

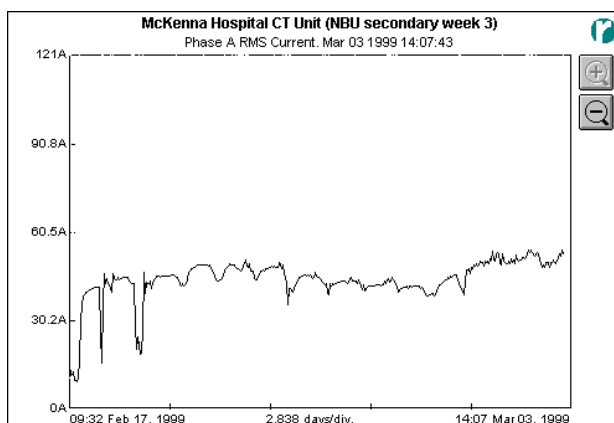
Pulsing Loads

Recently, higher levels of computerization have spread to many industries. Gasoline stations, medical imaging equipment, home appliances, factory automation - the list of equipment and industries that now rely on the computer and the microprocessor continues to grow. Along with this growth comes an increased requirement for power conditioning devices to protect these newly sensitive loads.

Sensitive Loads in the Past

In the past, computer loads were well defined. Most of the electronic equipment was located in a dedicated computer room and powered 24 hours per day. The sensitive load consisted of linear or switching power supplies, some small motorized loads (disk drives, tape drives, printers, etc.) and video monitors. The load profile was very stable - operating within a fairly tight demand interval over the course of the workday and work week.

Load changes were rare - equipment operation might produce step changes in load of 5-10% of total demand as motors switched on and off. New devices or components would increase the total demand, and equipment being idle at night or over the weekend might cause long term demand shifts.



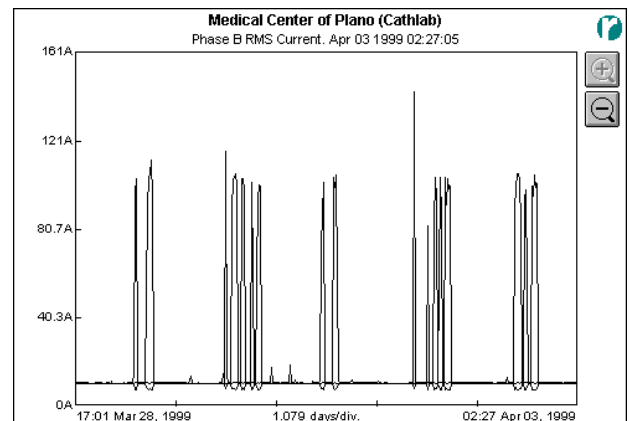
A conventional load fluctuates slowly, with gradual shifts in amplitude on a daily or weekly basis.

Application Note - AN-3

Today's Sensitive Loads

Today, sensitive loads continue to be made up of computers, electronics, disk drives, and associated equipment. However, these devices are now integrated into large components that perform other functions. There is no longer a dedicated computer room - instead, the computer equipment may be located on the factory floor, in the medical lab, or in a standard office. As a result, the sensitive electronic devices are often powered from the same branch circuits as other, high power process equipment that the computer is controlling.

High power equipment is often made up of intermittent or pulsing loads. Such loads draw power in a different way than computer and electronic systems in the past. There continues to be a steady-state electronic load, but the computer load is much smaller (lower kilowatts) than for an equivalent amount of computing power in the past. These *pulsing loads* have common components that require special considerations when designing electrical systems.



A pulsing load varies randomly or on a repetitive basis. Note the low stand-by current, and the high peak levels.

The process portion of modern sensitive loads can be made up of any number of electronic or electro-mechanical devices that draw power in small bursts or pulses.

Typical pulsing loads include phase controlled SCR loads for precise speed, voltage, or temperature control, switched loads for rapid On/Off control, large Switched Mode Power Supply (SMPS) loads.

These switched loads can be made more severe by the following factors:

- Capacitive inrush on start-up
- Lack of soft-start circuitry
- Inadequate filtering
- Continuous On/Off switching throughout the work-day

Problems with Pulsing Loads

If the electrical system feeding the sensitive equipment was a perfect voltage source, pulsing loads would not pose a problem for designers or electrical systems. Such an "ideal" supply would be characterized by an extremely low source impedance. With a source impedance of zero ohms, the voltage seen at the sensitive load would be equivalent to the voltage source regardless of the applied load. However, in the real world, the voltage at the sensitive load drops or sags in proportion to the applied load.

The Pulsing Load is a built-in source of interference for the other sensitive components in a system. Each time the pulsing load operates, the voltage drop across the source impedance rises.

