Teleline™

Dual 8-card Shelf HVI Backboard (751956/05) and Cabinet (751956/15) Description and Installation Guide

925W751041-04E

POSITRON
Positron Inc.

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Chapter 1

General Information

1.1 Publication Information

Teleline Dual 8-card Shelf HVI Backboard (751956/05) and Cabinet (751956/15) Description and Installation Guide
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1.2 About this Guide

This guide introduces you to the Teleline Dual 8-card Shelf HVI Backboard (751956/05) and Cabinet (751956/15) and describes how to install them. This guide was designed to be read from beginning to end.

1.2.1 Related Documentation

For any other technical document relating this system installation or applications cards and shelves, please refer to the Positron Web site: www.PositronPower.com.

1.2.2 Positron Products and Services

Positron engineers and manufactures high voltage isolation products to protect personnel and telecommunications circuits in high voltage areas that are susceptible to the effects of Ground Potential Rise (GPR).

Positron is the leader in isolation technology with its Teleline wireline products and TeleLite optical fiber wireline isolation/protection product families. Positron provides total flexibility in product configuration – from standalone units protecting a single circuit to high-capacity, multi-shelf HVI preconfigured systems.

Positron also provides a wide range of consulting, analysis and training services for communications companies and electrical utilities.

Full details and contact information are available at: www.PositronPower.com

1.3 Service and Support

1.3.1 Positron Contact Information

General information:	Positron Inc. 5101 Buchan Street, Suite 220 Montreal, Quebec, Canada H4P 2R9 US and Canada: 1-888-577-5254 International: 1-514-345-2220 Fax: 514-345-2271 E-mail: info@positronpower.com Website: www.positronpower.com
Customer Service and Repairs:	US and Canada: 1-888-577-5254 International: 1-514-345-2220 E-mail: customerservice@positronpower.com

1.3.2 Technical Customer Support

Positron is committed to providing excellent ongoing technical support to its customers. A team of specialists is always available for telephone consultations or for on-site visits to assist in the maintenance and troubleshooting of Positron equipment.

For pricing information or assistance in the planning, configuration and implementation of the installation of equipment, contact Technical Customer Service.

1.3.3 Customer Training

Full customer training courses on High Voltage Interface (HVI) are also available. For more information, contact Positron.

1.3.4 Repair Service

All warranty repairs are performed at no cost. Positron reserves the right to repair or replace any equipment that has been found to be defective.

For information about out-of-warranty repairs, contact Positron's Repair Department. Due to the varied nature of repairs, no specific turnaround can be guaranteed, but average turnaround time is 20 working days from date of receipt. In emergency situations, special arrangements can be made. All repaired items are warranted for a period of 90 days.

Before returning any items to Positron for repair, warranty repair or replacement, call the Repair department to obtain a Return Material Authorization (RMA) number. Parts returned without RMA numbers cannot be accepted. The RMA number must always be clearly marked on all boxes, crates, and shipping documents. Bulk repairs (more than five items) will require additional processing time, so please take this into consideration when requesting an RMA number.

To accelerate the repair process, whenever possible, include a report detailing the reason for return with the unit(s). Also, please include the name and phone number of a person who can be contacted should our Repair department need further information.

When packing items being returned for repair, please ensure they are properly packed to avoid further damage. Plug-in cards should never be shipped while installed in a shelf; this will cause damage that can extend the repair period.

1.4 Teleline Warranty

Subject to the provisions of this paragraph, Positron warrants that the equipment shall perform in accordance with Positron's specifications. The warranty remains valid for five (5) years from the date of shipment. The warranty fully covers workmanship, materials and labor. Positron shall, at its sole discretion, repair or replace the problem unit.

Freight costs to ship defective equipment to Positron are borne by the Customer, with return of replaced or repaired equipment to be at Positron's expense.

1.4.1 Limitation of Liability

Subject to anything to the contrary contained herein, Positron's sole obligation and liability and the customer's sole remedy for Positron's negligence, breach of warranty, breach of contract or for any other liability in any way connected with or arising out of, the equipment or any services performed by Positron shall be as follows:

- In all situations involving performance or non-performance of the equipment or any component thereof, the customer's sole remedy shall be, at Positron's option, the repair or replacement of the equipment or said component.
- For any other claim in any other way related to the subject matter of any order under, the customer shall be entitled to recover actual and direct damages; provided that Positron's liability for damages for any cause whatsoever, and regardless of the form of the action, whether in contract or in tort (including negligence), shall be limited to the value of the order.

Positron shall not be obligated to repair or replace any item of the equipment which has been repaired by others, abused or improperly handled, improperly stored, altered or used with third party material or equipment, which material, or equipment may be defective, of poor quality or incompatible with the equipment supplied by Positron, and Positron shall not be obligated to repair or replace any component of the equipment which has not been installed according to Positron specifications.

IN NO EVENT SHALL POSITRON BE LIABLE FOR ANY INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SIMILAR OR ADDITIONAL DAMAGES INCURRED OR SUFFERED INCLUDING

LOSS OF PROFITS, LOSS OF REVENUES, LOSS OF DATA, LOSS OF BUSINESS INFORMATION, LOSS OF GOODWILL, LOSS OF EXPECTED SAVINGS OR BUSINESS INTERRUPTION ARISING OUT OF OR IN CONNECTION WITH THE EQUIPMENT, A PURCHASE ORDER, SUPPLIES, MAINTENANCE SERVICES OR OTHER SERVICES FURNISHED HEREUNDER, EVEN IF POSITRON HAS BEEN ADVISED OR IS AWARE OF THE POSSIBILITY OF SUCH DAMAGES.

EXCEPT AS EXPRESSLY SET FORTH IN THIS AGREEMENT, POSITRON DISCLAIMS ANY FURTHER CONDITIONS, REPRESENTATIONS OR WARRANTIES, WHETHER WRITTEN OR ORAL, EXPRESSED OR IMPLIED, INCLUDING THE CONDITIONS AND WARRANTIES OF MERCHANTABILITY, MERCHANTABLE QUALITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, PERFORMANCE AND THOSE ARISING FROM STATUTE, TO THE EXTENT PERMITTED BY LAW. POSITRON DOES NOT WARRANT THAT THE SYSTEM WILL OPERATE WITHOUT INTERRUPTION OR THAT IT WILL BE ERROR FREE.

1.4.2 Cancellation and Rescheduling Charges

Should the customer cancel, prior to shipment, any part of an order, the customer agrees to pay to Positron cancellation charges, not as a penalty, which shall total all expenses, including labor expenses, incurred by Positron prior to said cancellation. Equipment that has been specially developed for the customer's specific applications shall not be subject to cancellation. Cancellation or rescheduling is not permissible after shipment of the System.

Chapter 2

Overview

2.1 Introduction

NOTE

- Throughout the document, the substation or local AC main is referenced as the “service 120 Vac”.
- The 120 Vac generated from the 130 Vdc station batteries is referenced as a “backed up 120 Vac”.

The Teleline Dual 8-card Shelf HVI Backboard (751956/05) and Cabinet (751956/15) feature:

- Two Teleline 8-card Shelves, model 751109/15
- Lightning Arrestor
- Two 5-pin Surge Tech Protector Blocks
- Isolation Jacks
- Frame ground
- Circuit ground
- Ground bar
- Station cable terminating block
- 6.4 cm (2.5”) cable entry holes
- Thermostat-controlled fan and heat strip (on the Cabinet 751956/15 only)

2.1.1 8-card Shelf, model 751109/15

The 8-card Shelf, model 751109/15, accommodates Teleline plug-in cards. The shelf is molded from specially treated polyurethane, making it lightweight and flame retardant of high dielectric strength. The polyurethane body limits the possibility of many kinds of infiltration while providing reliable isolation from external ground potentials.

The shelf itself is compliant with CSA CAN/CSA-C22.2 No.60950-1 for US and Canada.

See Figure 15 on page 84 for a view of the shelf.

2.1.2 Dual 8-card Shelf HVI Backboard and HVI Cabinet

Both the Dual 8-card Shelf HVI Backboard (751956/05) and HVI Cabinet (751956/15) have the same functionality and require the same connections and power input. The difference between them being that the HVI Cabinet assemblies have environmental controls and can be installed outdoors as well as indoors while the Backboard can only be installed indoors.

Figure 1: 8-card Shelf HVI Cabinet, 751956/15

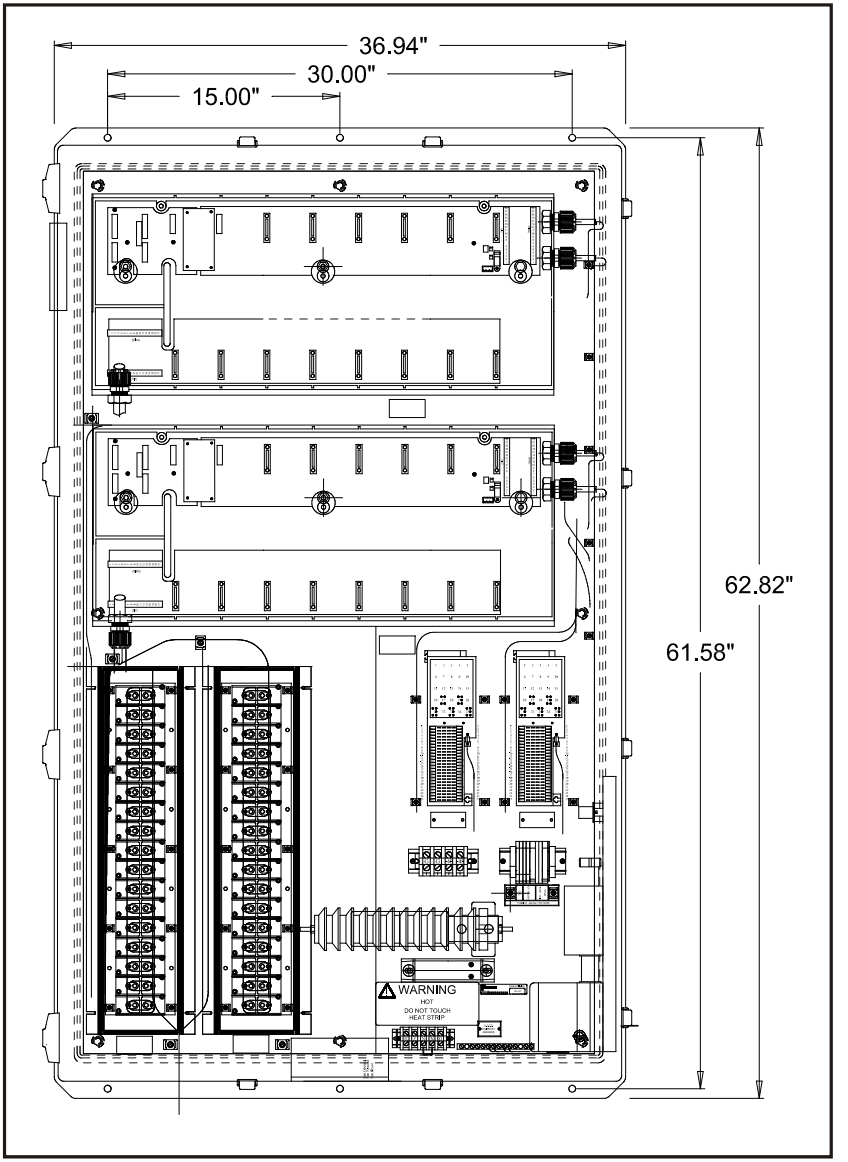
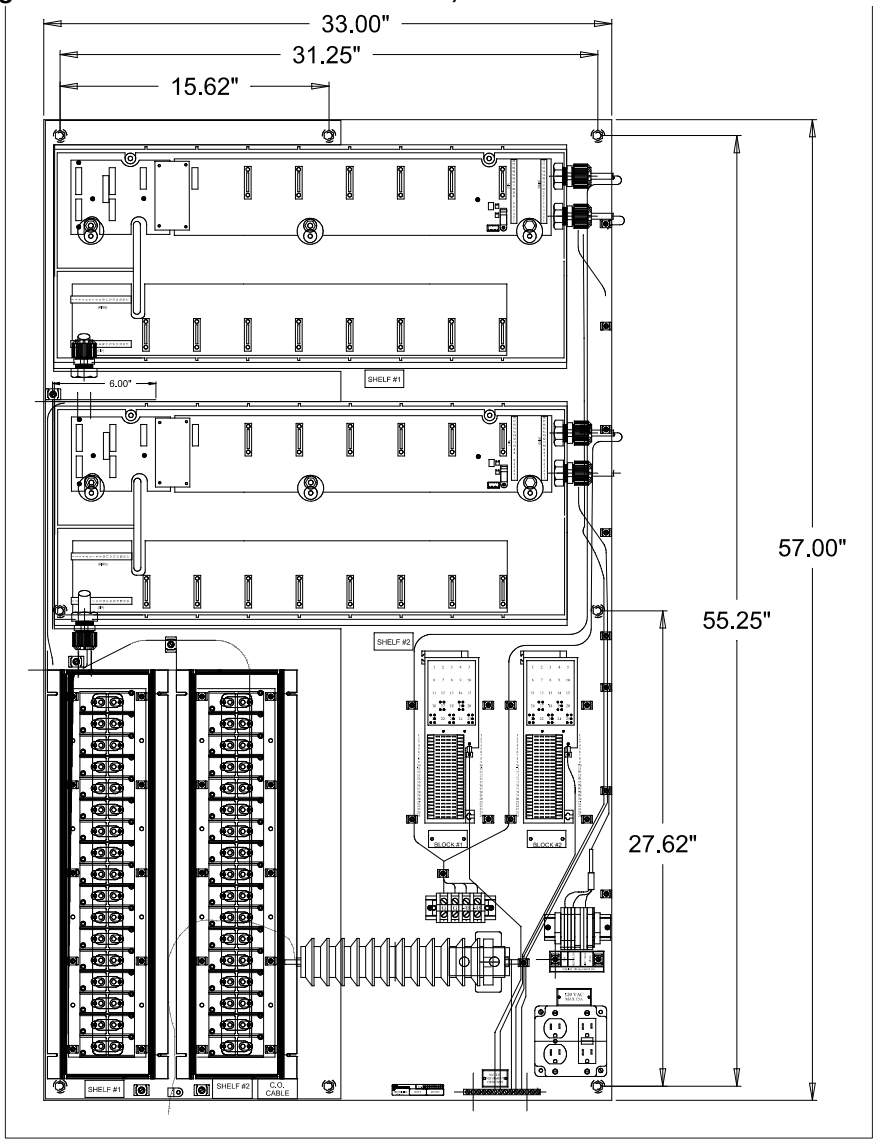


