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Protecting ADSL Deployment for EMS Applications at Power Utilities

BACKGROUND

ADSL (Asymmetric Digital Subscriber Line) or “high-speed Internet access” has transformed the way people use the Internet today. With ADSL, the user can access the Internet at up to twenty times faster (64Kbps to 2Mbps) than a standard dialup connection, and because it does not take-over the phone line, the user can still talk on the phone at the same time. In addition, there are no associated dial-up charges or a need for a second line, and the user benefits from having an 'always on' connection to the Internet.

At the power utilities’ end, ADSL service provides data access from a central site to individual substations and even between the individual substations. Once you have ADSL service, many improvements are possible for high value functions at the substations. These include:

- Instant access to key information regarding relay trips and operator-initiated switching access
- Remote control of circuit breakers
- Remote access to all substations from various communications network access locations
- Access to metering data every ten seconds
- Real-time display of substation bus voltages, feeder loads, and power exchanges
- Availability of all live and archived data on corporate intranet
- Improved customer service procedures

With ADSL becoming a key part in improved substation Energy Management Systems (EMS) functions, reliability of the service is crucial. However, many of the ADSL circuits deployed today are located in areas that expose them to extraneous energy sources. These energy sources can cause equipment damage and downtime, and in a worst-case scenario, injury or even fatality to personnel working on the circuit wiring or equipment when the event occurs.

CHALLENGE

- Provide safe reliable communications for monitoring power system controls and insuring revenue streams
- Provide reliable communications to high voltage facilities
- Provide safe and reliable communications to any site where Ground Potential Rise (GPR) can be an issue
- Secure the existing services while economically providing for future communication needs with minimal change to current methodologies or functions

GPR is defined in I.E.E.E. Standard 487 as “the product of a ground electrode impedance, referenced to remote earth, and the current that flows through that electrode impedance.”

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A GPR event can be caused by a power system fault or by a lightning strike. The energy from a lightning strike, while dissipating into the earth, causes a GPR just as if it were a power system fault. Therefore, any site containing a tower is subject to GPR energy.

Standard protection methods of shunting technology do not work on circuits that are subjected to GPR. This is because with a GPR potential the ground is the source of the energy, rather than a location designed to drain momentary bursts of energy. Standard drainage equipment would directly connect the electrical potential of the GPR onto the circuit. In effect, the energy would flow from the ground onto the circuit. This energy at the very least causes damage to equipment with the possibility of a fatality or injury being the foremost issue of concern.

SOLUTION

Protection on these circuits should have isolation equipment deployed rather than standard drainage protection equipment. The isolation process allows the electrical potential of the site to change as the GPR occurs from the event. At the same time the rest of the circuits on the Central Office (CO) side of the isolation equipment remain at the stable CO potential. Therefore the differing potentials across the isolation equipment are not seen by the total circuit, thereby providing safe reliable communication.

The Teleline equipment is designed to provide isolation to wireline services at a site subject to GPR. The isolation methodology is in concert with I.E.E.E. Standard 487. The Teleline product line can provide economic isolation to a variety of circuit types by deploying differing circuit cards and mounting methods.

This deployment will provide a minimum of an I.E.E.E. Service Performance Objective (SPO) Class ‘B’ circuit. With additional equipment a Class ‘A’ SPO can be established on some circuit types. The following SPO Classifications are extracted from I.E.E.E. Standard 487:

A) Class ‘A’: Non-interruptible service performance (should function before, during, and after the power fault condition)

B) Class ‘B’: Self-restoring interruptible service performance (should function before and after the power fault condition)

Circuit Description: ADSL Two-wire Circuit

This detailed application note applies to an ADSL circuit. It is comprised of two individual transport circuits on a single cable pair. The first circuit is a standard Plain Old Telephone Service (POTS) circuit that is utilizing the physical cable pair. The second circuit is a Digital Subscriber Line (DSL) high frequency circuit that is ‘riding’ on the copper pair “above” the working (Voice) frequency of the POTS circuit. In this way two individual circuits are supplied over one cable pair.

The first circuit is a normal Dial Tone based circuit that is usually attached to a telephone or a simple dial-up modem. The circuit is powered from the CO by 48 - 52 VDC at 23 - 60 mA

(nominal) current applied in a loop mode. In many instances this energy is used to power the circuit instrument (telephone). The working (voice) frequency range of this circuit is between 300 Hz and 3200 Hz.

The second or 'riding' circuit is a DSL Two-wire circuit. This circuit type equates to a first generation Two-wire DSL. To the telephone company, this circuit is a more economical way to provide very high-speed data to a customer than an engineered and regenerated standard Four-wire T1. A standard T1 requires regenerators every 6,000 feet of cable length and usually requires a single gauge of wire for a cable pair from one end to the other. A DSL will derive a standard T1 circuit (1.544 MB/Sec) at the output of the Network Interface Unit (NIU) utilizing the existing mixed gauge cable pairs that are in place. Depending upon the physical cable makeup and/or the length of the circuit, the DSL may be provided on a Two-wire or a Four-wire cable pair configuration. In the case of the ADSL circuit type it is provided on a single cable pair (Two-wire) configuration. The span power will be loop in function and consists of the same working energy of the POTS portion of the circuit since it is riding on top of the basic POTS circuit. The manufacturer of the ADSL equipment should provide circuit design requirements. It is important to note that any additional equipment inserted into the circuit may shorten the actual transmission distance of the ADSL portion of the circuit. In addition an ADSL has a shorter transmit distance than a conventional Two-wire HDSL.

