White Paper

Choosing UPS Protection For Underdeveloped Countries

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Facing Unusual Challenges

I. Introduction

Problems include: Frequent blackouts & AC mains voltages frequently fluctuate beyond the IEC assumed standard of a 184 to 264 VAC input range.

All electrical and electronic equipment users in underdeveloped countries face unusual difficulties in trying to cope with AC power problems. Among the problems are:

1. Frequent blackouts due to inadequate generation capacity;
2. Wide AC mains voltage variation due to inadequate distribution infrastructure;
3. Generally poor quality of the power, in areas such as distortion, spike/noise, frequency, sags/surges and dropouts, especially when generators are used to supplement utility power.

Of course, these problems also exist in developed countries. However, in underdeveloped countries in Africa, South America and Asia, such power problems can occur so often as to cause unacceptable levels of system down time and catastrophic equipment failures. Also, uninterruptible power supply (UPS) systems, which are installed to mitigate the above-mentioned AC power problems, often exhibit unacceptably high failure rates. Standard UPS systems are designed to meet IEC specifications for a mains AC voltage window of 184 to 264 VAC, while actual mains voltages quite often vary between 160 to 330 VAC in many developing countries.

Operating a UPS system outside of its specified AC mains voltage window is one of the primary reasons for premature UPS failure. When the other common power quality problems such as surges, spikes, noise, sags, and frequency problems are also considered, designing a reliable UPS system for underdeveloped countries poses a special challenge to UPS manufacturers.

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II. Differences In UPS Requirements

A standard UPS designed for use in a developed country (such as in the USA) might encounter the following difficulties when installed in underdeveloped countries:

Challenges include: Deep and numerous battery discharges, frequency of power disturbances, small generator aberrant output, wide temperature swings, and non-coordinated systems unable to handle lightning.

1. Because of frequent blackouts, the batteries in the UPS, whether online or standby, will be discharged and charged very often. Furthermore, because the duration of the blackout is usually longer than in developed countries, the batteries will be more deeply discharged. These two factors combine to drastically reduce the expected lifetime of the battery. For example, a typical lead-acid battery will last for about 1,200 discharge/charge cycles when the depth discharge is 30% of battery capacity. However, when the depth of discharge is 50%, this number is reduced to 450. And when the depth of discharge is 100%, the number is reduced to below 200. A UPS in the U.S. may experience a 100% discharge/charge cycle about 5 to 10 times a year. In underdeveloped countries, this may occur almost every day, reducing the expected life of the UPS to less than a year.
2. Because of the frequency of power disturbances, the power electronic circuitry in the UPS must work far more often and under greater stress. This is especially true for standby UPS systems, which must make the transfer to battery backup every time there is a power disturbance. Even in double-conversion online UPS systems (where transfer to battery is not required), the power transistors and transformers must operate at higher current and voltage levels during brownout and overvoltage conditions, resulting in a shorter-than-normal operating lifetime of the UPS.
3. The batteries cannot be charged fully when the power disturbances occur so frequently. Consequently, the UPS cannot provide the rated backup time during each power disturbance. This can cause severe problems with mission-critical computers or telecommunications equipment that depend on the UPS to provide the 99.99% (or higher) system availability.
4. Small emergency power generators can cause special problems for when they are used to power a UPS system. They are known to produce wide frequency/voltage fluctuations, surges/spikes, and highly distorted (often non-sinusoidal) outputs which can cause continuous mains/inverter transfer operations, shutdowns, and even catastrophic UPS failure.
5. For sites subject to frequent lightning strikes, absence of a coordinated surge protection system based on IEC Technical Specification 61312-3 "Requirement of Surge Protective Devices" may cause premature failure of UPS due to unmitigated surges and spikes induced on incoming AC power line(s).
6. If the ambient temperature is outside of the optimum 10 to 25 degree C range, standard sealed lead-acid batteries cannot be used. Standard batteries are rated to work only when temperature is above 0 degree C, and sudden battery failure can occur when operating temperature goes above 40 degree C. Even at 30 degrees C, expected battery lifetime is reduced by 50% compared to the expected battery lifetime at 20 degrees C.