Several power quality problems can occur as a result:

- *Sags* due to inrush currents or normal operation of the pulsing load
- *Harmonic Distortion* if the pulsing load is non-sinusoidal (high harmonics)
- *Transient Impulses* due to switching on and off of the pulsing load and the inductive elements of the source impedance

The best design technique for minimizing the effects of pulsing loads on other sensitive system components is to minimize the source impedance, using some or all of the following practices:

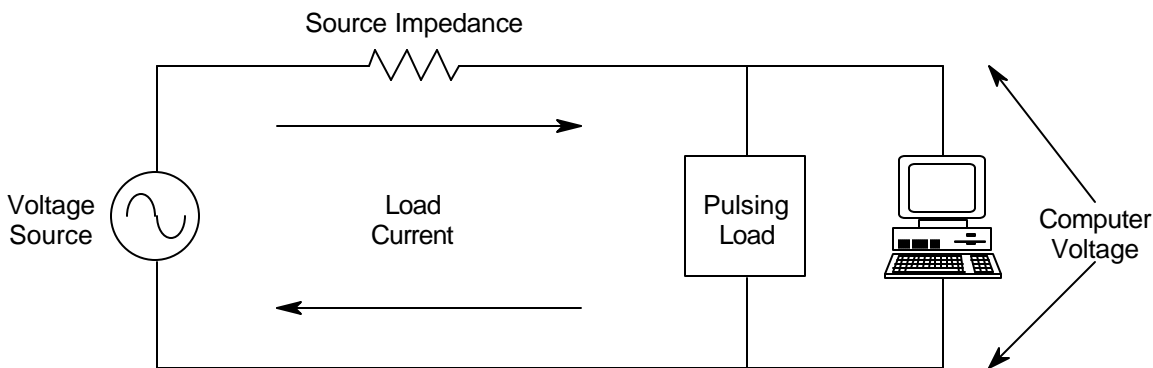
- Use higher voltage for long conductor runs
- Increase conductor size based on run length
- Select low impedance components (especially transformers)

Power Conditioners with Pulsing Loads

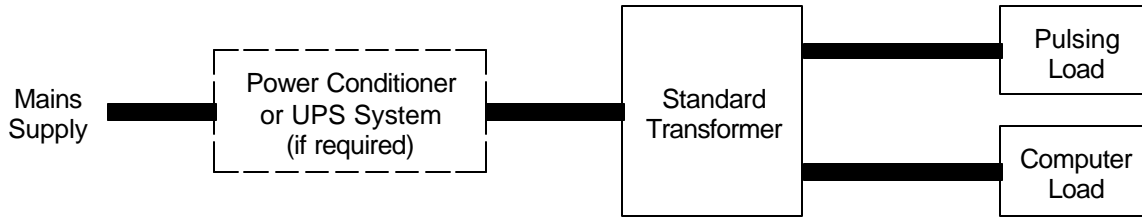
Conventional power conditioners, developed for the older style sensitive loads with a steady power demand, are often not suitable for use with pulsing loads found in modern sensitive equipment.

Some of the problems that may be encountered using these older style power conditioners include:

- Power conditioners must be overrated to supply stable voltage during step-loads
- Power conditioners with excessive impedance increase create sags, distortion, and impulses
- Some devices, such as synthesizers, UPS systems, or Ferro-resonant transformers, may shut-off or malfunction



$$\text{Voltage}_{(\text{computer})} = \text{Voltage}_{(\text{source})} - [\text{Impedance}_{(\text{source})} \times \text{Current}_{(\text{load})}]$$



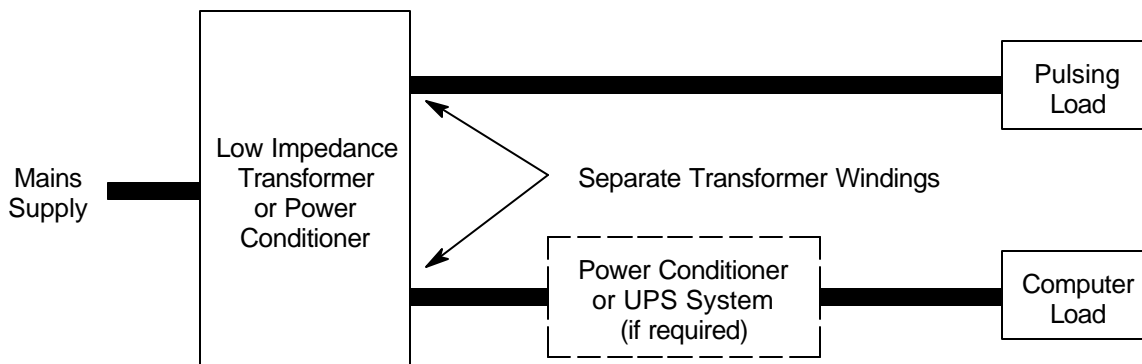
Using conventional Power Conditioning techniques and approaches can cause problems when dealing with a pulsing load.
Not Recommended!

Recommended Practices for Pulsing Loads

Pulsing loads are a challenge to the systems designer concerned with power quality, since the cause of the power problems is located within the sensitive system itself. Common power quality solutions (power conditioners) may be costly, ineffective, or even make problems worse. However, there are some simple design techniques that can minimize the power problems caused by pulsing loads.

The best design technique for pulsing loads is to minimize the source impedance. While conductor sizes are a portion of source impedance, by far the largest contributor to source impedance is any transformer in the electrical system feeding the sensitive load. As a result, a large improvement in source impedance can be made by using a low impedance transformer or power conditioner (1-2% impedance) in place of standard isolation transformers (5-8% impedance).

A low impedance transformer is a good start, but sometimes additional measures are required. If the sensitive, computer load and the pulsing load can be separated and powered from independent power sources, separation of these can be beneficial. A separate transformer or transformer winding for each sensitive load and pulsing load will minimize reflected impedance. If additional power conditioning is required, a small power conditioner or Uninterruptible Power Supply (UPS) for the sensitive load can be applied at a much lower cost than protecting the entire system.



Using low impedance transformers or power conditioners, and separating the pulsing load from sensitive or computerized loads prevents interaction and load
Recommended Practice!