High Voltage Interface

TELUSS Mobility – Lakeland Cell Site

IMPORTANT: Please read this document fully, especially the Safety Procedures, before performing work on this equipment.

Prepared by:
Kevin Jacobson, P.Eng.
Jacobson Engineering Services
780-983-1855
www.jacobsonengineering.ca
High Voltage Interface

TELUS Mobility – Lakeland Cell Site

1 Introduction

The purpose of the high voltage interface on communications facilities is to isolate metallic cable from ground potential rise (GPR). At certain power system sites, such as substations, generating stations, high voltage towers, etc., the site ground grid will rise to a very high voltage during power system faults and lightning strikes. The value of this GPR varies greatly between sites, but generally is in the thousands of volts.

As long as correct grounding is done within the site, all parts of the communication system within the site rise to the same voltage. This poses no problem for equipment or personnel within the site. However, the metallic cable entering the site is grounded at a distance away from the site, and therefore will remain at zero volts. This difference in voltage can cause communications outages, or even worse, safety risk to personnel and severe damage to equipment.

This problem is easily remedied by installing a high voltage interface (HVI) which electrically isolates the metallic components in the GPR zone from metallic components outside the GPR zone.

Not only is a HVI a good idea, it is required by law where deemed necessary. The installation of a HVI interface is required by Alberta’s Electrical and Communication and Utility Code (ECUC) and the Canadian Electrical Code (CEC), and recommended by the IEEE’s Std 487-2000 Recommended Practice for the Protection of Wireline Communication Facilities Serving Electric Supply Locations. Both the CEC and IEEE documents are enforced by provincial and municipal laws/codes.

Although a HVI is usually installed to protect against GPR due power line faults, it also provides protection against lightning induced damage.

2 Lakeland Cell Site Specifics

This cell site is located about 10 metres west of Altalink’s Sherwood Park substation. Bell Mobility has communications facilities into the site which are isolated by RLH Industries’ fibre optic link equipment.

AltaLink provided the following numbers for the substation:
Based on this information, the data in Table 2 was obtained according to IEEE Std 367 and IEEE Std 487 using a program written by Applied Professional Training (see Appendix A for the calculations).

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum fault current</td>
<td>10000</td>
<td>amperes rms</td>
</tr>
<tr>
<td>Ground grid resistance (GGR)</td>
<td>0.13</td>
<td>ohms</td>
</tr>
<tr>
<td>Ground grid area (GGA)</td>
<td>2336</td>
<td>m²</td>
</tr>
<tr>
<td>Ground potential rise (GPR)</td>
<td>1300</td>
<td>volts rms</td>
</tr>
</tbody>
</table>

Table 1.

The cell site is located within the 300 V (peak asymmetric) zone of influence of the substation, and therefore would be at risk during power line faults. High voltage isolation equipment is therefore required at this site according to IEEE Std 487.

Positron’s Teleline isolation equipment has a breakdown rating of 70 kV (peak), and thus will provide adequate protection for this installation. This was agreed to by TELUS’ standards engineer.

3 Equipment Description

A high voltage interface (HVI) electrically isolates the customer side equipment (station side) from the central office side copper entrance cable. This prevents voltage surges from passing across the interface (in either direction). The HVI installed at the Lakeland cell site is a red shelf that contains cards suitable for the type of communication circuits required. In this installation, Positron’s Teleline Isolator was used. Drawings TM-LL-0, -1 and -2 (Appendix C) show the details of the installation. See Positron’s documentation (Appendix C) for a complete description of the shelf and HDSL cards.

It is important to think of the HVI as having a **high voltage side** (GPR zone, station side or customer side) and a **low voltage side** (central office side or remote ground). The **high voltage side** may experience high GPR while the **low voltage side** remains at remote ground potential (zero volts). Equipment or personnel bridging across these two sides are at risk. The high voltage side includes all equipment within the site: grounding conductors, coax, cable trays, equipment bays, AC wiring, HDSL terminal, BICS blocks, etc. The low voltage side includes the copper entrance cable and terminations on the CO side of the HVI shelf. All metallic components on the low voltage side are contained within non-metallic enclosures so that they cannot be accidentally contacted. For clarity, this area is marked off with red tape and a Caution sign (see drawing TM-LL-1).

