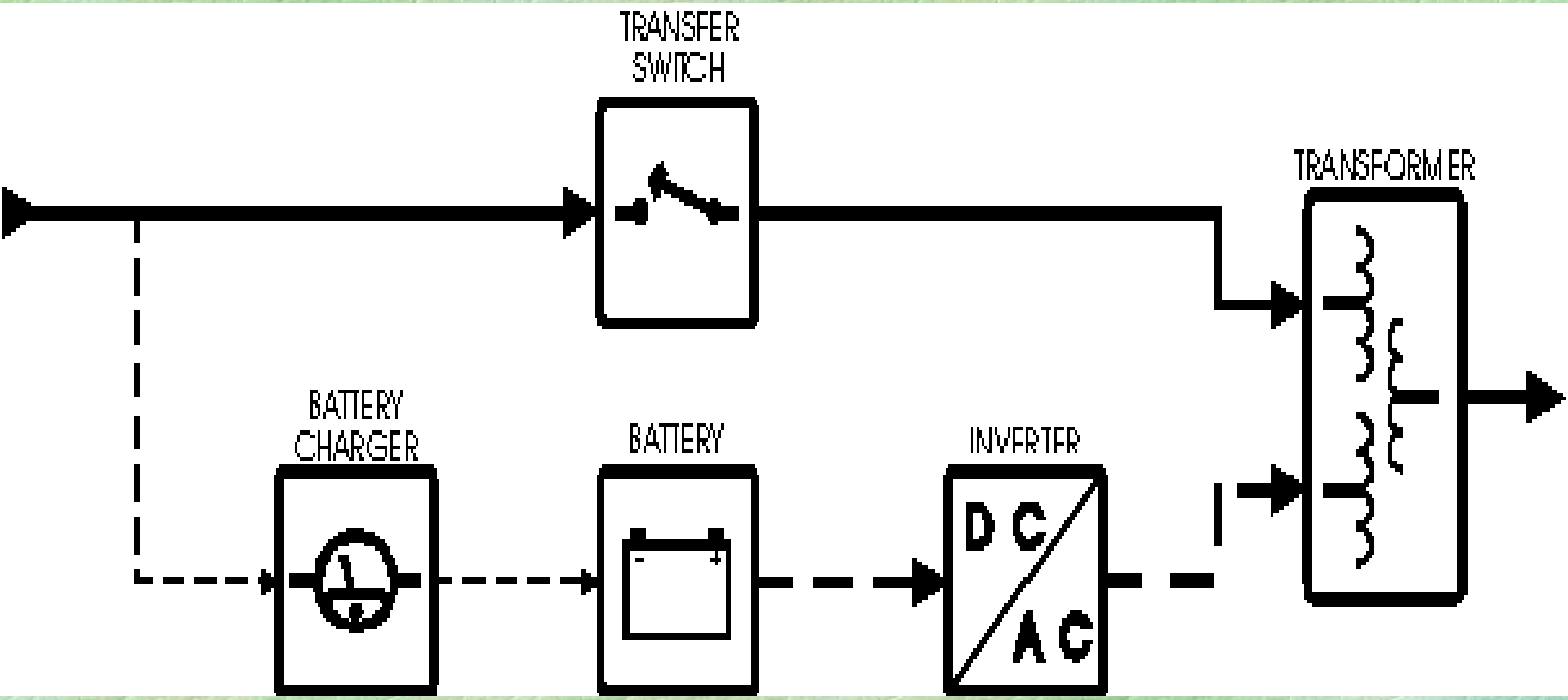
- Most common UPS used for small business, Web, and departmental servers
- High efficiency, low cost, high reliability coupled with the ability to correct low or high line voltage conditions make this the dominant type of UPS in the 0.5-5kVA power range.

Standby On-Line Hybrid



- The Standby On-Line Hybrid is the topology used for most UPS under 10kVA which are labeled "on-line".