Figure 2: 8-card Shelf HVI Backboard, 751956/05



2.1.3 Dual 8-card Shelf HVI Kit

The Dual 8-card Shelf HVI comes with a kit containing parts that can be required for the installation or as spare parts. Those parts are listed below:

Table 1: Dual 8-card Shelf HVI Kit Contents

Items Included	Quantity	Orderable Part Number
Dual 8-card Shelf HVI Backboard (751956/05) and Cabinet (751956/15) Description and Installation Guide	1	925W751041 (This document)
AC Power Supply cable	2	207-990000-093
Cable fastener, 2cm (0.75")	6	706-990000-010
Wing nut, 10-32 THD	4	714-990000-040
Holder, Retainer	4	598-040001-001
Fuse, 2 A, 250 Vac, FAST BLO, 5x20mm (for Fused Input Terminal Block)	2	294W000010-001
Fuse, 5 A, 250 Vac, FAST BLO, 0.25" x 1.25" (for Teleline shelf)	2	294W000020-001
ADC shorting plug (BLACK), PJ41	1	230-999000-046
ADC polarity reversing plug (RED), PJ42	1	230-999000-045

2.1.4 Physical Specifications

2.1.4.1 Dual 8-card Shelf HVI Backboard (751956/05)

Table 2: Physical Specifications:

Parameter	Specification
Height	145 cm (57")
Width	84 cm (33”)
Depth	28 cm (11")
Weight (without plug-in cards)*	50 kg (110 lbs.)

NOTE * Add the weight of the individual cards to be installed in the backboard (taken from their individual installation guides) to get the total weight of the backboard.

Table 3: Operating Temperatures:
(When using 65°C (149°F) Rated Cards)

Parameter	Specification
Inside installation	-20°C to 55°C (-4°F to 130°F)

NOTE

- See Table 22 on page 91 for temperature ratings of Teleline plug-in cards.

2.1.4.2 Dual 8-card Shelf HVI Cabinet (751956/15)

Table 4: Physical Specifications:

Parameter	Specification
Height	160 cm (63”)
Width	94 cm (37”)
Depth	35 cm (13.8")
Weight (without plug-in cards)*	110 kg (243 lbs.)

NOTE * Add the weight of the individual cards to be installed in the cabinet (taken from their individual installation guides) to get the total weight of the cabinet.

Table 5: Operating Temperatures
(When using 65°C (149°F) Rated Cards)

Parameter	Specification
Inside installation	-20°C to 55°C (-4°F to 130°F)
Outside installation (with solar load)	-20°C to 46°C (-4°F to 115°F)

NOTE

- See Table 22 on page 91 for temperature ratings of Teleline plug-in cards.

Chapter 3

Installation

3.1 Installation

The HVI must be located on the grid of the site. This installation location should also be chosen so as to provide easy access for maintenance.

The equipment utilized in this manual is designed to isolate energies, that is, it does not shunt or route damaging energy to a grounding field.

3.1.1 Placement Selection

The location selected for the HVI must take into account:

- Provision of room for the HVI and related equipment.
- The entrance point of the CO or Dedicated cable.
- The location and length of the grid ground connection.
- The elimination of all telephone equipment on the entrance cable to ensure that the cable enters the HVI assembly straight from the entrance conduit.
- The placement of the HVI unit and related equipment and wiring must be located so as to prevent an arcing condition from the CO cable.
- There must be a minimum 15.3 cm (6”) air gap from the CO or Dedicated cable jacket to:
  - the Station side cable
  - any grounded component or structure surface or member
  - any equipment on the low voltage side of the HVI

Similarly, there must be a minimum 15.3 cm (6”) air gap from anything at the station potential (station cable, fan, ground bar, etc…) to:

- the CO or Dedicated cable
- the top of the Lightning Arrestor
- any other equipment that is attached to the CO cable shield or cable pairs
- the CO side of the Teleline Shelf
- the CO side of any related equipment

3.1.2 Location Constraints for HVI Cabinet (751956/15)

3.1.3 HVI Installation location

The cabinet must not be mounted under the draining surface of a structure where runoff from the roof or draining structure could result in moisture penetrating the cabinet door seal. The draining surface must be extended beyond all surfaces of the cabinet. The extension should be sufficient to take into account the physical location of the cabinet, the physical distance between the cabinet and the extension and wind or any other effect.

3.1.4 Enclosure Weather Rating

The Teleline HVI enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water and should remain undamaged by the formation of ice on the enclosure.

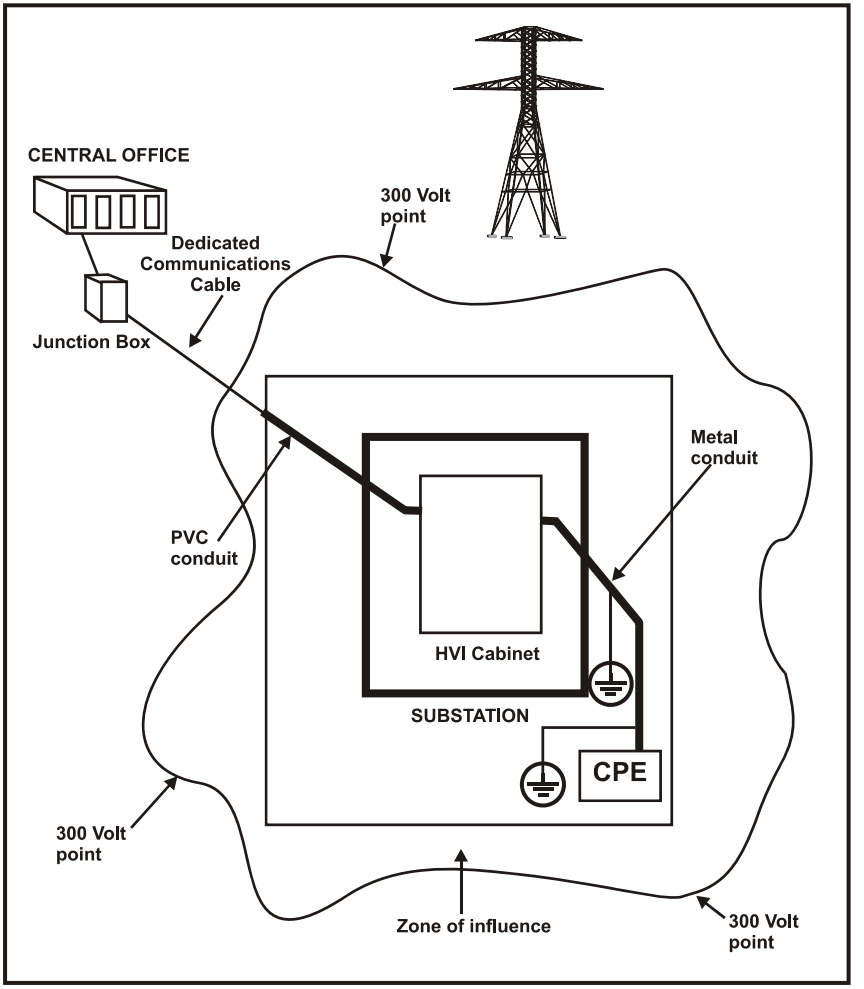
3.1.5 Protective Grounding - 300 Volt Point

- Grounding of the 300 Volt Point closure can be accomplished utilizing a ground rod driven within a 1.8 m (6 foot) radius of the closure.
- Attach a #6 AWG bare copper wire to this ground rod and route it to this same cable closure.
- Attach this ground wire to the cable closure bond bar. All cables within this closure are to be bonded to this cable bond bar, thereby effectively grounding them to a local ground.

CAUTION

- There can be no bond wire to any power system multi-grounded neutral conductor or other power system apparatus at this closure.

Figure 3: 300 Volt Point Location



3.1.6 Grounding conductor

The HVI grounding conductor can not be longer than 2 m (6 feet) from the HVI to a point where this conductor actually enters the earth or an energy dissipating point.

3.1.6.1 Cable Shields

The 300 Volt point for an installation is defined by the electrical parameters of the substation. This is the point where the Ground Potential Rise of the site is reduced to 300 Volts or less. This is usually a new or existing cable closure.

There will be a minimum of two cables in the closure at this point. The cable that originates at the Central Office will be called the general use cable. The cable that originates in this closure and routes into the substation switch room will be called the dedicated cable. Any other cables located in this closure will be referred to as other cable(s).

3.1.6.2 Cable Splicing

Splicing of the general use cable pairs to the dedicated cable pairs in this closure must follow the following rules:

WARNING

- All pairs spliced from the general use cable to the dedicated cable must be spliced using single conductor splice connectors. They cannot be spliced using modular connectors. This is an electrical dielectric strength item.

- All pairs spliced from the general use cable to other cable(s) can be spliced using any normal splicing method.
- All cable shields should be bonded together at this point.

CAUTION

- Grounding of the splice closure is a critical safety item. This ground will be used to dissipate any energy from the cable pair protectors, if utilized, and the cable shields. Please refer to the section on grounding the 300 Volt point closure.

3.1.7 Cable Pair Protectors

These units, if utilized, are provided to protect against conductor to conductor voltage imbalance on the Central Office side of the Positron Equipment. Imbalances may be present as a result of induction effects and or other energy sources during a power system fault. The protectors used should be of a balanced three element gas tube design.

3.2 HVI Equipment Layout

3.2.1 Concept

The concept of the equipment configuration is simple. All of the equipment that is subject to the effects of the remote ground aspect of the site are grouped and located on two sides of the HVI. Those sides are the High Voltage Side and the Low Voltage side. With the equipment laid out in this manner it is easy to determine what potential is possible on all equipment at any time. The equipment and wiring placement MUST NOT be compromised. That is, the CO cable cannot cross or come within 15.2 cm (6”) of any equipment on the low voltage side of the HVI. This also means that the station side or low voltage side equipment can not cross or come within 15.2 cm (6”) of the CO Cable, the top of the Lightning Arrestor, any other equipment that is attached to the CO cable shield, cable pairs, or the CO side of the Teleline Shelf or the CO side of any related equipment.

3.2.2 High Voltage Side

The High Voltage side, usually the left-hand side, of the HVI contains equipment and wiring that is essentially at remote ground potential. Therefore, if the installation is complete and connected with a feeding cable that originates beyond the substation, it is not at a safe potential to touch, unless using rubber gloves and standing on a rubber safety mat.

