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STANDING HEAD

Power Conditioning

Selecting the best power conditioning product type for your specific power problems.

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In Brief
Matching the proper power conditioning product to the task at hand.

Related Products:
Surge Protection Strips; Line Conditioners; Uninterruptible Power Supplies; Battery Backups; TVSS; Ground Rod Systems; Isolation Transformers.

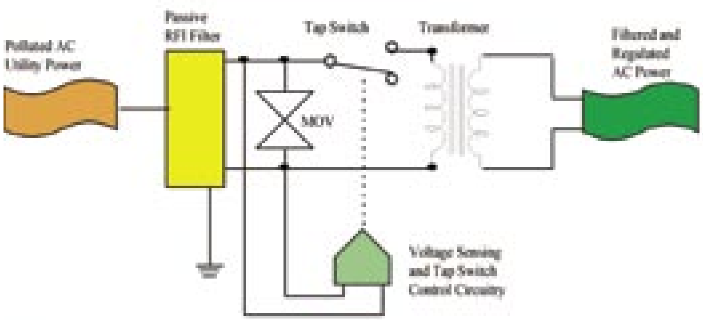
With the large number of power conditioning and protection products available on the market, the selection of a device that will provide the right level of protection needed for your specific power environment may seem a daunting task. The selection process can be simplified by first understanding the differing design methodologies available, in conjunction with understanding how these methods relate to solving specific power problems.

As a first step we will list the most common kinds of power problems that may be encountered:

- Surges
- High Voltage Transients
- Low Voltage (brownouts)
- Sustained Voltage Loss
- High Voltage (high line)
- Voltage Fluctuations
- Voltage Dropouts
- Frequency Fluctuations
- Common Mode Noise
- Noise and Harmonics
- Radio Frequency Interference (RFI)
- Lightning
- Localized Power Pollution

It must be understood that not all power conditioning equipment design topologies are the same, but yield differing levels of protection. Some may only provide surge protection, while others may include the added protection of volt-

TYPICAL TAP SWITCH POWER CONDITIONER



1. Passive RFI Filter minor line noise and RFI.
2. MOV clamps high voltage transients.
3. The Tap Switch Control Circuitry senses the incoming utility voltage and selects the transformer tap(s) in an attempt to keep the output voltage as close to nominal as possible.
4. The Tap Switch is usually a semiconductor type switch with switching made at the AC sinewave zero crossing point.
5. The Transformer used may be a full isolation type as shown or a non-isolated auto-transformer to reduce cost.

age regulation and RFI protection. High-end double conversion products can provide protection against most of the power problems listed above.

Surge & High Voltage Transients

Surge protection incorporated into these devices is usually accomplished through the use of an active line clamping device that is connected directly across the incoming power line. The clamping devices used may consist of Metal Oxide Varistors (MOV), Transorbs, gas discharge or spark gap devices. The most cost-effective and common device used is the MOV. It is found in most surge protected plug strips, small line conditioners and uninterruptible power supplies. The MOV provides a moderate level of protection against excessively high voltages, surges and transients. The gas discharge device provides the best level of protection, is more costly, and is found in large power conditioners.

Voltage, Frequency & Common Mode

In power conditioners, voltage regulation is accomplished using several different methods providing varying degrees of accuracy. The most commonly found in low cost line conditioners is the Tap Switching Regulator. It consists of a transformer with taps, which are automatically switched by a line voltage sensing circuit. This switching is done in an attempt to keep the output voltage as close to the nominal line voltage as possible. The output voltage regulation for this design typically ranges from ±12 percent to ±5 percent. If not designed properly, the switching of the taps can generate voltage dropouts, noise or transients at the output of the conditioner. To keep the cost low, many designs incorporate an auto-transformer, which does not offer the advantages of galvanic isolation.

Another method of voltage regulation incorporates a ferroresonant transformer. A ferroresonant transformer is a non-linear transformer that is designed to provide passive voltage regulation, using magnetics only. It typically has an output regulation from ±1-5 percent. Even though the voltage regulation is good, the ferroresonant is sensitive to changes in line frequency and should be avoided if it is to be powered from a motor-generator source. The ferroresonant power conditioner cannot provide any frequency regulation. It also has relatively high output impedance and may not support loads that have large inrush or step load current demands, unless oversized for a given application. The ferroresonant transformer used does provide galvanic isolation, which gives a good level of protection against common mode noise problems.

The third power conditioner topology incorporates active electronics, and is often referred to as double conversion or on-line technology. The incoming alternating current (AC) utility power is rectified to a direct current (DC), filtered and then regulated. The DC is next fed to a DC-AC converter stage that regenerates totally new, pure sinewave AC power. This topology removes more power quality problems than the tap switching or ferroresonant designs, while offering superior voltage regulation (±2–3 percent typical). Frequency regulation not achievable in the two previous topologies is also present. Some manufacturers also offer options such as 50, 60 and 400Hz frequency conversion, battery backup and galvanic isolation.

MOV level transient protection is usually incorporated in all three of the topologies. The double conversion on-line design has the advantage of an additional layer of active electronics between the utility source and the connected equipment, thereby providing superior protection against high voltage surges and transients.

The only protection against a long term voltage dropout or a full loss of utility voltage is battery backup protection. Some manufacturers of double conversion, on-line conditioners offer battery bank options that interface with their line conditioners. The option configures the power conditioner to operate as a true double conversion, on-line UPS.