**IMPORTANT:** Never install any station or customer side wiring or components within the marked-off low voltage zone. This will defeat the purpose of the HVI and create a potential hazard!
For the Lakeland cell site, a five-card shelf was installed equipped with three universal HDSL cards: Positron Teleline 751339-R2. Universal HDSL cards can handle HDSL1, HDSL2, or HDSL4, but were optioned for HDSL2 in this installation. Each card is configured to handle two 2-wire HDSL2 circuits. Up to six HDSL2 circuits can be installed without any changes to the current installation. Two empty slots allow further expansion if necessary. The HDSL cards are passive, containing only isolation transformers, so no shelf powering is required. Certain other types of circuits (regular telephone line for example) may require shelf powering. This installation was not designed for powered HVI cards, but can be redesigned easily if the need arises.

The entrance cable enters the building through PVC conduit, passing directly into an enclosed termination box. This box contains a termination strip to connect the entrance cable to the HVI shelf stub cable. The entrance cable sheath is not grounded within the cell site. All metallic components on this low voltage side are contained within non-metallic enclosures so there is no safety risk to personnel as long as the enclosures remain closed. All shelf positions are prewired for ten 2-wire circuits according to the pair assignments shown in Appendix B, so no additional wiring needs to be done on the low voltage side to add three more 2-wire circuits.

**IMPORTANT:** If there is a need to rewire within the low voltage zone, follow the safety recommendations outlined in Section 5.

Other miscellaneous notes:

1. With a HVI installed, the building entrance terminal (BET) is not necessary for providing protection – the HVI shelf is a replacement. However, the BET is a convenient termination point. Since the five-card HVI shelf accommodates up to ten pairs, only ten pairs were terminated in the 25 pair BET.

2. The ten pairs were terminated in sequential order in the enclosure. However, the wiring into the Positron shelf does not follow the usual colour code (white/blue, white/orange, etc.). Refer to their documentation and the table in Appendix B of this document.

3. The HVI cards do not pass DC, so the HDSL SIJ cards (HighGain H2TUR402 list 7H cards are required for local power – list 7G cards are for line power only) were optioned for local power from the fuse panel. The HDSL cards in the HVI were configured to loop back simplex power from the CO.

4 **Maintenance and Testing**

The HVI is fairly straightforward, so troubleshooting is not complicated. Since the 751339-R2 HDSL interface cards are passive, there are no indicator lights or testing routines. Fortunately, because there are very few parts, failure is very rare. See drawing TM-LL-0 for a block diagram of the signal flow.

**Note:** The HVI shelf is wired on the CO side of the SIJs. So when performing a loopback test from the CO to the SIJ, this will test through the HVI equipment.

If it is suspected that a 751339-R2 HDSL card has failed, then the easiest method to prove it is to swap a known good card into the suspect shelf position. Check the card visually for physical damage. Another method is to disconnect the HVI circuit from the path and test...
through the shelf with an HDSL test unit to make sure the signal is getting through unimpaired. Connect at the termination strip in the enclosure and at the BET. Visually check wiring and terminations for faulty connections.

**IMPORTANT:** Never leave the HVI bypassed. This creates a hazardous condition.

5 Safety Procedures

Safety procedures must be followed when any work is being done inside the low voltage zone, i.e. CO entrance cable, within the termination enclosure, or within the HVI shelf.

**Recommended procedures when working within the marked-off low voltage zone:**

1. Do not perform the work during lightning storms, high winds, or other severe weather.

2. Wear certified high voltage rubber gloves whenever possible.

3. Wear clean certified safety boots with a high dielectric rating (indicated by the appropriate CSA designation).

4. Avoid contact with equipment outside of the marked-off low voltage zone.

6 Contact Information

For further information on high voltage interfaces or for redesign of the HVI please contact:

Jacobson Engineering Services,  
Edmonton, Alberta,  
780-983-1855  
[http://www.jacobsonengineering.ca/](http://www.jacobsonengineering.ca/)

For equipment warrantees, or further information on Positron products, contact:

Positron Industries Inc.  
Montreal, Quebec  
1-888-577-5254  
[www.positronpower.com](http://www.positronpower.com)
Appendix A - Ground Potential Rise Calculations

GPR Calculator*

Brought to you by:
Applied Professional Training, Inc.