CAUTION

- If a fault event occurs, this equipment and or wiring will be at a potential that is stable and not subject to the Ground Potential Rise effects of the substation grid. Therefore, if the individual is standing on the grid, the effects of the fault will make this equipment energized to an unsafe voltage level.

The equipment normally found on this side contains but may not be limited to, the CO cable, the cable attachment to the surge or lightning arrestor, the connection at the top of the surge or lightning arrestor, isolation jacks if they are installed, and the CO side of the Teleline equipment.

The Teleline equipment is designed to isolate the personnel and equipment from the effects of the high and the low voltage condition of this site.

3.2.3 Low Voltage Side

The low voltage side of the HVI contains equipment and wiring that is essentially at substation ground potential. Therefore it is at a safe potential to touch.

CAUTION

- It is important to note that the circuit wires may be at an elevated potential in relation to the earthing or ground potential of the building or concrete floor that is being stood upon. Therefore care should be taken when handling circuit equipment and or wiring.

The Teleline equipment is designed to isolate the personnel and equipment from the effects of the high and the low voltage condition of this site.

3.2.4 Cable Routing CO-side Non-metallic Conduit

The CO Cable should be routed to the HVI utilizing a nonmetallic conduit as shown in Figure 3 on page 26. This increases the insulation of the cable shield from earth ground contact via the dielectric material of the conduit. This conduit should originate on the HVI backboard and extend to a distance of at least 3 m (10') beyond the grounded perimeter fence. In addition the cable after it leaves the nonmetallic conduit should not cross or come in contact with any grounded conductive surface.

3.2.5 Cable Routing Station-side Metallic Conduit

The Station-side cable(s) that terminate on the HVI backboard should be routed to this backboard utilizing a metallic conduit. If the distance between origination point and the termination point of the HVI backboard is substantial, greater than 30 m (100'), then a #2 copper bonding conductor should be run with the station cables either exposed or in a dedicated metallic conduit. This bonding conductor is then tied to ground at both ends and the equipment connected to the cable pairs is also bonded to this same ground point. This effectively puts both ends of the station cable(s) and the serving equipment at the same earthing potential.

3.2.6 Crossing Cables and Ground Wires

The CO cable, or any cable that has a shield at remote ground potential should not cross or come in contact with any ground wire or conductive surface within the Zone of Influence of the substation.

The station cables are at local or substation potential. Therefore, they can be run adjacent to or may cross local ground wires or grounded conductive surfaces.

3.2.7 Sealing Current

Sealing current will be simplexed back to the Central Office source by the circuit cards when utilized. No provision is made for sealing current to work beyond this card. Therefore it is anticipated that the NCTE equipment will be operated close to the HVI backboard.

3.2.8 High voltage Interface Overview

Review the plan view drawing for the equipment to be installed. Any problems associated with the placement of this equipment must be addressed before work is commenced.

Major items to review and confirm before work is started:

- That the supporting structure must be adequate to support the cabinet or backboard
- That the installation space must be adequate for the HVI exterior size and for the cabinet door to open
- That the CO or Dedicated cable enters at the correct location
- That the power source has been verified to be correct as identified on the drawing and in the document
- That the Substation Ground Grid connection is available and within 2 m (6 ft) of the HVI

3.2.9 8-card Shelf CCC, 751109/15

This HVI contains two updated Teleline 8-card shelves model 751109/15 featuring a CCC wiring standard.

The wiring to the individual slots has been designed to match the industry standard for a 4- wire telephone equipment shelf.

- Shelf slot 1 has cable pairs 1 & 2 of the CO stub wired to that slot.
- Shelf slot 2 has cable pairs 3 & 4 of the CO stub
- Shelf slot 8 has cable pairs 15 & 16 of the CO stub.

The other shelf slots (3 through 7) are wired in numerical order progression (pairs 5 - 14). This is shown in full detail in Table 19 on page 72.

The wiring arrangement for the 8-card shelf model 751109/13 shelf was for cable pairs 1 & 9 for slot 1, 2 & 10 for slot 2, 8 & 16 for slot 8. The 8-card shelf model 751109/15 wiring scheme greatly simplifies cable pair identification and wiring issues. This even assists the process of computer cable assignments for circuit orders by matching what is the normal process for an inside cable terminal utilizing a very fixed count.

Figure 4 on page 32 and Figure 5 on page 33 show the Station and CO side location of the cables in the Teleline shelves. Figure 6 on page 34 and Figure 7 on page 35 show the interconnection diagrams of the station and CO backplanes.

Figure 4: Station Side Terminal Blocks

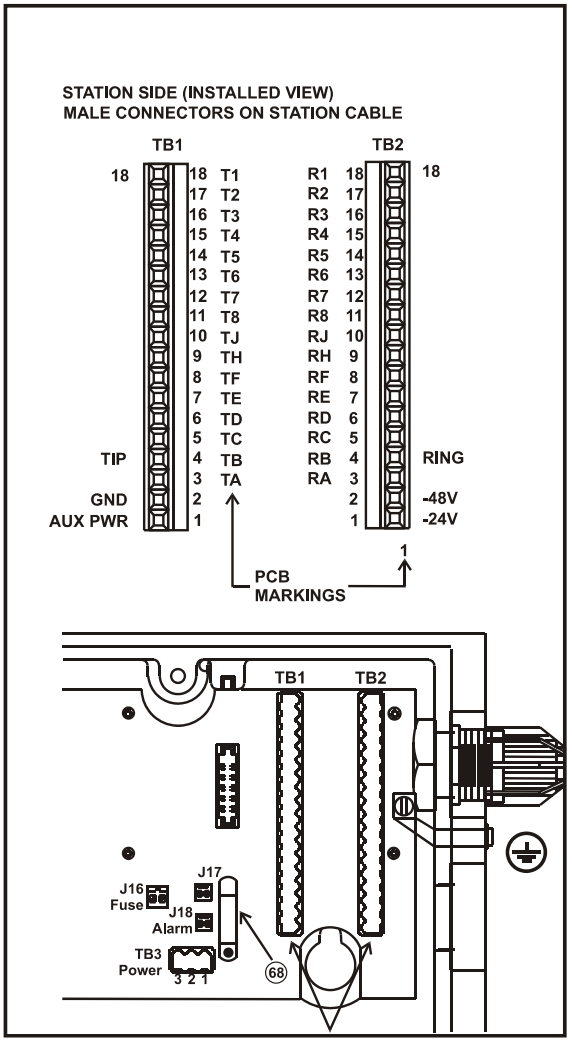


Figure 5: CO Side Terminal Blocks

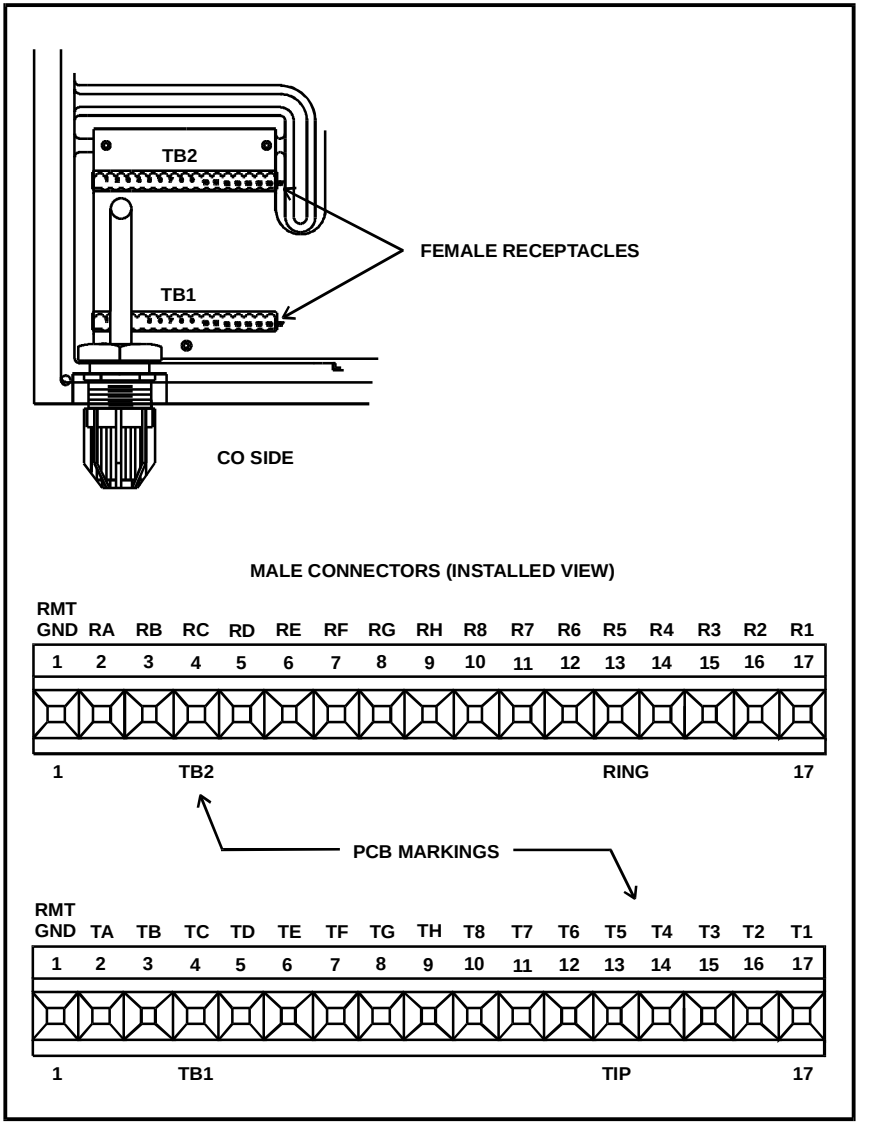


Figure 6: Station Side Motherboard Interconnection Diagram

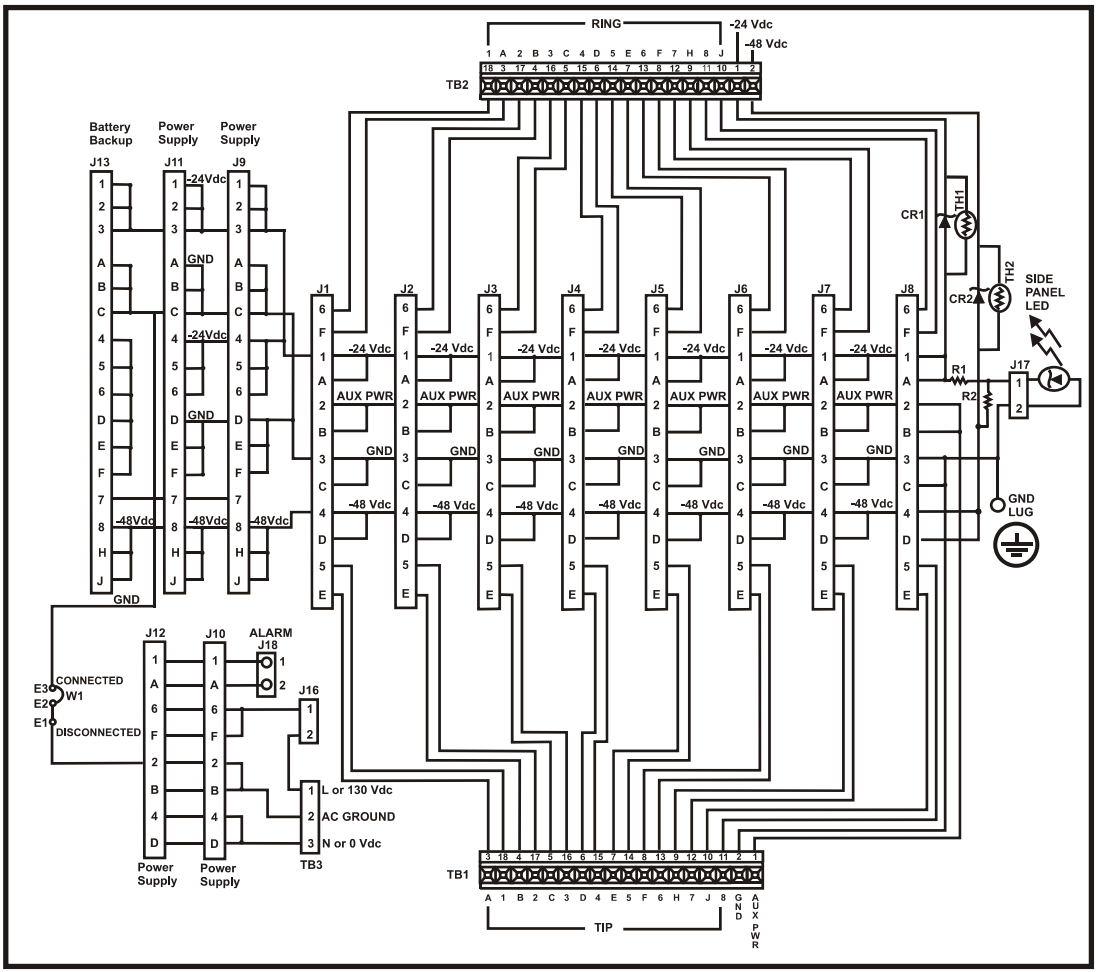
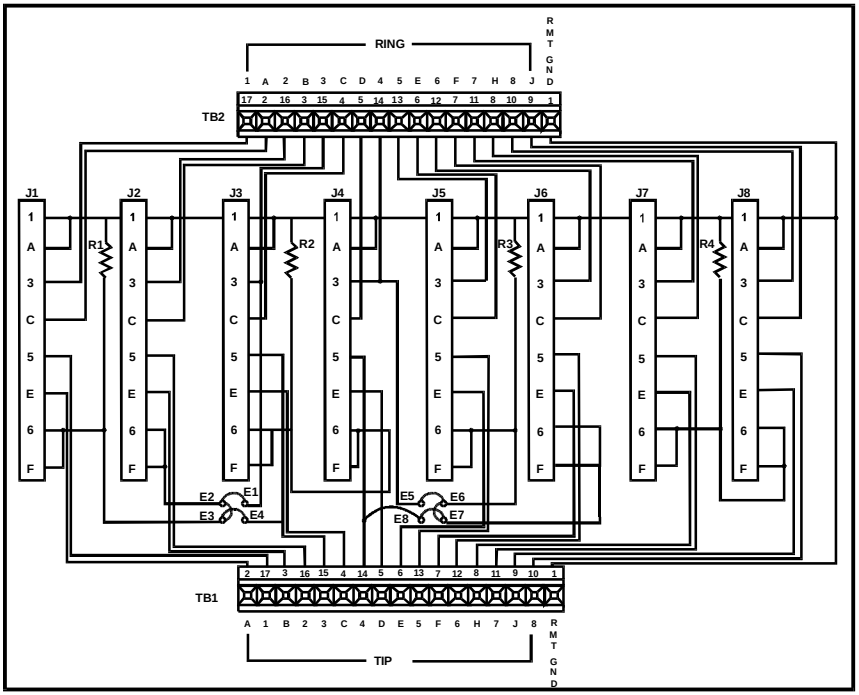