Standby-Ferro UPS



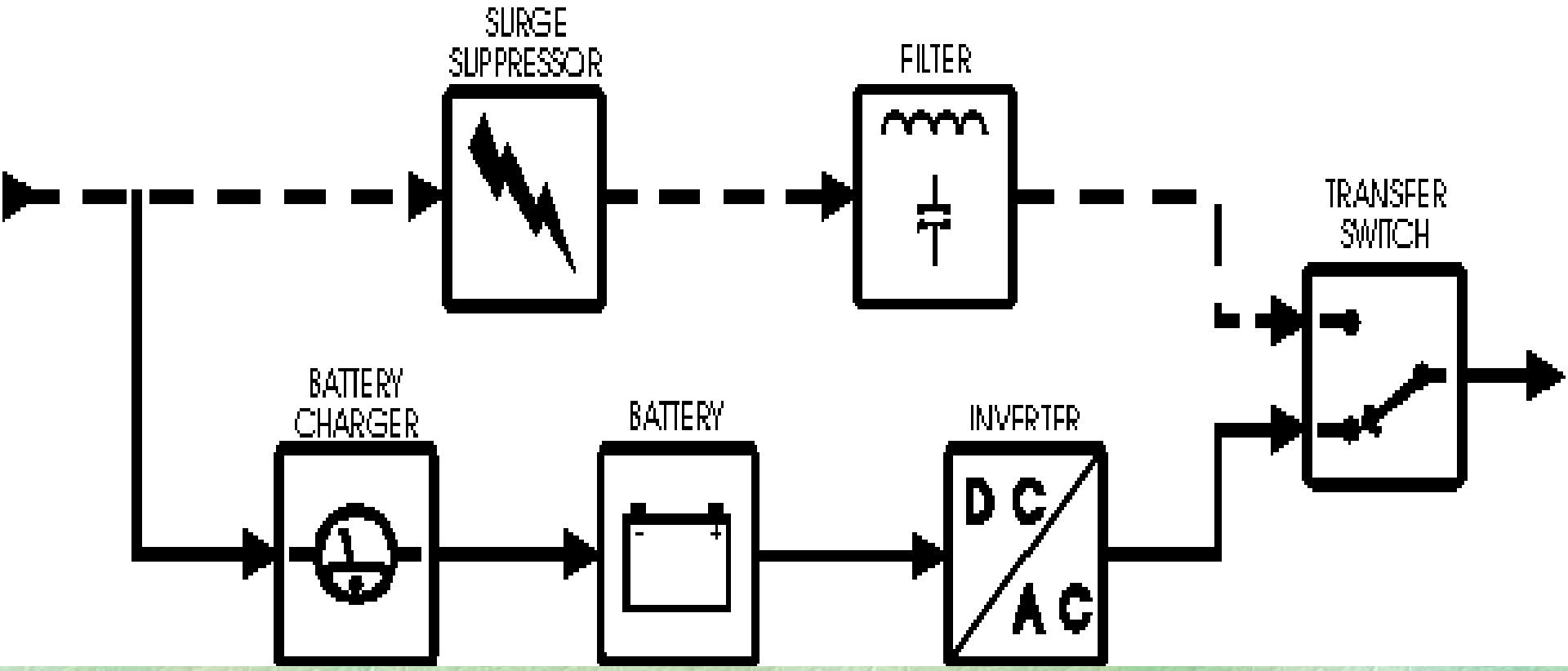
Standby-Ferro UPS

- The Standby-Ferro UPS was once the dominant form of UPS in the 3-15kVA range.
- Standby-Ferro UPS systems are frequently represented as On-Line units, even though they have a transfer switch , the inverter operates in the standby mode, and they exhibit a transfer characteristic during an AC power failure.

Standby-Ferro UPS

- High reliability and excellent line filtering are the strengths of the Standby-Ferro design. However, the design has very low efficiency combined with instability when used with some generators and newer power-factor corrected computers. This has caused the popularity of this design to decrease significantly.