Phone: (800) 431-8488    Website: www.aptc.com    Email: aptc@aptc.com

GPR Calculator can be used to determine quantities related to a power station GPR.
The program can:
1. compute the distance from the edge of a station ground grid to a given potential.
2. compute an earth surface potential at a given distance from a station ground grid.

User data should be entered in yellow cells only.
GPR Calculator stores computed data in purple cells.

Notes:
GPR Graph is updated with changes to entries in the Data Table.
Soils types 1, 2, and 3 are 100/20, 100, and 100/100 ohm-meters, respectively.
Valid grid sizes are from 1,600 ft² to 935,000 ft².
Valid distances from the edge of a station ground grid to a given point are from 0 ft to 10,000 ft.

Data Table

<table>
<thead>
<tr>
<th>User Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter Fault Current</td>
<td>10,000.0</td>
</tr>
<tr>
<td>Enter Earth Return Fault Current (%)</td>
<td>100.0%</td>
</tr>
<tr>
<td>Computed Current</td>
<td>10,000.0</td>
</tr>
<tr>
<td>Enter Grid Impedance</td>
<td>0.13 ohms</td>
</tr>
<tr>
<td>Enter X/R Ratio</td>
<td>6.0</td>
</tr>
<tr>
<td>Enter Soil Type (1, 2, or 3)</td>
<td>1</td>
</tr>
<tr>
<td>Enter Ground Grid Size</td>
<td>25,000.0</td>
</tr>
<tr>
<td>Computed GPR</td>
<td>1,300.0</td>
</tr>
<tr>
<td>Computed GPR (volts-rms-asymmetrical)</td>
<td>2,070.1</td>
</tr>
<tr>
<td>Computed GPR (volts-peak-asymmetrical)</td>
<td>2,927.6</td>
</tr>
</tbody>
</table>

GPR Distance Calculator

Enter a potential: 300.0 volts-peak-asymmetrical

GPR Calculator computes the distance (in feet) from the edge of the ground grid to that potential.

** Minimum acceptable input potential: 9.1 feet

221.2 feet

GPR Potential Calculator

Enter a distance: 30.0 feet

GPR Calculator computes the potential (in volts) at that distance from the edge of the ground grid.

1,015.1 volts-peak-asymmetrical

* Based on IEEE Std 367-1996.

DISCLAIMER

Applied Professional Training, Inc. (APT) disclaims all responsibilities for the use and results of this software program.
The purpose of this program is to assist in the determination of the technical requirements surrounding the proper use of high voltage isolation equipment.
Each application of this program may require additional professional investigations, research, safeguards, etc. to adequately meet site, equipment and safety concerns.
This program is not intended to replace federal, state, local, or other applicable codes, laws and regulations including the National Electric Code, the National Electrical Safety Code, IEEE standards, etc.
APT expressly advises each user of this program that use of or reliance upon the information resulting from this program is at the risk of the user and that APT shall not be liable for any damage or injury incurred by any person or company using this program.
Positron Teeline 751339R2
Universal HDSL card

Termination strip

Tx/Rx – HDSL Signals

HighGain
Service Interface
Jack (SIJ)

Local -48 DC power
from fuse panel

DC Simplex power
looped back on CO side
of HVI card

Tx/Rx –
DS1 Signals
Note: For clarity, not all existing details are shown in this drawing.