Figure 7: CO Side Motherboard Interconnection Diagram



3.2.10 Power Input to the 8-card Shelf, 751109/15

The power inputs of the 8-card Shelves have been pre-wired to a Fused Input Terminal Block at the bottom of the HVI (refer to Figure 1 on page 18 and Figure 2 on page 19). The terminal block has two 2A/250V fast blow fuses for input current limiting. This terminal block is used to bring in 120 Vac, 130 Vdc or 48 Vdc power to the shelf. The shelf plug-in power supplies have a floating input that will not ground the batteries. For a view of the terminal block, refer to Figure 8 below and for a view of the connections for the terminal block, refer to Table 6 below.

Figure 8: Fused Input Terminal Block

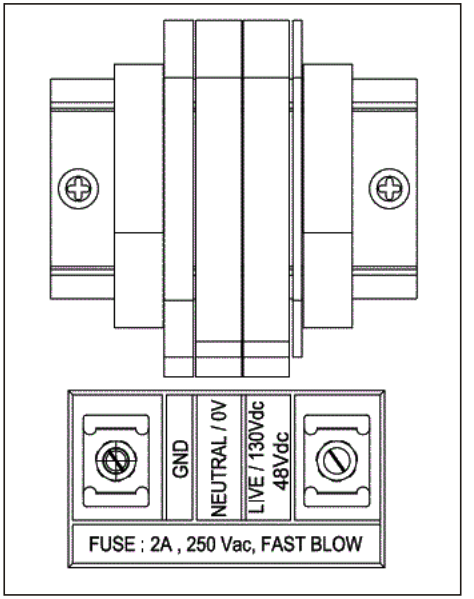


Table 6: Fused Input Terminal Block Connections

	120 Vac in	130 Vdc or 48 Vdc in
GND	Ground	Ground
NEUTRAL / 0 V	Neutral	DC Return (0 V)
LIVE /130 Vdc/ 48 Vdc	Phase (live)	DC Feed (130 Vdc or 48 Vdc)

NOTE

- The electrical panel (for the Cabinet) and the double duplex AC outlet (for the Backboard) are usually connected to the service 120 Vac because they are used to power the environmental equipment or power tools and they will not affect service in case of a power outage.
- The Teleline shelf and NTE interface should be powered from a source that will not be lost during a power failure, such as 130 Vdc from the station batteries or a backed up 120 Vac source powered from the station batteries. This is why the Fused Input Terminal Block input has not been wired to the electrical panel/double duplex outlet.
- Refer to section 3.4.3 on page 47 (for the Cabinet, 751956/15) or section 3.5.3 on page 55 (for the Backboard, 751956/05) on how to connect power (120 Vac, 130 Vdc or 48 Vdc) into the shelf on the Fused Input Terminal Block.
- The Cabinet (751956/15) has an extra duplex outlet located at the top right of the electrical panel that has not been pre-wired with the other electrical equipment. This outlet can be wired to a backed up 120 Vac. Refer to section 3.4.5 on page 50 for more information on this outlet.

3.2.11 Powering model 751313MC or 751318MC from an AC Source

CAUTION

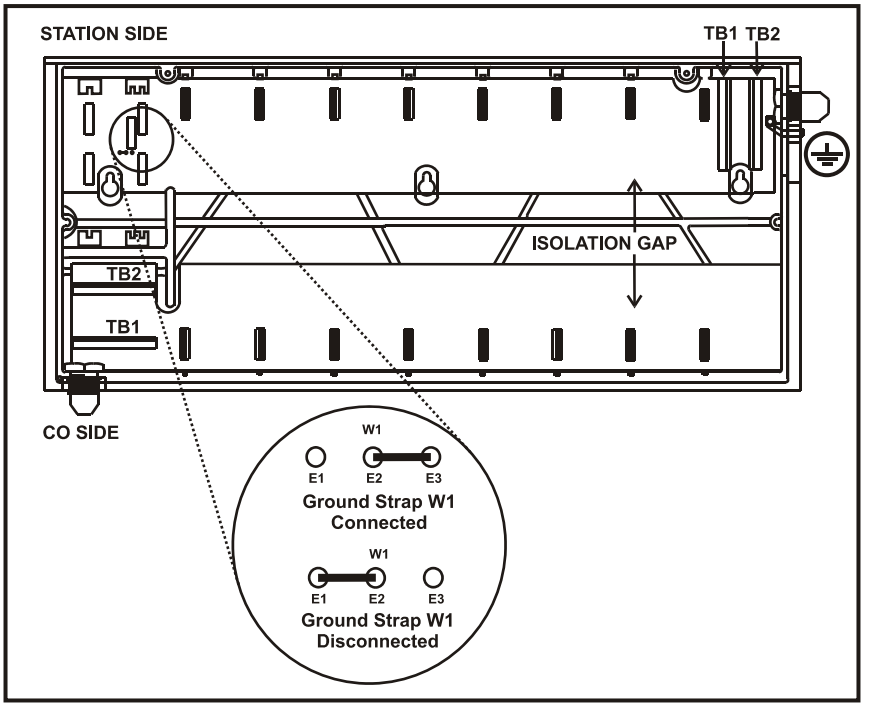
- Teleline Plug-in Power Supplies are CSA CAN/CSA-C22.2 No.60950 certified. No other power supply can be used inside the Teleline shelf.
- The shelf ground lug is the preferred way to ground the shelf.
- The 751313MC and 751318MC input is protected through the power cord ground wire, but since the ground lug provides better current carrying capacity, it is the preferred way of grounding the shelf. The jumper W1 is used to either connect the station backplane ground to the power cord ground (CONNECTED) or not (DISCONNECTED). If the ground lug is connected to a solid station ground and W1 is in the “CONNECTED” position, a ground loop could result and electrical “hum” could be present on the circuit cards. Therefore, when using the ground lug, do not connect a ground to TB3-2 and put W1 in the “CONNECTED” position. If local electrical code state that you must connect the power cord ground, then you must do so and put W1 in “DISCONNECTED” position.

If a Power Supply Card, model 751313MC or 751318MC is used and is powered from an AC source, the following instructions apply:

1. The preferred way of grounding the shelf is to connect a solid ground to the shelf ground lug, NOT connecting a ground to TB3-2 and setting W1 to “CONNECTED” position.
2. If the Station ground lug is used and you are forced to connect the power cord ground to TB3-2, the ground strap W1 on the Station side motherboard must be in the “DISCONNECTED” position. This will prevent creating a ground loop.
3. If a local Station ground is not available and grounding is done through the power cord ground wire (TB3-2), then ground strap W1 must be in its “CONNECTED” position. Doing this will connect the station backplane ground to the power cord ground wire.

For an illustration of the ground strap settings, refer to Figure 9 on page 39.

Figure 9: Ground Strap Settings



3.2.12 Power Supply Combinations

This shelf can use the following power supply combinations:

Table 7: Power supply combinations:

Input Voltage	Model(s)	Output Voltage	Supply Current
120 Vac or 130 Vdc	Single 751313MC or Dual 751313MC	-24 Vdc	2 A 4 A
120 Vac or 130 Vdc	Single 751318MC or Dual 751318MC	-48 Vdc	1 A 2 A
Mixed Configuration: 120 Vac or 130 Vdc	Single 751313MC and Single 751318MC	-24 Vdc & -48 Vdc *	2 A 1 A
48 Vdc	Single 751316 or Dual 751316	-24 Vdc	2 A 4 A
48 Vdc	Single 751319MC or Dual 751319MC	-48Vdc	1 A 2 A
48 Vdc	Single 751316 and Single 751319MC	-24 Vdc & -48Vdc *	2 A 1 A

* These two output voltages will appear simultaneously on the shelf backplane, on the -24 Vdc and -48 Vdc power rails

Either or both of these output voltage(s) can be utilized to power external equipment to the shelf. However, calculations as to power consumption should be done to ensure that the various supply outputs are not exceeded. This of course assumes that the respective power supply is in and working in the shelf power supply area and they have been energized by the respective input voltage source(s).

3.2.13 8-Card Shelf Power Output

The power outputs of the shelf are routed through the shelf's station cable. The -24 Vdc is routed to the protector block pair # 20 (yellow/slate & slate/yellow wires) while the Ground pair #18 (yellow/green & green/yellow wires) and -48V pair #22 (violet/orange & orange/violet wires) are routed to the Output Terminal Block that is located on the right side of the HVI, below the 8-card shelf. If station side equipment needs to be powered by -48Vdc, such as an NIU housing, it can be powered through this terminal block.

For a view of the Output Terminal Block, please refer to Figure 10 below and for a view of the connections for the Output Terminal Block, refer to Table 8 below.

Figure 10: Output Terminal Block

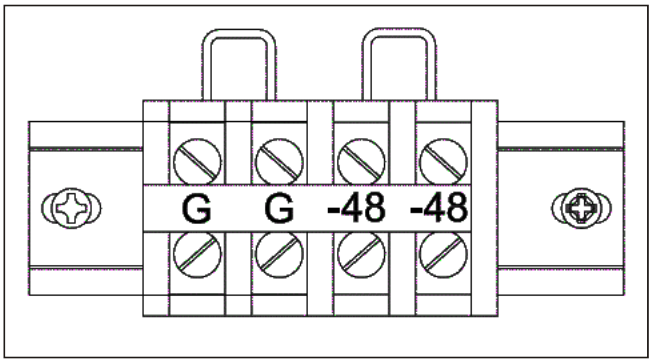


Table 8: Cable Pair Output Voltages

Cable Pair #	Function	Protector Block	Output Terminal Block
18 (Yellow/Green)	Ground. (+)	Not Connected	G (both pins)
20 (Yellow/Slate)	-24 Vdc	Pair #20	Not Connected
22 (Violet/Orange)	-48 Vdc	Not Connected	- 48 (both pins)

3.2.14 Power Supply Alarm

This shelf offers the means of monitoring the output of Model 751313MC, Model 751318MC and Model 751319MC plug-in power supplies using dry alarm contacts. The wires Violet/Slate and Slate/Violet of the Station cable (pair #25) provide Normally Open (NO) contacts during normal operation. If the output of an internal plug-in power supply disappears, either through an AC or DC primary source power outage, an input fuse failure, a power supply failure or a power short-circuit in the load (internal or external), the alarm contacts will close to enable a current, AC or DC, to circulate in the alarm circuit.