Positron manufactures a plug-in circuit card that provides isolation protection for this combined circuit type. Positron's circuit card supports both modulation schemes used in ADSL; the Discreet Multi-tone (DMT) and Carrierless AM/PM (CAP). Because of the DC voltage on the cable pair, a POTS circuit cannot be configured for the more critical Class 'A' type of circuit. The usual additional equipment required for a Class 'A' utilizes full period drainage on the circuit that cannot be done with the required DC power on the circuit. For the same reason the DSL portion of the total ADSL circuit cannot be configured for a Class 'A' circuit. It can be configured only for a Class 'B'.

Wireline Isolation Equipment Required:

A 751321B Plug-in circuit card in a multiple slot shelf can be utilized to isolate the total ADSL circuit from GPR events.

The 751321B ADSL Plug-in circuit card can be deployed in the 751101, 751109, 751112, or 751127 shelf models. The early version 7501-08 shelf can not utilize the full potential of this card (only the POTS portion of the card) as there is no cable connection for the secondary portion of the card.

See ***Figure 1*** for a graphical representation of the ADSL circuit in use.

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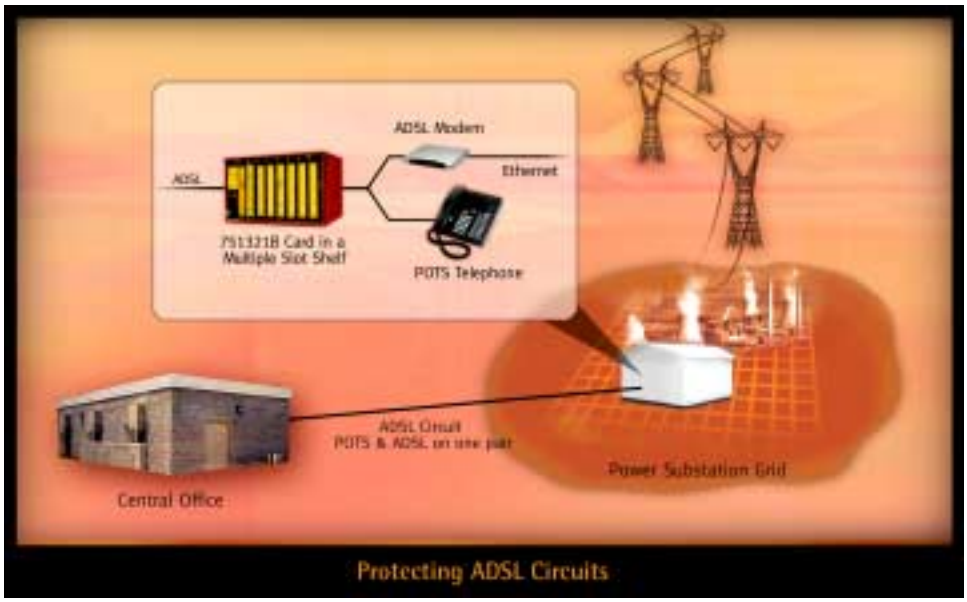

Figure 1
This Figure shows a typical ADSL circuit utilizing the 751321B ADSL card to provide a POTS circuit and a DSL circuit at the same time using only one economical isolation card.

Circuit Card Features:
The 751321B Plug-in circuit card serves two circuit types over the same cable pair. This card requires specific wiring for the input or feeding circuit. It must be wired to the secondary pair of the shelf slot to support both the POTS and ADSL portions of the circuit. The POTS portion of the circuit will be delivered on the primary pair for the shelf slot while the DSL will be delivered on the secondary pair for the shelf slot. Therefore, the splitting function is imbedded in the card. Specific wiring instructions for the various functions and options on the card are provided with the operating manual.

Circuit Current:
The local power to the shelf is used to power the POTS portion of the circuit. The DSL NIU will have to be powered locally.

BENEFITS

Protecting circuits with isolation equipment versus standard drainage protection has numerous benefits. First, there is less downtime (if any) in the circuits, thereby not affecting revenues. In addition, maintenance dollars are saved since less equipment is damaged by GPR events.

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Another benefit of using isolation protection is the fact that you are building extremely reliable and affordable communication circuits with growth potential built into the protection scheme. The circuits will work to a Class 'B' SPO. Some can be equipped to function to a Class 'A' SPO when the required additional equipment is installed at critical circuit points on the cable route.

And most important, by deploying isolation protection, the risk of personnel injury through exposure to GPR-caused potentials on communication circuits and equipment is reduced.