Double Conversion On-Line UPS



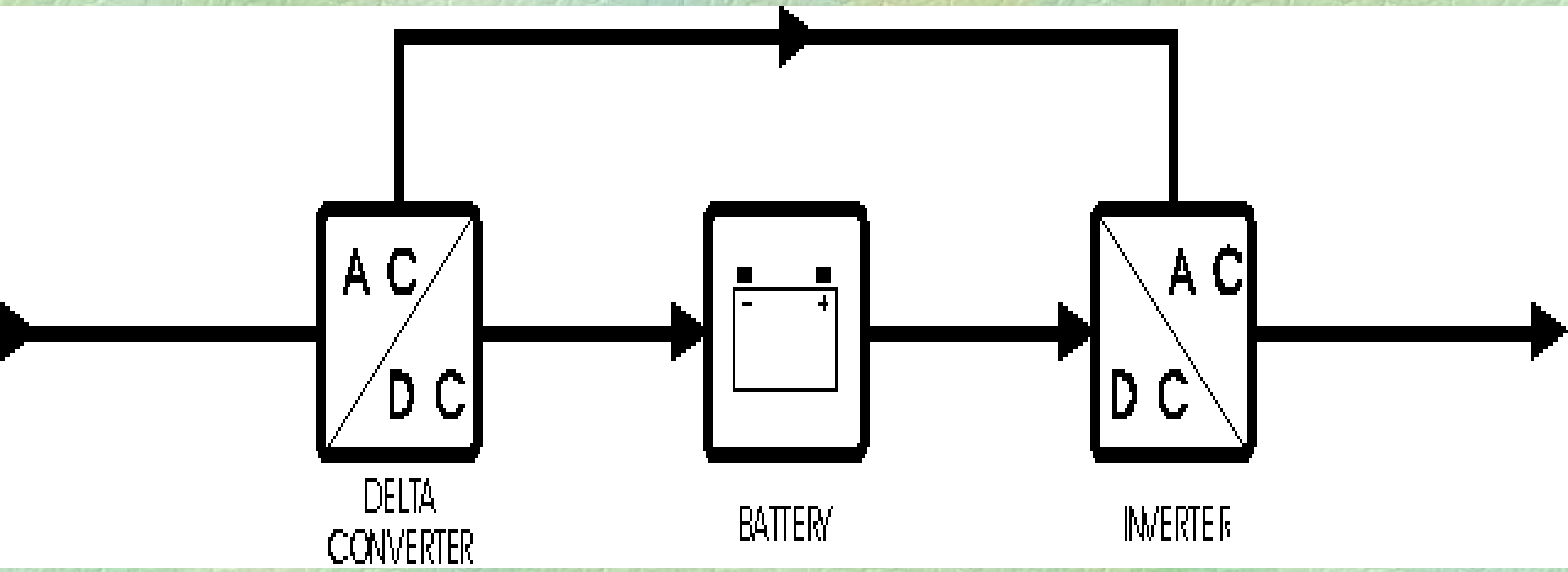
Double Conversion On-Line

- This is the most common type of UPS above 10kVA.
- provides nearly ideal electrical output performance.
- However, the constant wear on the power components reduces reliability over other designs and the energy consumed by the electrical power inefficiency is a significant part of the life-cycle cost of the UPS.

Double Conversion On-Line

- Also, the input power drawn by the large battery charger is often non-linear and can interfere with building power wiring.

Delta Conversion On-Line



Delta Conversion On-Line

- the Delta Conversion On-Line UPS offers reduction in energy losses and costs by approximately a factor of 4.
- Delta Conversion On-Line technology is the only core UPS technology today protected by patents and it is therefore not likely to be available from a broad range of UPS suppliers for some time.

Parallel Redundant UPS

- Often called N+1 Redundancy
- uses a series of UPS operating in parallel
- Typically, there will be one more module in the configuration than is necessary to support the load, enabling a faulty module (battery or UPS) to be hot-swapped out without interrupting the supply to the load.

