White Paper

How Reliable is Your Broadband Power System?

[Power]

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As broadband networks proliferate, network operators need to know their power systems won't shut down.

The world's communications infrastructure supports more business, entertainment and education now than at any other time in history. Because of this trend, overall system reliability has become one of the most critical technological challenges facing today's broadband service provider.

Billions of dollars of electronic money transfers traverse the communications network daily. Thousands of lives depend on immediate forwarding of emergency response information. Consumers speed data from one side of the globe to the other without considering the sophistication of the delivery network.

But world dependence on communication brings both benefits and vulnerability. It's no longer a mere inconvenience when service is interrupted, and downtime is not an acceptable option. As might be expected, power disturbances – originating from either the utility provider or a secondary source – are one of the most common causes of downtime. As s consequence, system operators are focusing on increasing the reliability of their power systems as one step toward improving overall broadband system reliability.

Power reliability begins with a broadband power system designed specifically for the application. Power system vendors and customers alike have a commitment to application-specific technology, which must be carried through to component specifications, manufacturing standards, operating efficiencies and maintenance programs. The key issue is designing technology appropriate for the application.

Broadband power requirements are unique, but familiarity with these delivery networks is critical for evaluating proposed broadband powering solutions. One key consideration is the ability of a proposed broadband power system to withstand and function in harsh outdoor environments. These include inner-city, suburban, rural, desert and coastal environments, and they embrace every imaginable temperature, humidity and weather extreme. Other conditions, such as vandalism and natural disasters, further drain the power system's ability to perform without interruption and deliver clean, reliable power to the network.

Although weather-resistant enclosures serve broadband power systems as a first line of defense against environmental extremes, the design of each electronic component in the power system is equally important. Design features – such as functionality over a wide range of operating temperatures, battery pack thermal management and temperature-compensated battery charging – all reflect necessary environmental requirements.

Surge and lightning protection

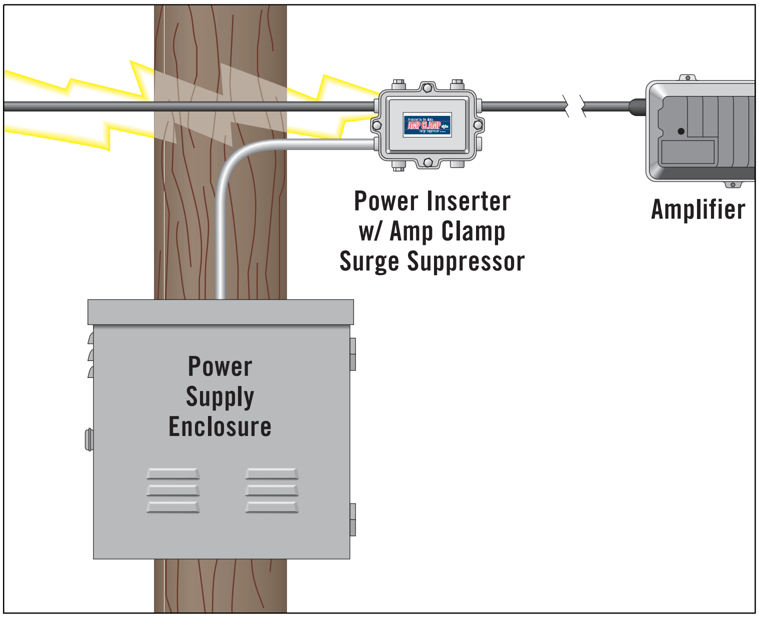
Broadband power systems are located in environments prone to lightning strikes, power utility switching, sheath currents caused by ground faults and other extreme power surges. The power systems must provide input-to-output isolation, thereby protecting electronics from these extreme conditions.

Popular power systems appropriate for broadband applications provide up to 1000-to-1 isolation, effectively preventing surge voltages from damaging line electronics. This isolation ratio means that an incoming 1000V surge from the utility line results in an output voltage surge of only 1V. It also provides the power system's internal logic and monitoring circuitry with the necessary level of protection (see Figure 1 on next page).

Massive surges can affect the system in at least two ways: by traveling downstream through the utility grid and into the system via the input voltage, and by using a reverse upstream path through the coaxial cable connection. As a result, communication power systems must be able to manage surges that simultaneously affect both input and output.

Recognizing the need for such protection, power system vendors have developed outside plant surge suppression products for most broadband applications. These auxiliary protective devices work in conjunction with the inherent protective characteristics of power systems suited for broadband applications.

FIGURE 1: Broadband Power System With Surge Protection



Until the late 1980's, traditional cable television content and its delivery system could easily accommodate the typical 8 to 12 msec. transfer time. But with the emergence of combined voice, video and data services, it became clear that even milliseconds of power interruption could cause a degradation in digital signal quality. The industry quickly developed uninterruptible power supply (UPS) systems capable of meeting the stringent requirements of broadband applications for seamless power transfer to and from system backup batteries. Today, UPS-grade power systems with backup power capabilities are a baseline requirement for broadband networks.

The backup power component of these systems has been greatly improved by incorporating integrated engine generators, dual power grid switching and enhanced thermal battery management.

