RLH Industries, Inc.

Multiprotocol Label Switching Application Information

High Voltage Isolation for the MPLS Network

RLH Industries, Inc.
www.fiberopticlink.com

MD-047 2017A-0510

MPLS

Multiprotocol Label Switching (MPLS) is used in high performance business networks as the desired method for managing the exchange of data. MPLS networks are highly scalable, and can be implemented by telecom providers to make the exchange of data communications easy and efficient. It enables them to build next-generation (NGN) networks that deliver a wide variety of advanced and cost effective services over a single infrastructure.

Power utilities are implementing MPLS on their networks to gain the improvements in speed, capacity, and infrastructure efficiencies demanded by current and future Smart Grid initiatives. Service providers are using the speed and capacity provided by MPLS to provide dynamic, transparent Virtual Private Networks. This flexibility enables power utilities to incorporate substations, data centers and other facilities into their corporate network while avoiding link failures, congestion and bottlenecks.

HVP considerations

Power substations have to deal with the additional challenge of implementing MPLS networks within a high voltage environment. GPR (ground potential rise) occurs during fault conditions within the high voltage corridor (generation facilities, substations, and transmission towers). These events can have a serious impact on network infrastructure. Modems, routers, switches and cabling will be damaged due to high voltage events causing service outages along with the potential for serious injury to personnel working on the equipment.

The fiber optic solution

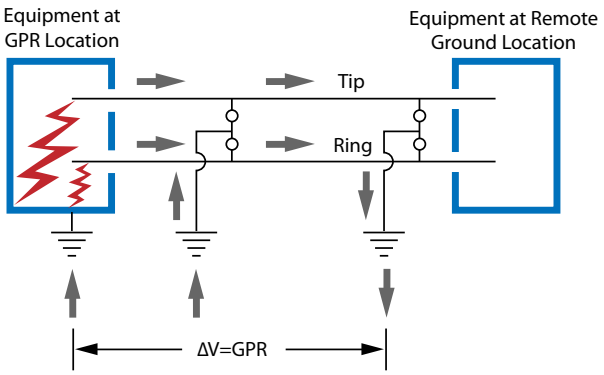
The objective of HVI (high voltage isolation) is to ensure the safety of personnel, protect communication facilities and equipment, and maintain reliable service. Simply put, this is done by keeping station ground referenced MPLS network wiring separated from the earth referenced wiring. The RLH fiber optic solution, where the two high voltage potentials are separated by all-dielectric fiber optic cable, where the two potentials are separated by greater distances than the four inches provided by a copper based system, is the best solution from both an installation and a maintenance perspective.

RLH Industries has been providing HVP fiber optic communication solutions for over 24 years, with isolation products engineered to protect critical circuits in power substations, power generation sites, manufacturing, mining, critical cellular sites, public safety and municipal communications, military communications and wind farms.

Isolation methodology

The block diagram below depicts a communication network without isolation protection. When a high voltage event occurs, the potential difference between the ground planes connected with a conductor such as with a wireline telecom circuit will produce a ground fault current.

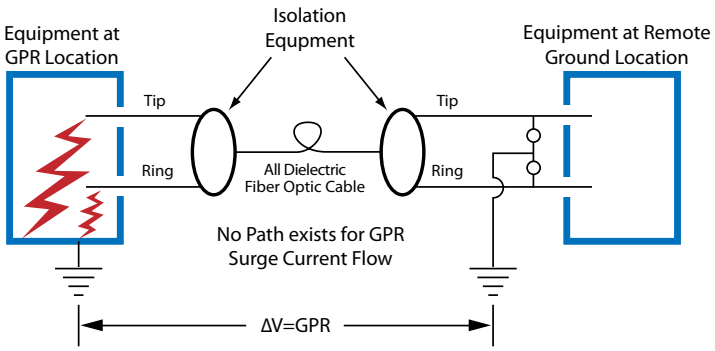
Communications without isolation protection



Ground potential faults in the thousands of volts at power substations or even tens of thousands of volts on high voltage power lines and towers are realistic in worst case scenarios. It is for the worst case scenario that we have to design the HVP system for.