UPS types

	Practical Power Range (kVA)	Voltage Conditioning	Cost per VA	Efficiency	Inverter always operating
Standby	0 - 0.5	Low	Low	Very High	No
Line Interactive	0.5 - 3	Design Dependent	Medium	Very High	Design Dependent
Standby On-Line Hybrid	0.5 - 5	High	High	Low	Partially
Standby Ferro	3 - 15	High	High	Low	No
Double Conversion On-Line	5 - 5000	High	Medium	Low	Yes
Delta Conversion On-Line	5 - 5000	High	Medium	High	Yes

APC UPSs

	Use in APC products	Benefits	Limitations	APCs Findings
Standby	Back-UPS	Low cost, high efficiency, compact	Uses battery during brownouts, Impractical over 2kVA	Best value for personal workstations
Line Interactive	Smart-UPS, Back-UPS Pro, and Matrix	High reliabilty, High efficiency, Good voltage conditioning	Impractical over 5kVA	Most popular UPS type in existence due to high reliabilty, ideal for rack or distributed servers and/or harsh power environments
Standby On-Line Hybrid	not used by APC	Excellent voltage conditioning	Low efficiency, Low reliabilty, High cost, Impractical over 5kVA	Line Interactive provides better reliabilty and similar conditioning at a better value

APC UPSs

Standby On-Line Hybrid	not used by APC	Excellent voltage conditioning	Low efficiency, Low reliabilty, High cost, Impractical over 5kVA	Line Interactive provides better reliabilty and similar conditioning at a better value
Standby Ferro	not used by APC	Excellent voltage Conditioning, High reliability	Low efficiency, unstable in combination with some loads and generators	Limitied application because low efficiency and instability issues are a problem, and N+1 On-Line design offers even better reliabilty
Double Conversion On-Line	Symmetra	Excellent voltage conditioning, ease of paralleling	Low efficiency, Impractical under 5kVA	Well suited for N+1 designs
Delta Conversion On-Line	Silcon	Excellent voltage conditioning, High efficiency	Impractical under 3kVA	High efficiency reduces the substancial life-cycle cost of energy in large installations

Choosing the right UPS

- Short or Long term operation
  - several hours
- Enclosure
  - free standing
  - 19" rack mounting
- Waveform
  - For modern SMPS supplies on PCs and similar equipment (faxes modems and printers) the waveform is not significant.

Choosing the right UPS

- On- and off-line
- Power conditioning
- Shutdown software
- Power rating (VA watts etc)
- Input Window

Choosing the right UPS

Choosing the right UPS

- Which devices are to be protected ?
- Do you place all UPSs in one room? (a large UPS or some small UPSs)
- how long is backup time?
- Do you need closedown s/w?
- is it higher than 3KVA ? (an external bypass is recommended).
- One phase or three phase ?

Choosing the right UPS

- How long do you need gaurantee ?

UPS Manufacturers

- **American Power Conversion**
- **Best Power Technology**
- Clary Corporation
- Controlled Power Company
- Deltec Electronics
- Elgar Corporation
- **Exide Electronics (PowerWare)**
- IMV/Victron
- IntelliPower Inc.
- **MGE UPS Systems**
- Tripp Lite

UPS Technology, BestPower

- Off-Line
- Line-Interactive
- On-line (Double conversion)
- Ferro-resonant

UPS Technology : Offline

- A break on the output
- little or no power conditioning
- surges on mains when switchning to inverter & back
- break on mains when switching to inverter & back
- square wave/non sine wave output
- no battery addon capacity

UPS Technology : Offline

- Inverter only operates in mains failure conditions
- typical 1ms transfer time
- Comm port, software is optional extra

UPS Technology:line interactive

- Offline but improved with Buck/Boost technology
- limited voltage regulation/condition
- spikes, surges,.. may pass through
- is there a break ? Yes
- usually no addon battery options
- square stepped or sine wave output?
- RS232 or contact closure comm port ?
- Free software/chargeable, what OS?

UPS Technology : On-line

- True double conversion tech
- regulated & conditioned output
- integral bypass ? Best power does.
- Additional battery packs/recharge times
- External bypass ?
- Comm port & s/w included, chargeable, what OS?
- 50/60 Hz, 220/230/240 V user selectable?

UPS Technology Ferroresonant

- The ultimate in reliability
- unsurpassed MTBF
- extended runtimes available
- integral diagnostics?

UPS Technology, BestPower

- Unity
- Patriot
- Fortress 3
- 610 online
- FERRUPS

- CheckUPS (II) s/w

UPS Technology, BestPower

- Panasonic batteries
- Johnson control battery
- NiCAD & planty

- Best Link

UPS Technology, BestPower

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