III. Solutions For Reliable & Cost-Effective UPS Protection

TSi Power has developed 4 distinct UPS topologies to handle the challenging problem of reliability in underdeveloped countries.

The above-mentioned international power quality problems provide UPS manufacturers with a difficult challenge in trying to design UPS systems for underdeveloped countries. It must be recognized that no UPS system can provide foolproof protection against all types of power problems, especially at a reasonable cost. To provide the best solution to power problems in underdeveloped countries requires an intelligent application of technology, coupled with an intimate familiarity with the nature of the problems. Involved in international AC power protection since 1990, TSi Power has developed a family of UPS systems which are particularly useful in underdeveloped countries, with the following features:

1. A Voltage Range Extended UPS (VRe-UPs) provides an input voltage range of 160 to 330VAC for a nominal 230VAC in/output UPS system. Battery lifetime is maximized since battery discharge takes place during blackouts only (and not for brownout or overvoltage periods). The up-time percentage of a VRe-UPS is significantly higher than a standard UPS since the battery is always kept fully charged even during deep brownouts or overvoltage conditions.
2. Since only regulated 230VAC is supplied to transistors and transformers in a VRe-UPs, they are not subjected to excessive voltage, current, or heat even during brownouts or overvoltage periods. Thus, the maximum lifetime of transistors and transformers can be expected, thus increasing the reliability (and up-time percentage) of the VRe-UPS and the connected equipment.
3. When a small emergency power generator is used to power a UPS, the Precision Voltage Regulated UPS (VRp-UPs) should be used. The VRp circuit constantly regenerates a clean sine wave even from a highly distorted and non-sinusoidal output typical of a small power generator. By providing only high-quality, regulated sinewave input to the UPS, the VRp-UPs provides maximum UPS up-time percentage as well as maximum UPS and connected equipment lifetime.
4. When a site is subject to frequent and severe lightning strikes, an Isolation Line Conditioned (ILc-UPs) should be used. By providing transformer isolation, a new neutral-to-ground bond, surge protection at the output side of isolation transformer, and excellent noise filtering between incoming AC and the UPS, a coordinated protection system based on IEC Technical Specification 61312-3 is included. Therefore, the maximum level of surge protection for the mission-critical equipment is provided by the ILc-UPs.
5. If the ambient temperature is expected to be outside of the recommended 10 to 25 degree C window, a special class of wide-temperature rated batteries (which are guaranteed to work from -20 to +55 degrees C) must be used in order to obtain 5 years (or longer) of battery lifetime.

IV. Conclusion

A UPS manufacturer must be knowledgeable in handling all the possible power quality problems in the country where the UPS must be installed.

There are special challenges in designing a UPS system which can provide the requisite AC power protection and backup in underdeveloped countries. A UPS manufacturer must be knowledgeable in handling all the possible power quality problems in the country where the UPS must be installed.

Armed with this knowledge of actual conditions in underdeveloped countries, it is possible to provide an enhanced-performance, yet cost-effective UPS system that can withstand hostile conditions and fully protect the connected equipment against the following problems:

1. Wide AC mains voltage variation from 160 to 330 VAC,
2. Distortion, spike/noise, frequency, sags/surges and dropouts produced by small emergency power generators in wide use in underdeveloped countries due to the shortage of adequate power generation and distribution infrastructures,
3. Surges and spikes caused by frequent lightning strikes nearby, or
4. Ambient temperature outside of the 10 to 25 degree C range.

Since 1992, TSi Power has developed several special optional modules, which can be added to the standard UPS, which extend the operating voltage range significantly and maximize the equipment protection level, up-time percentage and the lifetime of the UPS.

In order to ensure reliable UPS operation in an underdeveloped country, a specially modified UPS might be required. TSi Power's experienced technical staff can work with customers to arrive at the best UPS design for underdeveloped countries.

About The Author

Nam Paik ~ Director of Technology, TSi Power Corporation
Mr. Paik has over 15 years experience in the power electronics industry. He was with Northern Telecom (now Nortel Networks) for 4 years prior to joining TSi Power in 1988. Nam has focused on UPS, Line Conditioner and DC to AC inverter products and most recently has developed a number of customized power protection and conversion systems for several U.S. government agencies and international applications.

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