Breaking the metallic continuity with an isolation system using all dielectric fiber cable will stop high voltages from flowing in the telephone cable between two ground planes of different potential (Substation Ground Potential and Remote Ground Potential). Therefore the same GPR will not cause any damage, since the two ground planes are completely isolated from each other.

Communications with isolation protection



IEEE 487 and 1590

Provisioning HVI equipment utilizing copper facilities entering the ZOI has been long accepted within the industry. Inherent to this application is the necessity to isolate the remote earth referenced ground of the dedicated cable, both the metallic shield and the pairs, from station ground referenced plant.

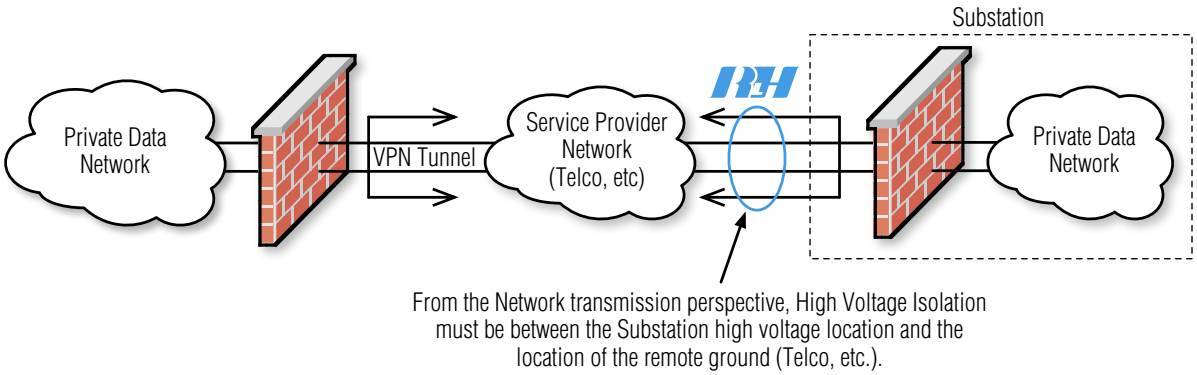
When it is not practical to bring the dielectric fiber cable from the subscriber all the way to a point outside of the zone of influence (ZOI), the placement of the CO end of the fiber within the ZOI is a viable alternative and satisfies both the IEEE 487 and the IEEE 1590 requirements.

For additional information, please refer to the white paper titled “RLH applications within the ZOI”, available for download from www.fiberopticlink.com.

MPLS and HVP

VPN technology has replaced the need to requisition and maintain expensive dedicated leased-line telecommunication circuits once typical in wide-area network installations. Integration of MPLS application components, including Layer 3 VPNs, Layer 2 VPNs, Traffic Engineering, QoS, GMPLS, and IPV6 enable the development of highly efficient, scalable, and secure networks.

Private data is transmitted over the Public Switched Telephone Network (PSTN) over an MPLS data network. It has the advantage of extending a company’s private data network beyond its traditional firewall.



MPLS supports a range of access technologies, including T1/E1, ATM, Frame Relay, and DSL that can be delivered over a private or public data network or a combination of both.

Considerations

The telecom provider will provision the service delivery to carry the data and establish the conditions to support the VPN connection. Considerations may Include:

- Length of the loop
- Number of pairs available
- Proximity of the Central Office (CO)

The distance from the CO to the service location is important, and determines the service delivery and performance. The CO service demarcation point may be inside or outside the 300V point or the ZOI (zone of influence) of the high voltage facility.

For additional information on determining GPR and ZOI, please refer to the white paper titled "Recommended Practice for Establishing Ground Potential Rise (GPR) and Zone of Influence (ZOI)", available for download from www.fiberopticlink.com.