If the shelf contains two redundant power supplies, one unit would generate an alarm closure to signify loss of output, while the redundant power supply takes over the powering of the shelf. This enables a service call without a service outage.

The alarm contacts are rated for voltages of up to 125 Vac or 30 Vdc and currents up to 150 mA (AC or DC).

There are many applications for use of dry alarm contacts, such as:

- Closing a circuit to turn on a 12 Vdc light indicator
- Using the contact closure to drive a higher current relay that could turn ON a light bulb or horn alarm
- Closing a circuit to drive a piezo alarm sounder
- Provide a contact closure for an input of alarm monitoring/reporting unit

This feature is especially useful for installations with critical circuits that cannot tolerate a service outage or where downtime must be minimized.

3.3 Safety Procedures

The following sequence of procedures should be followed to insure a safe and easy installation. If the splicing of the dedicated cable to the general use cable is started or accomplished early in the designed work sequence, a safety hazard will exist. That safety hazard will then require the use of a rubber mat and rubber safety gloves for the remaining installation work to protect personnel against Ground Potential Rise and/or transients.

Additionally, as a safety issue, it is recommended that the installation be done on a clear day with no lightning activity.

3.3.1 Safety Precautions

CAUTION

When working on the equipment, the following safety issues should be noted:

- A rubber safety mat and rubber safety gloves must be available for use at the job site at all times. These gloves and the mat should be tested regularly for insulation integrity.
- There is an extreme hazard in working on or coming in contact with the lightning arrestor during inclement weather. The lightning arrestor is connected to the cable shield so a lighting strike may at any time energize it.
- Direct contact with conductors and equipment while standing on a moist surface is hazardous. Ensure that the rubber safety mat does not allow water or any conducting material to come in contact with personnel.
- Precautions should be taken to ensure that moisture is prevented from entering or splashing on the unit.
- AC and DC power used to power communications and environmental equipment may be present at all times. Normal working procedures for powered circuits and devices should be followed.
- Communication pairs that leave the cabinet can be energized at any moment. Rubber gloves and mats should be utilized at any time when there is a potential for contact with an energized conductor.
- Do not install or work on these circuits or cables during a lightning storm. Power substations and their transmission systems attract lightning due to their designed aerial ground wires above the substation grid and support structure.

3.3.2 Additional Safety Precautions for Exterior Locations

CAUTION

- When necessary to work on the cabinet for long periods of time during wet weather conditions, a rainproof umbrella or tent should be used to keep the work area dry.
- If the craftsman standing area is wet or saturated, a raised platform for the mat may be required.

3.4 HVI Cabinet Installation

3.4.1 Additional Hardware Required

Table 9: Additional Hardware Required

Quantity	Description	Use
6	3/8” diameter studs or lag bolts	For mounting to the supporting surface
6	3/8” washers	For use with the mounting fasteners
1	Connector	For the Grid Ground wire to the #6 cabinet ground wire connection

➤ **To unpack the HVI Cabinet unit**

1. Cut any packing straps holding the cabinet box to the pallet.
2. Open the box and remove the lag bolts holding the cabinet to the pallet.
3. Open the cabinet and remove any packing material.
4. Remove any other loose items and set aside for later use.

3.4.2 Mounting to the Supporting Structure

CAUTION

- The cabinet weight is substantial.
- Mounting should be accomplished by two or more persons.

➤ To mount the cabinet

1. Orient the cabinet as shown in Figure 1 on page 18.
2. Locate and drill the top three holes as indicated in Figure 1 on page 18, to mount the cabinet to the support surface.
3. Use three studs or lag bolts and washers to bolt the cabinet to the supporting structure.
4. After the cabinet is supported by the top three fasteners, drill and install the studs or lag bolts and washers for the bottom three holes.
5. Secure the cabinet to the supporting structure by tightening the mounting hardware assemblies.

The cabinet is now ready for connection to the external wiring sources.

3.4.3 Installing The Power Service

The double duplex outlet of the Backboard and the electrical panel of the Cabinet are usually powered from the service 120 Vac because they do not affect service during a power outage. They can be powered from a backed up 120 Vac if the extra power drain from the batteries or generator is not an issue.

➤To install the Power Service

1. Route the incoming power cables into the cabinet using 2" conduit.
2. Route the incoming service 120 Vac power cable through the cabinet hole marked “120 Vac”.
3. Route the power cable to the electrical panel inside the cabinet on the right of the backboard. Attach the cable to the backboard and panel using cable platforms and cable ties.
4. Connect the service 120 Vac conductors to the electrical panel wiring through the base of the double duplex box using the pre-installed wire connectors.

3.4.4 Alternative Power Configurations

To power the Teleline shelf from the service 120 Vac, choose one of the following:

- Refer to Figure 8 on page 36 and Table 6 on page 36 for a view of the Fused Input Terminal Block for the following steps:

1. Wire the AC power cord included in the HVI kit bag to the Fused Input Terminal Block (using the same color code as the pre-wired cable going to the shelf)
2. Plug the AC power cord into one of the AC outlets.

OR

1. Connect the 120 Vac conductors from the double duplex box to the Fused Input Terminal Block.

To power the Teleline shelf from 130 Vdc or 48 Vdc batteries:

- Refer to Figure 8 on page 36 and Table 6 on page 36 for a view of the Fused Input Terminal Block for the following steps:

1. Feed the power cable through the cabinet hole marked “130 Vdc”
2. Wire it to the Fused Input Terminal Block at the bottom of the cabinet.

To power the Teleline shelf from a backed-up 120 Vac source:

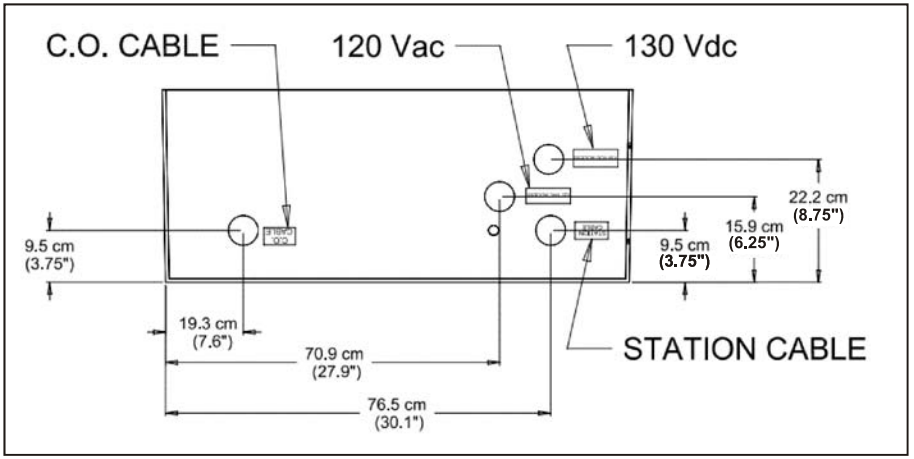
- Refer to Figure 8 on page 36 and Table 6 on page 36 for a view of the Fused Input Terminal Block for the following step:

1. Refer to section 3.4.6 on page 51.

For any powering issues, please refer to the documentation for the 8-card Shelf model 751109/15 and /or the Power Supply Card documentation.

Documentation is available on the Positron Power website:
www.PositronPower.com

Figure 11: Cable Entry Holes for HVI Cabinet



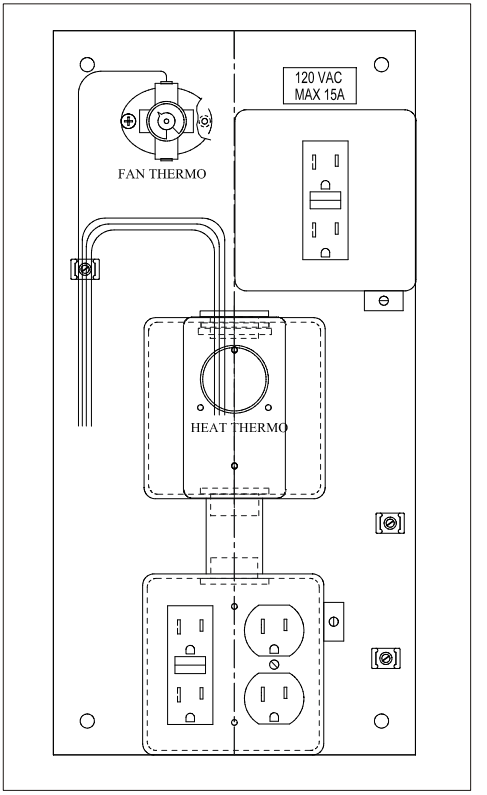
3.4.5 Additional Duplex Outlet

An additional duplex outlet has been installed in the Cabinet to allow connections from a backed up 120 Vac powered from the station batteries. For a view of the electrical panel, see Figure 12 below.

If no backed up 120 Vac is used, this outlet can be wired with the double duplex outlet to provide and additional service 120 Vac outlet.

When wired to a backed up 120 Vac, this outlet should must be labelled “UPS 120 VAC”

Figure 12: Additional Duplex Outlet



3.4.6 Backed-up 120 Vac Power Source

A separate duplex outlet is provided on the electrical panel to route a backed-up 120 Vac powered from the station batteries.

➤ **To modify the HVI Cabinet to permit backed-up 120 Vac power**

1. Connect the backed-up 120 Vac conductors to the duplex outlet located at the top of the electrical panel. Refer to Figure 12 on page 50 for a view of the electrical panel.
2. Apply a label on the duplex box to indicate “Backed-up 120 Vac”

The 8-card Shelf should then be powered from the backed-up 120 Vac outlet. This will avoid communication system failure during local substation power loss.

There are three conductors needed to power the equipment:

Table 10: Equipment Power Conductors

Conductor	Wire Color
120 Vac	Black Wire
Neutral Vac	White Wire
Ground	Green wire with yellow stripes

To power the shelf from the UPS 120 Vac, choose one of the following:

- Refer to Figure 8 on page 36 and Table 6 on page 36 for a view of the Fused Input Terminal Block for the following steps:

1. Wire the AC power cord included in the HVI kit bag to the Fused Input Terminal Block (using the same color code as the pre-wired cable going to the shelf) and plug the AC power cord into one of the UPS outlets.

OR

1. Connect the UPS 120 Vac duplex box to the Fused Input Terminal Block.

3.4.7 Testing Environmental Equipment

The HVI cabinet including all environmental equipment was tested and verified prior to shipment. A functional test of the fan and heater can be done by changing the operating setting on the thermostats.

➤ To test the environmental equipment

1. Record the current temperature setting levels as that is the optimum levels for proper control of the cabinet temperature.
   - The heater should be set at: 10ºC ± 3ºC (50ºF ± 5ºF).
   - The fan should be set at: 35ºC ± 3ºC (95ºF ± 5ºF).

3.5 HVI Backboard Installation

The HVI backboard should be located on the grid of the site. This installation location should also be located so as to provide easy access for maintenance. The equipment utilized in this manual is designed to isolate energies, that is, it does not shunt or route damaging energy to a grounding field.

3.5.1 Additional Hardware Required

The following customer-supplied hardware will be required to install the unit

Table 11: Additional hardware required:

Quantity	Article	Application
6	3/8” diameter studs or lag bolts	mounting to the supporting surface
6	3/8” washers	use with the above mounting fasteners
1	connector	connect Grid Ground wire to the #6 backboard ground wire connection

➤To unpack the HVI backboard unit

1. Cut any packing straps holding the backboard box to the pallet.
2. Open the box and remove the lag bolts holding the backboard to the pallet.
3. Examine the backboard and remove any packing material.
4. Remove any other loose items and set aside for later use.

3.5.2 Mounting to the Supporting Structure

CAUTION

- The backboard weight is substantial. Mounting should be accomplished by two or more persons.

➤ To mount the backboard

1. Orient the backboard as needed to fit the installation surface on the supporting structure. The orientation shown in Figure 2 on page 19 is the only one allowed.
2. Locate and drill the top three holes as indicated in Figure 2 on page 19, to mount the cabinet to the support surface.
3. Use three studs or lag bolts and washers to bolt the cabinet to the supporting structure.
4. After the cabinet is supported by the top three fasteners, drill and install the studs or lag bolts and washers for the bottom three holes.
5. Secure the backboard to the supporting structure by tightening the mounting hardware assemblies.

The backboard is now ready for connection to the external wiring sources.