Noise, Harmonics & RFI

Tap switching, ferroresonant and on-line topologies offer differing degrees of noise, harmonic and RFI protection. All typically incorporate passive high frequency noise filtering elements that reduce the level of the interference. The transformers used in the tap switching and ferroresonant designs, by their nature, reject most high frequency noise and RFI. The on-line design incorporates the same passive RFI and noise filtering techniques, in addition to eliminating a greater level of noise and RFI through its unique active electronics design.

Lightning

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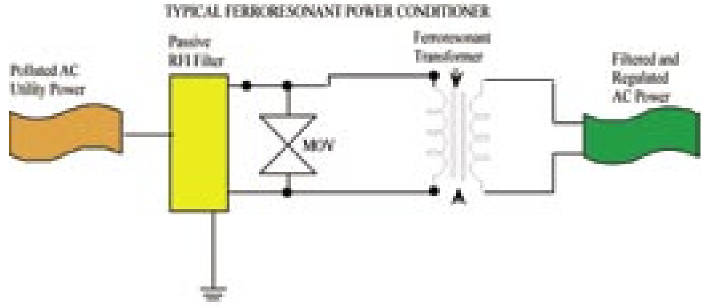

1. Passive RFI Filter minor line noise and RFI.
2. MOV clamps high voltage transients.
3. The Ferroresonant Transformer self regulates its output over a limited input voltage range and is sensitive to changes in frequency

surge protected plug strip, line conditioner or uninterruptible power supply. Lightning protection is best accomplished through the installation of heavy duty lightning suppression devices (TVSS) at the building's incoming utility electrical panel. The installation of the proper protection devices, and their associated grounding techniques, must be performed by a reputable electrical contractor specializing in lightning suppression. All work must be performed in accordance with national and state electrical codes and regulations.

A star configuration building grounding scheme is paramount when it comes to lightning protection. It starts with a properly installed ground rod system located as close to the utility entrance panel as possible. Ground conductivity tests should be performed at the time of initial installation, and at five year intervals thereafter to assure the ground integrity. The wiring connection from the ground rod to the entrance panel should be as large as practical and meet all National Electrical Code (NEC) requirements. All building subpanel grounds should emanate directly from the entrance panel, not daisy chained from panel to panel. Secondary ground rods for subpanels, computer equipment, etc. should be

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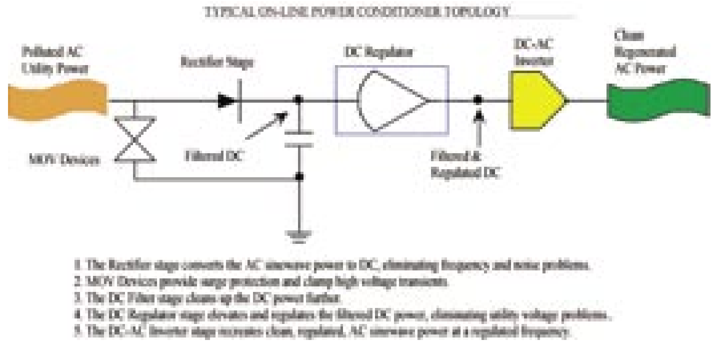
avoided. If used, they must be connected to the building's primary grounding point per the NEC. If left unconnected to the main building ground, they represent a significant safety hazard, and can cause substantial damage to the connected equipment, should a lightning strike occur.

Computer, numeric controlled machines, Telco and other equipment that is interconnected through hardwire network cabling can benefit from the installation of galvanic isolation (isolation transformers) at the power connection of each interconnected computer, machine or device. This isolation breaks the direct and neutral to ground paths, reducing the potential for damage. The key word here is reducing, as nothing can totally eliminate this possibility due to the extreme amounts of energy released in a lightning strike.

All computer network cabling to be connected between buildings must use fiber optic cable or incorporate optical isolation devices at each end of the cable, if hardwired. All satellite, data and radio communications antennas must have the proper lightning suppression devices installed in line with all connected cabling. Roof top antenna locations must



be protected with adequate lighting rod installations. Again, all of the aforementioned must be installed by a licensed contractor, in accordance with all national, state and local codes and regulations.

Localized Power Pollution

Localized power pollution is generated by pieces of electrical equipment operating on the building's electrical system. Typically the worst offenders are equipment with large motors such as air conditioners, electric heaters and furnaces, machining equipment, pumps, etc. In office environments, photo copiers, laser printers, vacuum cleaners and electric fans can generate enough power pollution to adversely effect the operation of computers, file-servers, networks or sensitive test and measurement equipment.

Installing centralized power conditioners or on-line uninterruptible power supplies large enough to protect the entire building will not solve localized power pollution problems. The power conditioning equipment must be connected directly to the sensitive equipment to be effective.

Backup generators can represent an intermittent source of power pollution. Often there is a switch-over or startup delay period where power is lost to the building or critical loads. At initial startup or during periods of high current demands, generators often exhibit frequency drift. Both of these problems can cause sensitive microprocessor-based equipment, computer or network reliability problems. It may even result in the failure of the equipment. The solution to these problems is an on-line power conditioner with battery backup capability, or an on-line UPS.

The information presented should assist in determining a wide range of power problems, and in the selection of the best power conditioning product for your unique requirements.

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