The provided service at the telco demarcation point may be:

- 2 Wire ISDN
- 2 Wire DSL/ADSL
- 2 pairs for a 4-wire 56 Kb/s or 64 Kb/s circuit
- 4 Wire T1 service
- 2 or 4 Wire HDSL service
- 2 Wire HDSL ADTRAN® (Provides 4 Wire HDSL1)
- 2 Wire ADTRAN Total Reach® or Westell® 64k DDS (Provides 4 Wire Frame Relay 64k)

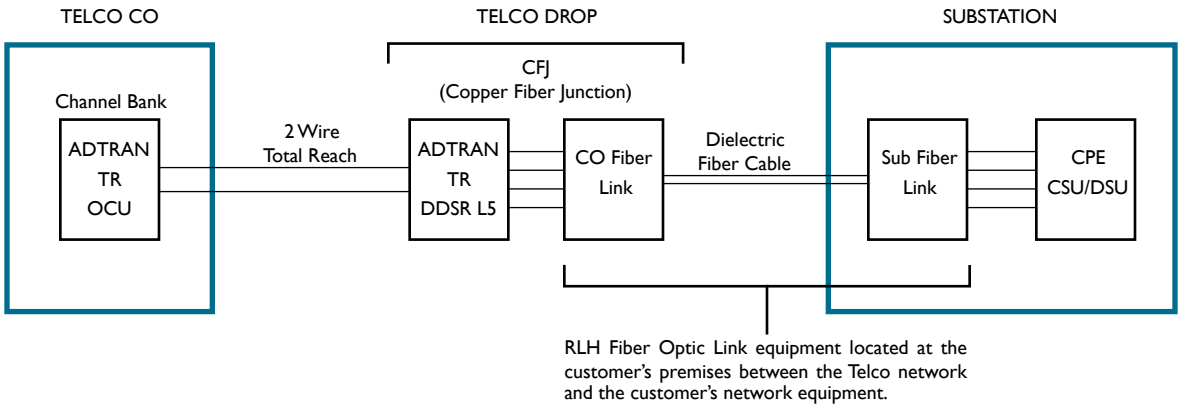
The ADTRAN and Westell® systems allow 2 Wire service from the CO/OCU to provide 4 Wire service at the drop side of the ADTRAN® or Westell® equipment on the customer premisis.

Common network topologies

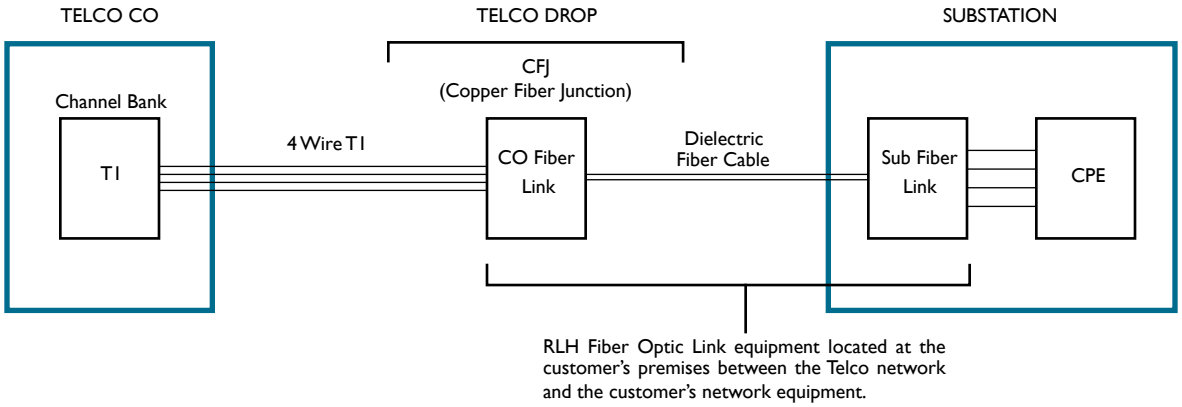
Depending on the type of MPLS connection, a suitable 2 or 4 wire HVP solution is required to match the type of service provided. Most RLH fiber optic isolation systems are line powered directly by the CO Telco copper service, requiring no local power on the CO side. This has the advantage of greatly simplifying installation of an effective HVP system. Please check the RLH product information for additional information.