3.5.3 Installing the Power Service

The double duplex outlet of the Backboard and the electrical panel of the Cabinet are usually powered from the service 120 Vac because they do not affect service during a power outage. They can be powered from a backed up 120 Vac if the extra power drain from the batteries or generator is not an issue.

➤To install the power service

1. Route the incoming power cables (120 Vac, 130 Vdc or 48 Vdc) to the bottom right hand side of the backboard.
2. Connect the incoming service 120 Vac (main or inverted) through the base of the double duplex box using the pre-installed wire connectors.

To power the shelf from the service 120 Vac, choose one of the following:

- Refer to Figure 8 on page 36 and Table 6 on page 36 for a view of the Fused Input Terminal Block for the following steps:

1. Wire the AC power cord included in the HVI kit bag to the Fused Input Terminal Block (using the same color code as the pre-wired cable going to the shelf) and plug the AC power cord into one of the AC outlets.

OR

1. Connect the service 120 Vac conductors from the double duplex box to the Fused Input Terminal Block

To power the shelf from 130 Vdc or 48 Vdc batteries:

- Refer to Figure 8 on page 36 and Table 6 on page 36 for a view of the Fused Input Terminal Block for the following steps:

1. Feed the power cable through the cabinet hole marked “130 Vdc” and wired to the Fused Input Terminal Block at the bottom of the cabinet.

To power the shelf from a backed-up 120 Vac source:

1. Refer to section 3.5.4 on page 57.

Documentation is available on the Positron Power website: www.PositronPower.com.

3.5.4 Backed up 120 Vac Power Source

➤ **To power the HVI backboard from a backed-up 120 Vac power**

1. Connect the backed-up 120 Vac conductors to the double duplex outlet located at the bottom right section of the backboard. Refer to Figure 2 on page 19 for a view of the backboard.
2. Apply a label on the duplex box to indicate “Backed-up 120 Vac”

The 8-card Shelf should then be powered from the backed-up 120 Vac outlet. This will avoid communication system failure during local substation power loss.

There are three conductors needed to power the equipment:

Table 12: Equipment Power Conductors

Conductor	Wire Color
120 Vac	Black Wire
Neutral Vac	White Wire
Ground	Green wire with yellow stripes

To power the shelf from the UPS 120 Vac, choose one of the following:

- Refer to Figure 8 on page 36 and Table 6 on page 36 for a view of the Fused Input Terminal Block for the following steps:

1. Wire the AC power cord included in the HVI kit bag to the Fused Input Terminal Block (using the same color code as the pre-wired cable going to the shelf) and plug the AC power cord into one of the UPS outlets.

OR

1. Connect the UPS 120 Vac duplex box to the Fused Input Terminal Block.

Chapter 4

Wiring

4.1 Station Side Work Items

THE CO CABLE BRINGS FOREIGN VOLTAGES INTO THE HVI ENVIRONMENT. IT MUST THEREFORE BE THE LAST CONNECTIONS MADE ON THE HIGH VOLTAGE INTERFACE FOR SAFETY REASONS.

4.1.1 Ground Wire

This HVI must be connected to the substation grid ground. Provisions have been made for connecting the HVI to ground via the provided ground bar located in the lower right hand area of the HVI. See Figure 1 on page 18 and Figure 2 on page 19. The lightning arrester, 751109/15 shelf and the secondary protector block are connected to this same ground bar

➤ **To ground the HVI**

1. Connect the bar to the grid with a minimum gauge #6 ground wire. The ground wire should be 2 m (6') or less external to the HVI.
2. Cut off all excess ground wire after the connection to the grid conductor is made.
3. Install a grounding clamp sized for the grid conductor and the HVI grounding conductor. The use of a non oxidation compound is recommended. Exothermic welding of this connection would be acceptable.

4.1.2 Terminated Shelf Pairs on 5 Pin Protector 66 Block

The shelves output station cables have been terminated on the left-hand side of the 5 pin protector 66 block using a 66 type punch tool. See Figure 1 on page 18 and Figure 2 on page 19 for the location of the 66 Block.

The color code sequence is shown in Table 13 on page 61.

For a view of the protector block pairs location and protectors location, please refer to Figure 13 on page 63.

For the Station side cable / Shelf slot pairs list refer to Table 14 on page 62.

Table 13: 5-pin Protector Block Color Code Sequence for Both Shelves

Station Cable Ring	Tip	Pair #	Shelf Slot Position	Block Position Pair #
Blue/White	White/Blue	1	1	1
Orange/White	White/Orange	2	1	2
Green/White	White/Green	3	2	3
Brown/White	White/Brown	4	2	4
Slate/White	White/Slate	5	3	5
Blue/Red	Red/Blue	6	3	6
Orange/Red	Red/Orange	7	4	7
Green/Red	Red/Green	8	4	8
Brown/Red	Red/Brown	9	5	9
Slate/Red	Red/Slate	10	5	10
Blue/Black	Black/Blue	11	6	11
Orange/Black	Black/Orange	12	6	12
Green/Black	Black/Green	13	7	13
Brown/Black	Black/Brown	14	7	14
Slate/Black	Black/Slate	15	8	15
Blue/Yellow	Yellow/Blue	16	8	16
Orange/Yellow	Yellow/Orange	17	Not Used	Not Connected
Green/Yellow	Yellow/Green	18	GROUND	Connected to Terminal Block
Brown/Yellow	Yellow/Brown	19	Not Used	Not Connected
Slate/Yellow	Yellow/Slate	20	-24 Vdc	20
Blue/Violet	Violet/Blue	21	Not Used	Not Connected
Orange/Violet	Violet/Orange	22	-48 Vdc	Connected to Terminal Block
Green/Violet	Violet/Green	23	Not Used	Not Connected
Brown/Violet	Violet/Brown	24	Auxiliary Power	24
Slate/Violet	Violet/Slate	25	PWR ALARM (NO)	25

Table 14: Station Cable / Shelf Slot Pairs List

CO Dedicated Cable Pairs	Station Side Shelf #1 Stub	Shelf #1 Slot Position	Station Side Shelf #2 Stub	Shelf #2 Slot Position
1 & 2	1 & 2	1		
3 & 4	3 & 4	2		
5 & 6	5 & 6	3		
7 & 8	7 & 8	4		
9 & 10	9 & 10	5		
11 & 12	11&12	6		
13 & 14	13 & 14	7		
15 & 16	15 & 16	8		
26 & 27			1 & 2	1
28 & 29			3 & 4	2
30 & 31			5 & 6	3
32 & 33			7 & 8	4
34 & 35			9 & 10	5
36 & 37			11 & 12	6
38 & 39			13 & 14	7
40 & 41			15 & 16	8

4.1.3 Secondary Protector Modules

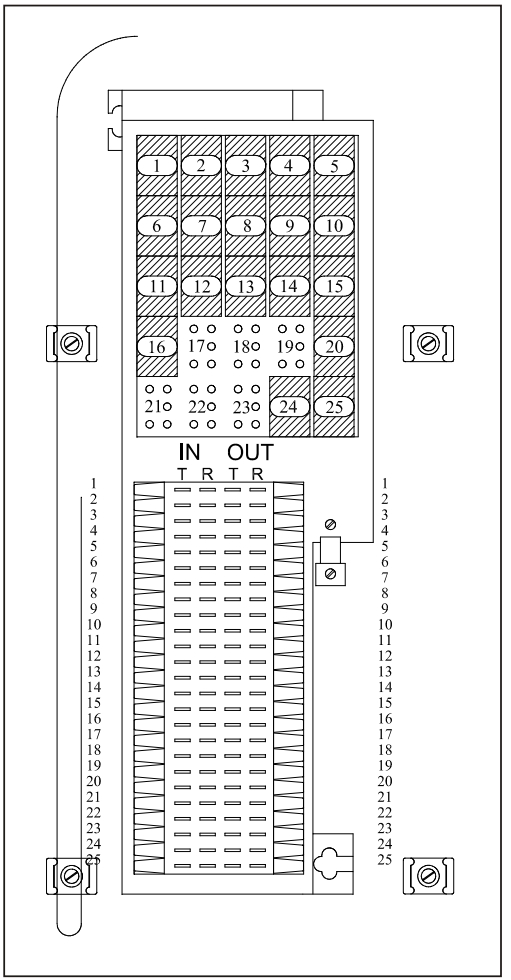
The station cable terminating block is a terminating block for the Teleline module output pairs and the station service cable pairs. It acts as a secondary protector block. The protector modules inserted into the 5-pin receptacle are matched solid state. These modules must be plugged into the protector block field for the circuit to function through the interface block. These protector modules are installed to prevent damage to the Teleline modules.

In the event one of the protector modules fails, it will fail shorted to ground and should be replaced.

Pairs 20, 24 & 25 have Pass-Through modules instead of protector modules on the protector block to prevent the permanent shorting of a protector module by the DC current present on the pair.

For a view of the protector block pairs location and protectors location, please refer to Figure 13 on page 63.

Figure 13: Protector Block



4.1.4 Site Originating Station Circuit Cables

➤ **To Install the Station Circuit Cables**

1. Route the station cable(s) to the bottom of an HVI Backboard or through the strain relief on the bottom of an HVI Cabinet.
2. Continue routing the cables up to the interface blocks located below the second Teleline shelf on the right side of the backboard.
3. Prepare the cable by exposing the conductors
4. Place the conductors on the right hand side of the terminating block corresponding to the shelf to be wired and press them into place on the block.
5. Press the conductors home on the block using a punch-down tool and cut off the excess with the cutter blade on the tool.
6. Observe that a cable pair is oriented on the block in a left to right manner on a single row of connectors. Match the Tip to Ring configuration to equal that of the left side of the block (cable pairs from the shelf & modules). The cable pair count is vertical with the top pair being pair #1 and is associated with row #1 on the 66 protection block terminals.
7. Secure the cable(s) or conductors to the backboard.

4.1.5 Power Supply Alarm

This shelf offers the means of monitoring the output of Model 751313MC, Model 751318MC and Model 751319MC plug-in power supplies using dry alarm contacts. The wires Violet/Slate and Slate/Violet of the Station cable provide Normally Open (NO) contacts during normal operation. If the output of an internal plug-in power supply disappears, either through an AC or DC primary source power outage, an input fuse failure, a power supply failure or a power short-circuit in the load (internal or external), the alarm contacts will close to enable a current, AC or DC, to circulate in the alarm circuit.

If the shelf contains two redundant power supplies, one unit would generate an alarm closure to signify loss of output, while the redundant power supply takes over the powering of the shelf. This enables a service call without a service outage.

The alarm contacts are rated for voltages of up to 125 Vac or 30 Vdc and currents up to 150 mA (AC or DC).

There are many applications for use of dry alarm contacts, such as:

- Closing a circuit to turn on a 12 Vdc light indicator
- Using the contact closure to drive a higher current relay that could turn ON a light bulb or horn alarm
- Closing a circuit to drive a piezo alarm sounder
- Provide a contact closure for an input of alarm monitoring/reporting unit

This feature is especially useful for installations with critical circuits that cannot tolerate a service outage or where downtime must be minimized.

4.2 CO Side Work Items

4.2.1 Central Office Cable

The telco's CO cable is to be connected to the isolation jacks as described in section 4.2.3 on page 68, after attachment to the top of the lightning arrestor. The connection between the lightning arrestor and the cable shield is a critical energy path. As such, it is imperative that this connection be done allowing for an easy transfer of energy from the cable shield to the arrestor wire to the top of the lightning arrestor. This must be done considering that the conductors involved can not have sharp bends or bend back on themselves, that is, no 180 degree bends. Another analogy is to think of this total circuit path as a high pressure water hose, therefore all bends and curves have to allow the water to flow while still maintaining the correct path.

4.2.2 Cable Color Code Identification

The Positron Teleline Shelf conforms to The North American Communication Cable Color Code.

The color-coded cable pairs consist of a Ring conductor and a Tip conductor.

- The Ring conductor has a negative DC voltage standing on the circuit when in an idle condition.
- The Tip conductor has an Office ground standing on it when the circuit is in an idle condition.

This of course assumes that this is a DC powered circuit not an Analog or Digital Data circuit. This DC powered circuit will function with a telephone type device, but is not limited to that purpose.

- The first color of the code is the primary or major color of the conductor.
- The second color of the code is the secondary or tracer color of the conductor.

In the event the conductor is one color only, then that color will be the first of the conductor code. Therefore, if a cable pair has two conductors, one is solid colored blue and the other is solid colored white.

- The blue conductor is the ring conductor.
- The white conductor is the tip conductor.