These improvements boost overall network reliability by providing much longer backup run time during extended utility power outages and by enhancing battery life. However, it is not enough to ensure that output power remains uninterrupted during the transition from the power utility network to the backup batteries.

Analyzing waveforms

The nature of that power and the transition's effect on power characteristics is equally important. Unless the system has been provided with a way of controlling the output waveform, unstable power can introduce frequency transients and other disturbances that can interfere with the signal and the operation of processing equipment.

The output waveform can become distorted whenever utility power is interrupted and the backup inverter takes over. The same thing can happen when the system reverts to utility power. Therefore, power systems, must be able to analyze the utility waveform and confirm that it is stable before switching back to utility power. When this transition takes place, the system must instantly synchronize the power from its inverter with the waveform arriving from the utility network. The higher-quality systems available today accomplish these seamless synchronous transfers without compromising efficiency or battery life.

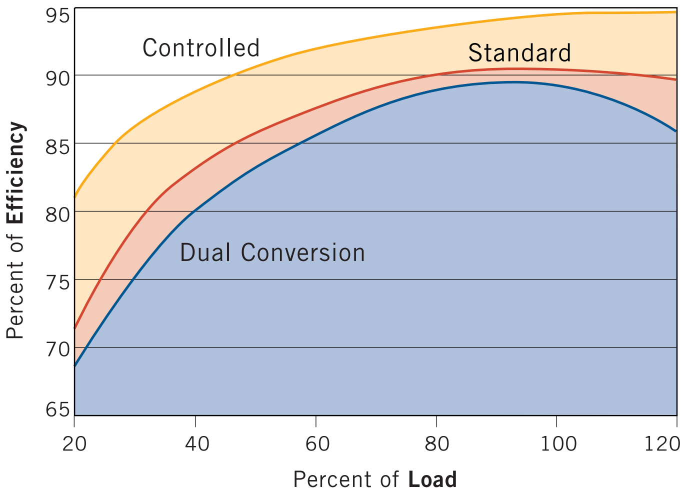
Steep growth in the number of telecom users and the added sophistication of the networks used to deliver the services have caused a dramatic increase in power demand. Because power requirements and their associated costs are climbing, system designers now carefully scrutinize the power efficiency of each system component.

This is especially true of larger systems in which efficiency losses can be high. According to conservative estimates, a mere 5% increase in the operating efficiency of a broadband power supply multiplied over 200 network power supplies can produce average annual power savings of $50,000. Considering that many networks require far more than 200 power supplies, their operating efficiency is clearly an important criteria in power supply selection.

While power supply operating efficiency has become a familiar topic, the issue goes much deeper than just a single efficiency rating. Broadband power loads are not constant, especially with hybrid fiber/coax systems. Telephony and other related communication services, for example, can double the amount of required power during peak load demand periods. Because it is unusual for a power supply to operate consistently at 100% load, it is important to evaluate efficiency in partial, full and even overload operating conditions.

Three types of technologies are commonly used for power systems: standard ferroresonant-based transformer technology, dual conversion technology and newer-generation controlled transformer technology.

FIGURE 2: Power System Operating Efficiency



The standard ferroresonant-based transformer technology is more efficient in all modes than typical dual conversion technology (Figure 2). Dual conversion technology is less efficient because it must convert the incoming AC to DC, which it then converts back to alternating current for output to the load.

However, the operating efficiency of controlled transformer technology is better than either of these. Not only are the efficiency ratings of the other technologies lower at partial loads, but they also decline rapidly at loads higher than 100%. Conversely, power systems employing newer technology either increase or uphold their efficiency at higher loads and maintain excellent operating efficiency over the entire load range.

Other considerations

Two other considerations for broadband networks are input power factor, and input and demand management.

As power demands increase and deregulation causes power utilities to become more competitive, more service providers will be billed based on power factor, which is an input power usage efficiency ratio with values typically ranging from 0.5 to 1, with 1 being the ideal power factor.

For many involved in the design of traditional broadband networks, input power factor and its effect on demand charge has not been a significant issue. However, this situation may soon change.

Newer-generation broadband power systems provide an average input power factor of 0.98, very close to the ideal. As alternative technologies are introduced, they must meet the efficiency benchmarks already set by industry-leading products.

Another concern is that, unless appropriate provisions are included in the design of a broadband power system, wide variations in utility input voltages and high levels of load variation can play havoc with the reliability of a broadband system.

An input voltage window wide enough to accommodate a broad voltage range must be an integral part of broadband power system design. A wide input voltage window translates directly into extended life for the power system and its batteries, especially in areas experiencing frequent reduced voltage brownout conditions. Systems with an input voltage window that is too narrow will switch to battery backup more frequently and thereby shorten the life of the batteries and power system.
Additionally, the broadband power system design should enable it to perform effectively at up to 150% of normal load during short periods of peak demand.

Broadband power systems featuring robust design and technologies capable of delivering efficient, reliable performance are available today. As other technologies emerge, they must match or exceed the reliability and performance of today's systems.

More than ever before, reliability must be the watchword for broadband networks and their respective power systems.