Given that the served sites are situated within high voltage areas, the network terminating equipment is located on the protected side of the network. Therefore, the protection equipment must be selected to be suitable with the method of transport chosen by the Telco.

Block diagram of ADTRAN® NIU before FIber Link



Block diagram of typical T1 service installation



As shown in the diagrams above, the protection equipment is placed at the substation side before the network terminating equipment. The use of all dielectric fiber cable ensures complete high voltage isolation, and achieves the objective of keeping station ground referenced MPLS network wiring separated from the earth referenced wiring.

High Voltage Protection

IEEE 487 is the recommended practice for the protection of wireline facilities at electric supply locations. It states that High Voltage Protection (HVP) is required at sites with a peak GPR greater than 1,000 volts. For sites with a GPR of 1,000 volts peak or less, gas tubes or other shunting devices are suitable.

However, a gas-tube operation will cut power for the span and the digital signal. During this period, the network would be unavailable, which could have serious consequences for an interconnected Smart Grid. After the gas-tube operation, there will be a period of down time while the digital services reinitialize. To achieve a robust protection scheme for digital services entering electrical supply locations, isolation techniques will enable the circuit to continue operating during a high voltage event.

HDSL Service information

Characteristics		HDSL	HDSL2	HDSL4
Standard		TR-28	T1.417	T1.417 Issue, 2
Number of Pairs		2 pairs	1 pair	2 pairs
Line Rate		784 Kbps x 2 pair	1.544 Mbps	784 Kbps x 2 pair
Line Code		2B1Q	16-TCPAM	+14.1 dBm
Transmit Power		+13.5 dBm	+16.8 dBm Downstream +16.5 dBm Upstream	+14.1 dBm
Spectrum Mask		Symmetric	Asymmetric	Asymmetric on 1st span Symmetric on 2nd/3rd span
Power Back-Off		None	Yes	Yes
Maximum Reach	without Repeaters	12 Kft	12 Kft	16 Kft
	with Repeaters	60b Kft with 4 repeaters	N/A	46 Kft with 2 repeaters
Spectral Compatibility	without Repeaters	Yes	Yes	Yes
	with Repeaters	No	No	Yes
Support Interoperability		No	Yes	Yes
Span Powering Voltage		Across Loop 1 and 2	Across Tip and Ring (Loop 1)	Across Loop 1 and 2

RLH Fiber Link HVP Products

Service	
2W Analog Phone	RS-232
2 Channel Analog Phone Mux	RS-422/485
2 Wire DID	10/100 Ethernet
2 Wire ISDN/BRI	10/100/1000 Ethernet
2/4W Analog Data/Audio/SCADA	HDSL1 Adtran®
2/4W Data E&M (Contact Closure)	DS3/T3
4W 9.6k DDS	DSL/ADSL
56k/64k Frame Relay DDS (Total Reach® Compatible)	4 Ch. Contact Closure
4 Wire T1/E1	8 Ch. Contact Closure
T1 4x1 Mux	4 Ch. 4-20mA/0-10VDC System
Universal 2 or 4 Wire HDSL	AC/DC Fiber Optic Alarm System
2 Wire Data (SCADA)	2W Digital Phone

Technical Support

Normal technical support: (Mon - Fri 6am - 6pm PST)	(714) 532-1672 Toll Free 1-800-877-1672 Toll Free 1-866-DO-FIBER
Email:	support@fiberopticlink.com
24/7 technical support: (Outside normal business hours)	Toll Free 1-855-RLH-24X7 Toll Free 1-855-754-2497

Contact Information

Corporate Headquarters:	RLH Industries, Inc. 936 N. Main Street Orange, CA 92867 USA
Phone:	(714) 532-1672 Toll Free 1-800-877-1672 Toll Free 1-866-DO-FIBER
Fax:	(714) 532-1885
Email:	info@fiberopticlink.com
Web site:	www.fiberopticlink.com

RLH Industries, Inc.
936 N. Main Street, Orange, CA 92867 USA
T: (714) 532-1672
F: (714) 532-1885

Please contact your RLH sales representative for pricing and delivery information.