- **Terminal strip or building entrance terminal**
- **Plywood backboard**
- **Ground bar**
- **#12AWG ground wire**
- **High Voltage Interface equipment - five card Positron shelf**
  13.5”H x 21.5”W x 9.71”D
  See details in drawing TM-LL-2
- **SIJ housing(s)**
- **Local power**
- **Caution sign 5” x 7”**
- **Enclosed termination box**
  14”H x 12”W x 8”D
- **PVC conduit containing entrance cable**
- **Red tape demarcating remote ground exposure zone – LOW VOLTAGE SIDE.**
  See documentation for more information
- **Approx. 30”**
- **Approx. 40”**

---

**Drawing Title:** High Voltage Interface

**Detail:** - wall layout

---

**Client:**
TELU Mobility

**Project:**
Cell Site - Lakeland

**Drawing Title:** High Voltage Interface

**Detail:** - wall layout

---

**Scale:**
N.T.S.

**Drawing #:**
TM-LL-1

**Date:**
2004.11.08

**Drawn By:**
K. Jacobson

**Project #:**
TM-LL-1

---

**Jacobson Engineering Services**
Edmonton, Alberta, 780-983-1855
www.jacobsonengineering.ca
Notes:
1. When working on cabling, follow safety recommendations outlined in documentation.
2. HDSL cards are passive so no power is needed for the shelf. powering may be needed if other services are added.
3. Each 751339-R2 Universal HDSL card will handle two HDSL2 circuits or one HDSL1 circuit.
4. The first 10 pairs are terminated, the remaining are capped off for safety.
CAUTION

This site may experience high ground potential rise (GPR). This marked off area encloses items at remote ground potential.

SAFETY MEASURES MUST BE FOLLOWED WHEN WORKING ON WIRING WITHIN THIS AREA

DO NOT INSTALL ANY INTERIOR WIRING WITHIN THIS AREA

For more information, see documentation supplied with High Voltage Interface shelf.
<table>
<thead>
<tr>
<th>PAIR</th>
<th>COLOUR</th>
<th>DESIGNATION</th>
<th>STRIP</th>
<th>TERMINAL</th>
<th>POSITRON SHELF</th>
<th>CARD INSTALLED</th>
<th>POSITRON CABLE COLOUR</th>
<th>CIRCUIT DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White</td>
<td></td>
<td>1</td>
<td>SLOT 1</td>
<td>4W TX</td>
<td>HDSL</td>
<td>White</td>
<td>T1 - HDSL2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Blue</td>
<td></td>
<td>2</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>White</td>
<td></td>
<td>3</td>
<td>4W RX</td>
<td></td>
<td>HDSL</td>
<td>Red</td>
<td>T1 - HDSL2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Orange</td>
<td></td>
<td>4</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>White</td>
<td></td>
<td>5</td>
<td>SLOT 2</td>
<td>4W TX</td>
<td>HDSL</td>
<td>White</td>
<td>T1 - HDSL2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td></td>
<td>6</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>White</td>
<td></td>
<td>7</td>
<td>4W RX</td>
<td></td>
<td>HDSL</td>
<td>Red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Brown</td>
<td></td>
<td>8</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Slate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>White</td>
<td></td>
<td>9</td>
<td>SLOT 3</td>
<td>4W TX</td>
<td>HDSL</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Slate</td>
<td></td>
<td>10</td>
<td>(2W)</td>
<td></td>
<td>HDSL</td>
<td>Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Red</td>
<td></td>
<td>11</td>
<td>4W RX</td>
<td></td>
<td>HDSL</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Blue</td>
<td></td>
<td>12</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Blue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Red</td>
<td></td>
<td>13</td>
<td>SLOT 4</td>
<td>4W TX</td>
<td>SPARE</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Orange</td>
<td></td>
<td>14</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Red</td>
<td></td>
<td>15</td>
<td>4W RX</td>
<td></td>
<td>SPARE</td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Green</td>
<td></td>
<td>16</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Red</td>
<td></td>
<td>17</td>
<td>SLOT 5</td>
<td>4W TX</td>
<td>SPARE</td>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Brown</td>
<td></td>
<td>18</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Slate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Red</td>
<td></td>
<td>19</td>
<td>4W RX</td>
<td></td>
<td></td>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Slate</td>
<td></td>
<td>20</td>
<td>(2W)</td>
<td></td>
<td></td>
<td>Green</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Site – northeast view. Substation on right, cell site on left.

Site – northwest view. Substation on right, cell site on left.
High voltage interface (HVI) installation.
High voltage interface (HVI) installation – cover of Positron shelf open.