You get what you pay for

With Uninterruptible Power Supplies, as with most things in life you get what you pay for. That is to say that if you are a regular user of UPS's it is worth spending a little time getting to know the basics of UPS technology to ensure that you get what you ask for.

Any UPS is made up of three basic "sub-systems" or modules.

1. **Charger**
   - Aside from rotary UPS's which I'll not discuss here all UPS's incorporate a battery charger to recharge the batteries required for the standby operation.

2. **Battery Bank or DC Bus**
   - A *Direct Current* power source is required to provide the backup power during a mains failure. This is usually made up from a string of batteries in series and parallel configurations to provide the required DC BUS voltage and runtimes.

3. **Inverter**
   - The inverter converts the DC from the batteries to 230V AC on the output of the UPS.

Depending on the application these modules are incorporated differently. Before we look at how the three systems are connected lets quickly look at the inverter which is where the greatest cost of any UPS lies.

There are two basic ways that an inverter generates an AC output:

1. **Square Sine Wave**
   - Also known as "*Quasi Sine Wave"*, "*Stepped Sine Wave"* or "*Modified Sine Wave".* This is the simplest and crudest way of generating an AC output. Essentially all that happens is the DC is switched in several steps from 0V to +230V and back through 0V to -230V creating a wave form as represented in Fig 1.

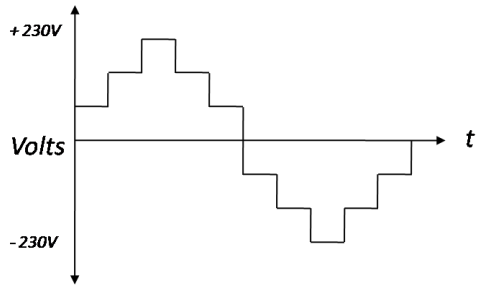

Fig. 1

2. **Pure sine wave**
   - A pure sine wave inverter uses high frequency switching technology to produce a smooth continuously alternating output wave as shown in Fig 2.

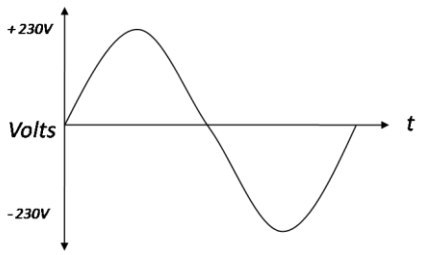

Fig. 2

The technology required to produce a pure sine wave output is significantly more complicated and expensive than that required to produce a modified sine wave. Unfortunately, although modified sine wave UPS's are very cost effective, the stepped wave form is only compatible with certain small loads such as Desktop PC's, TV's and small HiFi's to name a few. In many cases modified sine wave UPS's can even cause damage to equipment so it is critical to assess what type of load you have and obtain professional advice before simply buying the cheapest UPS. Because of their limited application modified sine wave UPS's are very rarely produced in sizes above 3KVA and are more often restricted to the 400VA-1000VA sizes.

There are many aspects to consider when making an assessment of one's UPS requirements, not the least of which is the charger and DC Bus or battery arrangement; however I'll concentrate this article on one other aspect of the UPS which is the difference between On-line or Line Interactive technology.

Unscrupulous vendors will often use jargon to deceive less informed users in to thinking they are purchasing an *online* UPS at a cheap price when in fact it may be a *line interactive* UPS. It is therefore critical to understand not only the actual difference between the two technologies but also the correct terminology for each system and how to test your UPS to ensure you are getting what you pay for.

Let's first examine the difference between the two UPS types.

LINE INTERACTIVE UPS's essentially incorporate an *offline* inverter arrangement (Fig. 3). Under normal power conditions the incoming supply is connected directly to the output and so the "raw" AC is supplied to the load. Only when the mains supply fails is the inverter switched on and brought on-line. In order to do this the output has to be switched from mains to inverter via a high speed relay and whilst modern technology ensures that this transfer time is very small, there is nevertheless a delay of 2-8mS. This transfer time can be even longer in lower cost UPS's.

Because of the high switching currents in larger UPS's, Line Interactive UPS's are very rarely manufactured in sizes above 5KVA.

The advantage of using a line interactive UPS is that they cost significantly less than their online counterparts and are a sound solution when one only requires the UPS to provide backup and not high quality clean power.

As a protection element however line interactive UPS's provide very little benefit. Some of the better quality line interactive UPS's incorporate voltage regulation (AVR) to regulate the output to 230V with an input variation of ±20% but besides this, the raw incoming power, with all of its spikes, surges, sags, harmonics, noise etc is connected directly to the load. It's only under mains failure conditions that the clean inverter power is supplied.