If the cable pair has two colors on each conductor, those colors being mostly blue with a white tracer and mostly white with a blue tracer.

- The mostly blue conductor will be the ring conductor.
- The mostly white conductor will be the tip conductor.

Table 15: Color Code for 25-Pair Cable

Ring Color	Tip Color	Cable Pair
Blue/White	White/Blue	1
Orange/White	White/Orange	2
Green/White	White/Green	3
Brown/White	White/Brown	4
Slate/White	White/Slate	5
Blue/Red	Red/Blue	6
Orange/Red	Red/Orange	7
Green/Red	Red/Green	8
Brown/Red	Red/Brown	9
Slate/Red	Red/Slate	10
Blue/Black	Black/Blue	11
Orange/Black	Black/Orange	12
Green/Black	Black/Green	13
Brown/Black	Black/Brown	14
Slate/Black	Black/Slate	15
Blue/Yellow	Yellow/Blue	16
Orange/Yellow	Yellow/Orange	17
Green/Yellow	Yellow/Green	18
Brown/Yellow	Yellow/Brown	19
Slate/Yellow	Yellow/Slate	20
Blue/Violet	Violet/Blue	21
Orange/Violet	Violet/Orange	22
Green/Violet	Violet/Green	23
Brown/Violet	Violet/Brown	24
Slate/Violet	Violet/Slate	25

4.2.3 Terminating Dedicated CO Cable Pairs on Isolation Jacks

The dedicated cable pairs are to be terminated onto the wire-wrap isolation jacks. The tip of the jack is the 'Tip' conductor and the shorter or higher pin on the jack is the 'Ring' conductor location. The jacks are numbered from top to bottom, with the top jack being number 1.

The jacks are installed in two columns and are numbered from top to bottom, with the jacks of the first column being numbered 1 to 17 from top to bottom and the jacks of the second column being numbered 18 to 34 from top to bottom. Refer to Figure 1 on page 18 and Figure 2 on page 19 for a view of the jacks.

NOTE

- Do not bond or ground the cable shield.

Table 16: Attachment Sequence: Dedicated Cable Pairs

Dedicated Cable			Jack Position	Jack Position
Ring	Tip	Cable Pair #	Shelf #1	Shelf #2
Blue/White	White/Blue	1	1	
Orange/White	White/Orange	2	2	
Green/White	White/Green	3	3	
Brown/White	White/Brown	4	4	
Slate/White	White/Slate	5	5	
Blue/Red	Red/Blue	6	6	
Orange/Red	Red/Orange	7	7	
Green/Red	Red/Green	8	8	
Brown/Red	Red/Brown	9	9	
Slate/Red	Red/Slate	10	10	
Blue/Black	Black/Blue	11	11	
Orange/Black	Black/Orange	12	12	
Green/Black	Black/Green	13	13	
Brown/Black	Black/Brown	14	14	
Slate/Black	Black/Slate	15	15	
Blue/Yellow	Yellow/Blue	16	16	
Slate/Violet	Violet/Slate	25	17	
Blue/White	White/Blue	26		18
Orange/White	White/Orange	27		19
Green/White	White/Green	28		20
Brown/White	White/Brown	29		21
Slate/White	White/Slate	30		22
Blue/Red	Red/Blue	31		23
Orange/Red	Red/Orange	32		24
Green/Red	Red/Green	33		25
Brown/Red	Red/Brown	34		26
Slate/Red	Red/Slate	35		27
Blue/Black	Black/Blue	36		28
Orange/Black	Black/Orange	37		29
Green/Black	Black/Green	38		30
Brown/Black	Black/Brown	39		31
Slate/Black	Black/Slate	40		32
Blue/Yellow	Yellow/Blue	41		33
Slate/Violet	Violet/Slate	50		34

4.2.4 Dedicated CO Cable Pairs to Shelf Stub Color Code Assignments

The 751109/15 8-card Shelf CO Cable Pairs are already connected within the shelf. The connection to the CO Cable must be done inside the cabinet utilizing the isolation jacks. See section 4.2.3 on page 68.

NOTE

- Do not bond or ground the cable shield.

The attachment sequence for the dedicated cable pairs is shown in Table 17 below and Table 18 on page 71.

Table 17: CO Cable Pairs to Shelf #1 Stub Color Code Attachment

Dedicated Cable			Shelf #1 CO Cable Stub			Shelf #1 Slot #
Pair #	Ring	Tip	Pair #	Ring	Tip	
1	Blue/White	White/Blue	1	Blue	White	1
2	Orange/White	White/Orange	2	Orange	White	1
3	Green/White	White/Green	3	Green	White	2
4	Brown/White	White/Brown	4	Brown	White	2
5	Slate/White	White/Slate	5	Slate	White	3
6	Blue/Red	Red/Blue	6	Blue	Red	3
7	Orange/Red	Red/Orange	7	Orange	Red	4
8	Green/Red	Red/Green	8	Green	Red	4
9	Brown/Red	Red/Brown	9	Brown	Red	5
10	Slate/Red	Red/Slate	10	Slate	Red	5
11	Blue/Black	Black/Blue	11	Blue	Black	6
12	Orange/Black	Black/Orange	12	Orange	Black	6
13	Green/Black	Black/Green	13	Green	Black	7
14	Brown/Black	Black/Brown	14	Brown	Black	7
15	Slate/Black	Black/Slate	15	Slate	Black	8
16	Blue/Yellow	Yellow/Blue	16	Blue	Yellow	8
25	Slate/Violet	Violet/Slate	25	Slate	Violet	RMT GND

Table 18: CO Cable Pairs to Shelf #2 Stub Color Code Attachment

Dedicated Cable			Shelf #2 CO Cable Stub			Shelf #2 Slot #
Pair #	Ring	Tip	Pair #	Ring	Tip	
26	Blue/White	White/Blue	1	Blue	White	1
27	Orange/White	White/Orange	2	Orange	White	1
28	Green/White	White/Green	3	Green	White	2
29	Brown/White	White/Brown	4	Brown	White	2
30	Slate/White	White/Slate	5	Slate	White	3
31	Blue/Red	Red/Blue	6	Blue	Red	3
32	Orange/Red	Red/Orange	7	Orange	Red	4
33	Green/Red	Red/Green	8	Green	Red	4
34	Brown/Red	Red/Brown	9	Brown	Red	5
35	Slate/Red	Red/Slate	10	Slate	Red	5
36	Blue/Black	Black/Blue	11	Blue	Black	6
37	Orange/Black	Black/Orange	12	Orange	Black	6
38	Green/Black	Black/Green	13	Green	Black	7
39	Brown/Black	Black/Brown	14	Brown	Black	7
40	Slate/Black	Black/Slate	15	Slate	Black	8
41	Blue/Yellow	Yellow/Blue	16	Blue	Yellow	8
50	Slate/Violet	Violet/Slate	25	Slate	Violet	RMT GND

4.2.5 Attachment Sequence: Dedicated Cable Pairs

This splicing sequence will then marry sheath cable pairs 1 & 2 through 15 & 16 to slots 1 through 8 for a 4-wire circuit, and this for both shelves.

Table 19: Cable Pair Assignment For a Series of 4-wire Circuits

Dedicated Cable Pair	Shelf #1 CO Cable Pair	Shelf #1 Slot Position	Shelf #2 CO Cable Pair	Shelf #2 Slot Position
1 & 2	1 & 2	1		
3 & 4	3 & 4	2		
5 & 6	5 & 6	3		
7 & 8	7 & 8	4		
9 & 10	9 & 10	5		
11 & 12	11 & 12	6		
13 & 14	13 & 14	7		
15 & 16	15 & 16	8		
26 & 27			1 & 2	1
28 & 29			3 & 4	2
30 & 31			5 & 6	3
32 & 33			7 & 8	4
34 & 35			9 & 10	5
36 & 37			11 & 12	6
38 & 39			13 & 14	7
40 & 41			15 & 16	8

4.2.6 Terminated Shelf Stub Cable Pairs on Isolation Jacks

The cable pairs are terminated onto the isolation jacks. The red conductor is the ring conductor and the white conductor is the tip conductor. This will insure that the circuits will appear in the shelf as expected, designed, and listed in the Circuit Assignment List. The jacks are numbered from top to bottom, with the top jack being number 1 for the left column (shelf #1) and number 18 for the second column (shelf #2).

NOTE

- Do not bond or ground the cable shield.

Table 20: Attachment sequence:751109/15 CO cable stub to isolation jack for Shelf #1

Shelf # 1 Stub			
Ring	**Tip**	**Cable Pair**	**Jack Position**
Blue	White	1	1
Orange	White	2	2
Green	White	3	3
Brown	White	4	4
Slate	White	5	5
Blue	Red	6	6
Orange	Red	7	7
Green	Red	8	8
Brown	Red	9	9
Slate	Red	10	10
Blue	Black	11	11
Orange	Black	12	12
Green	Black	13	13
Brown	Black	14	14
Slate	Black	15	15
Blue	Yellow	16	16
Slate	Violet	25	17

Table 21: Attachment sequence: 751109/15 CO cable stub to isolation jack for Shelf #2

Shelf # 2Stub Ring	Tip	Cable Pair	Jack Position
Blue	White	1	18
Orange	White	2	19
Green	White	3	20
Brown	White	4	21
Slate	White	5	22
Blue	Red	6	23
Orange	Red	7	24
Green	Red	8	25
Brown	Red	9	26
Slate	Red	10	27
Blue	Black	11	28
Orange	Black	12	29
Green	Black	13	30
Brown	Black	14	31
Slate	Black	15	32
Blue	Yellow	16	33
Slate	Violet	25	34

4.2.7 Remote Ground Shelf Pair

The remote ground pair of the shelf appears on CO Pair #25 (Violet/Slate). This cable pair should be used only if a remote ground connection is required. This is usually done with a 751323 series card or for use with a ground start PBX trunk or a coin phone circuit.

4.2.8 Teleline #751125 Lightning Arrestor

This unit has been installed into this cabinet and correctly wired to the ground bar as designed. The cabinet #6 ground wire must be connected to the grid ground connection as instructed in the item titled GROUND WIRE. The connection to the CO cable must be done as instructed in order for the unit to dissipate energy from the cable as designed. See the instructions in the section for the CO cable installation for correct connection procedures.

Additional information may be found in the documentation found in the envelope marked #751125 for this unit.

➤ **Attaching the Lightning Arrestor to the Cable Shield**

NOTE

- Please see Figure 14 on page 77.

1. The insulation around the cable sheath should be stripped only in an area of 10 cm (4") where it is to be clamped to the lightning arrestor. Caution should be taken not to strip the insulation or cut the cable in any other area.
2. Using a sheath knife, make a 5 - 6 cm (2" to 2 1/2”) long slit longitudinally in the shield along the length of the cable. Be careful not to damage the inner poly wrap if the cable is so equipped.
3. Using a sheath knife, make a 4 cm (1-1/2”) long slit circumferential in the shield, perpendicular to the slit in step 1. DO NOT cut all the way around the cable. This cut would be approximately 2 cm (3/4”) long on each side of the longitudinal slit created in step 1.
4. Repeat at the opposite end of the slit. Be careful not to damage any inner poly wrap.
5. Carefully fold these created shield flaps back, sufficiently far to allow for the base of the cable bond clamp to be placed in the created void.

6. Place the cable clamp base into the created void. If there is no inner poly wrap on the cable in use, use two layers of vinyl tape to create an insulating blanket under the clamp.
7. Carefully bend the shield flaps back into place and on top of the bond clamp. This action captures the base of the bond clamp between the inner poly insulation and the shield material.
8. Place the outer bond clamp pressure plate and one nut on the stud of the bond clamp then tighten securely.
9. Apply four layers of vinyl tape over the exposed shield and bond clamp, working the tape layers from one end of the made sheath opening to the other. This will create a good physical bond to the material and an efficient coverage of a dielectric insulating wrap.

NOTE

- Do not tape over the nut on the stud.

10. Place a #6 bond strap or equivalent flex braid on the stud. Use the second nut to secure.
11. Route the other end of the bond strap to the indicated lightning arrestor attach point. See Figure 1 on page 18 or Figure 2 on page 19 for an overview.