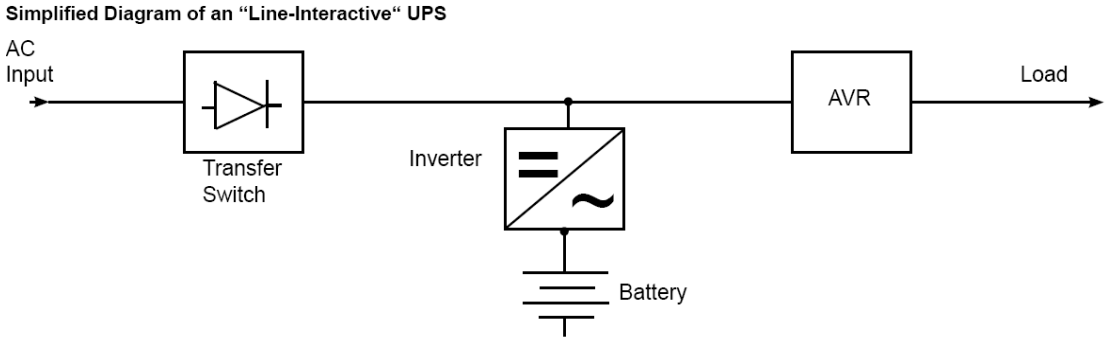

Fig. 3

With ***ONLINE*** **UPS's** the inverter permanently supplies power to the load regardless of the input mains condition. The mains supply is used simply to drive the battery charger and charge the battery banks. The output of the UPS is permanently supplied by the inverter independently from the mains. Thus the output is completely isolated from the input.

It stands to reason that the inverter which has to run 24/7 has to be far more robust and reliable than its line-interactive counterpart. This makes online UPS's significantly more expensive, sometimes as much as double the cost of the equivalent line interactive models. Larger UPS's (above 5KVA) and 3-phase units are almost exclusively online machines.

As a protection element, an online UPS is extremely effective, ensuring continuous, clean power regardless of the condition of the mains supply.

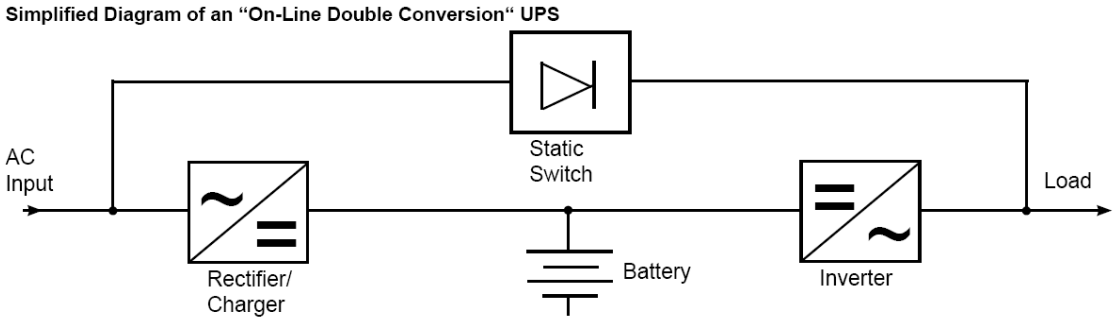

Fig. 4

But in today's competitive markets with every manner of jargon being bandied about how does one know you are getting an online UPS?

Before we consider how to test the UPS lets analyse the Jargon being employed currently.
Line interactive UPS's are referred to as "*off-line*", "*IN-LINE*", "*single conversion*", or "*single conversion, inline*" UPS's some of which are intended to mislead the purchaser into thinking he is purchasing an online unit when in fact they are not. The simple fact is that if the unit you are buying is half the cost of other online units there is a good chance you are buying a line interactive unit being passed off as an online unit.

Online UPS's are referred to as "*Online*", "*Double Conversion*", "O*nline, Double Conversion*" or "*True Online, Double Conversion*" UPS's and not even less scrupulous vendors will use these terms to refer to line interactive units for concerns of liability claims.

If the jargon has got your head spinning and you are still not sure you are getting what you pay for then there is a simple non invasive way of testing what type of UPS you are getting, and one can insist that your supplier prove to you using the same test that if you are paying for an online UPS that, that is in fact what is being supplying.

To carry out the test you will need to connect an incandescent globe to the output of the UPS. This can be done using a lead with a male IEC connector on one end and a Janus coupler on the other end (Or simply give PHD a call and we'll supply a pre-made up lead free of charge) . A simple bedside reading lamp can then be plugged into the Janus coupler. Switch the Mains and the UPS on. When the lamp is glowing steadily disconnect the input to the UPS. If your UPS is online there will be absolutely no effect on the globe. However if the globe flickers then there is no doubt that the UPS is in fact a line interactive unit.

The truth is that one technology is not superior to other. It is simply a matter of horses for courses. Each type of UPS is perfectly suited to the application for which it is designed. It's using the wrong

UPS for your application which results in poor performance and undesirable results, but if all the jargon and technical spec has is a little confusing PHD Powerhouse will provide you with objective

and unbiased advice. We are even prepared to provide testing free of charge to ensure that you get what you pay for.

For more information or free advice and testing contact PHD Powerhouse

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