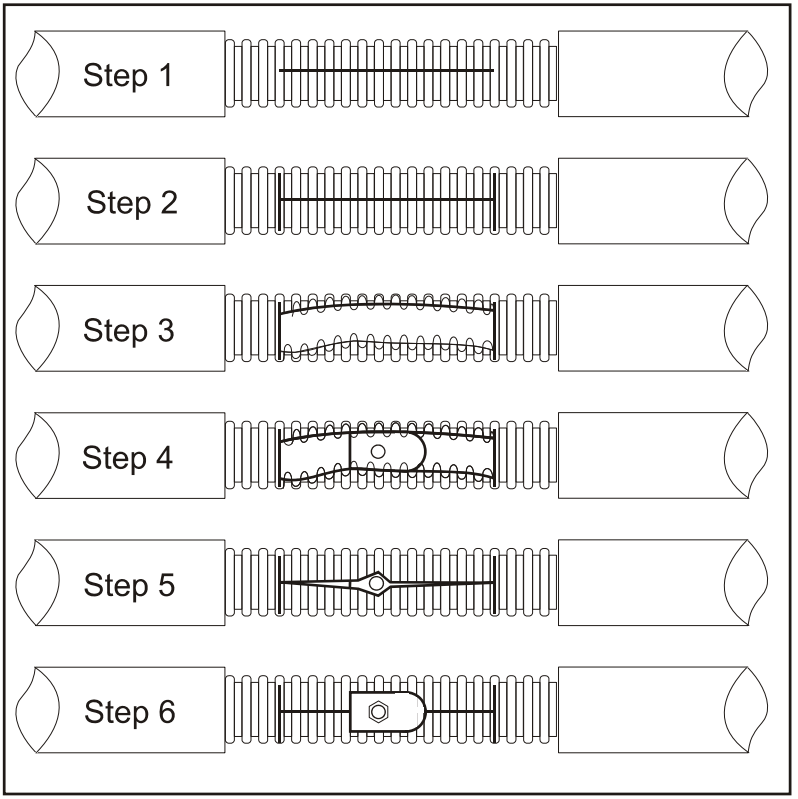
These actions have now resulted in a connection of the cable shield to the cable side of the lightning arrestor.

The ground side of the lightning arrestor has been secured to the cabinet ground wire and was identified in a previous section.

NOTE

- This ground connection must be a substation grid or equivalent connection to ensure proper arrestor operation and adequate energy dissipation.

Figure 14: Grounding the Cable Shield



Chapter 5

Circuit Testing and Module Installation

5.1 Wiring Testing

5.1.1 CO Side Wiring Validation

CAUTION

Fault Exposure Hazard

- All work performed in this work sequence requires the use of a rubber mat and rubber safety gloves when working on or touching any cable pair on the CO side of the shelf.
- Use of the mat and gloves is also required when using the Test Card since this card brings contact with the cable pairs out to the edge of the card on the CO Pairs terminal pins.
- In the event of inclement weather obey the precautions listed in section 3.3.1 on page 44

➤ To test CO Side of pairs

1. Insert the test card Model 751366 into a slot in the shelf.
2. Test the cable pairs from the shelf slot to the CO Main Distributing Frame or any other available test point that is at or beyond the 300 Volt point closure using appropriate test equipment.
3. The kit included with the HVI contains an ADC shorting plug (BLACK) and a polarity reversing plug (RED). The shorting plug can be used to measure the span total resistance from the Main Distributing Frame when shorting the incoming CO cable or to measure the shelf CO cable continuity along with the 751366 test card when shorting the right side of the ADC jacks.

   If a pair reversal is suspected on the incoming CO cable, the reversing plug can be used easily to reverse the pairs and confirm the pair reversal. The plug MUST NOT be left in place. The pair reversal needs to be corrected and a normal plug installed back.
4. Test all pairs for shorts, grounds and opens. This test is being done to insure that all connections are complete between the CO side of the shelf to the Central Office, thereby proving the reliability of the circuit.
5. If there are any problems with the pairs, open the Isolation jack plug and access the cable pair directly on the CO side of the jack field.
6. Repeat this test for all shelf slot positions.

5.1.2 Station Side Wiring Validation

CAUTION

- All work performed in this work sequence requires the use of a rubber mat and rubber safety gloves when using the Test Card since this card brings contact with the cable pairs out to the edge of the card on the CO Pairs terminal pins. This presents the entire fault created voltage potential across the CO and Station cable pair pins on the test card.
- In the event of inclement weather, obey the precautions listed in section 3.3.1 on page 44.

➤ **To test Station Side of pairs**

1. Insert the test card Model # 751366 into a slot in the shelf.
2. Test the cable pairs from the substation side of the shelf to the 66 protection block on the protector block on the backboard using appropriate test equipment.
3. Repeat this test for all cable pairs in all shelf slot positions.

5.2 Module Installation

BEFORE INSTALLING PLUG-IN CARDS AND POWER SUPPLY MODULES, MAKE SURE YOU HAVE COMPLETED THE THERMAL ANALYSIS AND COMPLETED THE TEMPERATURE CALCULATION WORKSHEET AS DETAILED IN CHAPTER 6

5.2.1 Environmental and Temperature Considerations

The HVI designs comply with Standard I.E.E.E 487 recommendations. Compliance with this standard will insure a safe working environment for all personnel, while protecting the telecommunications network from hazardous voltages and currents.

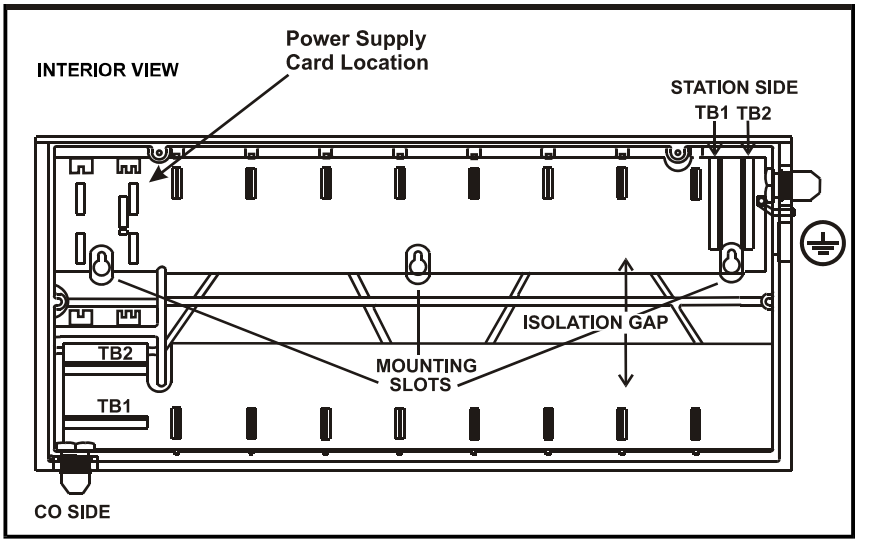
The shelf enclosure is made of an insulating material, which under normal operating conditions (i.e. shelf closed) results in a higher temperature internally than externally (ambient room temperature). If using an HVI Cabinet, the cabinet itself will also limit the air flow around the shelf and be subject to solar loading, causing an increase in the internal temperature. Therefore, special care must be taken to ensure that the internal temperature never exceeds the operating temperature of each module.

Chapter 6 provides a procedure for the calculation of the temperature inside the shelf of the HVI.

5.2.2 Power Supply Card

Insert the Power Supply Card into an available slot in the upper left-hand corner area of the shelf as shown in Figure 15 on page 84.

Figure 15: 8-card Shelf Layout



5.2.3 Card Insertion

After all thermal considerations have been taken into account, insert the cards into the shelf.

For information relevant to any of the cards, refer to their respective documentation.

➤ **Inserting plug-in cards:**

1. Push up on the yellow retaining clip slightly with one hand
2. Insert the cards with the other hand.
3. Close and secure the cover by fastening the wing nuts.

NOTE

- The yellow retaining clips prevent the dislodging of cards due to vibration when the shelf is mounted near mechanical equipment
- Two spare yellow retaining clips have been included with the installation kit to be used in the event that a clip becomes unusable.

DANGER

- The cover must be kept closed and secured at all times in order to protect personnel from potentially hazardous voltages, and to prevent damage to the cover.
- To prevent minor injury to your fingers when removing a card from the shelf, use your right hand only. Push up on the yellow retaining clip with your right thumb and then pull the card out.

5.2.4 Testing Power in the Shelf

CAUTION

- Make sure that the rubber mat is in place and rubber gloves are being utilized before starting work in this step.

➤To confirm the presence of power in the shelf and HVI

1. Insert the Test Card Model 751366 into slot 1 of the shelf and verify that the appropriate power LED turns ON (-24 V, -48 V, 130 V/AUX PWR).
2. Repeat step 1 for all the slots of the shelf.
3. With a Voltmeter, measure the voltage across the output terminal block (G) and (-48). You should get -48 Vdc if you have a 751318MC or 751319MC module in the shelf.
4. With a Voltmeter, measure the voltage across the punch block pair 20 (-24 Vdc) and the shelf's ground lug. The reading should be -24 Vdc if a 751313MC, 751316 or 751324 Power Supply has been installed in the shelf.
5. With an Ohmmeter, measure the resistance across the punch block pair 25 (PWR ALARM). The reading should show a high resistance (MΩ) to indicate normal operation.
6. Pull out the fuse of the Fused Input Terminal Block at the bottom of the HVI to shut off power. The resistance across pair 25 of the punch block should be very low (< 1 Ω) to indicate loss of power.
7. Put back the input fuse. The HVI is ready for use.

5.2.5 Installing Plug-in Circuit Cards

CAUTION

- Make sure that the rubber mat is in place and rubber gloves are being utilized before starting work in this step.

➤To install and test circuit cards

1. Place the circuit cards into the slots in the shelf.
2. Turn the circuits up for service. It is recommended that the NCTE circuit components be powered from a backed up source (130 Vdc batteries or inverted 120 Vac) to maintain operation upon power failure.
3. Test each circuit to verify that the circuits are working through the equipment as expected. Sealing current will be simplexed back to the Central Office source by the circuit cards when utilized. No provision is made for sealing current to work beyond this card. Therefore it is anticipated that the NCTE equipment will be operated close to the HVI backboard.

All circuits requiring power from the shelf for operation should be studied to insure that their transmission circuit resistance does not exceed 400 Ohms. This limit applies when the card is powered by 24 Vdc only.

NOTE

- When a power substation sustains a fault, it will usually lose the 120Vac service power at the substation. It is therefore recommended that NCTE equipment be powered from either 130 Vdc batteries or inverted 120 Vac to maintain equipment operation during the power fault.
- One solution is to use the 24 Vdc or 48 Vdc power available from the Positron power supply that powers the shelf. Another solution is to use a 120 Vac UPS system.

Chapter 6

HVI Temperature Calculations

6.1 Thermal Specifications of Positron Plug-in Cards and Thermal Worksheets

For a list of the thermal specifications for all Teleline cards designed for use within shelves, see Table 22 on page 91.

Table 22: Positron Plug-in Cards Thermal Specifications

Note	Model	Power Consumption	Power Dissipation	Operating Temperature Range	
1	7501-16B	8.4 W from -24 Vdc	8.5 W	**0° to 50° C**	**32° to 122°F**
1	7501-16C	6 W from -48 Vdc	6 W	**0° to 50° C**	**32° to 122°F**
	7501-24	N/A	N/A	-20° to 65° C	-4° to 149°F
	7501-72	N/A	< 200 mW if loop current is < 80 mA	-20° to 65° C	-4° to 149°F
		N/A	< 5 W if loop current is > 80 mA	-20° to 65° C	-4° to 149°F
1	751312	270 mA (charging)	N/A	**0° to 50° C**	**32° to 122°F**
2	751313MC	N/A	**25% of output power**	-20° to 65° C	-4° to 149°F
2	751318MC	N/A	**25% of output power**	-20° to 65° C	-4° to 149°F
2	751316	N/A	**25% of output power**	-20° to 65° C	-4° to 149°F
2	751319MC	N/A	**25% of output power**	-20° to 65° C	-4° to 149°F
	751322	1.8 W avg at -24 Vdc	1 W at (-24 Vdc)	-20° to 65° C	-4° to 149°F
		2.4 W avg at -48 Vdc	2 W at (-48 Vdc)	-20° to 65° C	-4° to 149°F
	751322 &	2.6 W at -24 Vdc	2 W at (-24 Vdc)	-20° to 65° C	-4° to 149°F
	751322/1	3.6 W at -48 Vdc	3.5 W at (-48 Vdc)	-20° to 65° C	-4° to 149°F
	751322/2	2.6 W at -24 Vdc	2 W at (-24 Vdc)	-20° to 65° C	-4° to 149°F
		3.6 W at -48 Vdc	3.5 W at (-48 Vdc)	-20° to 65° C	-4° to 149°F
	751323	1.7 W avg at -24 Vdc	1 W at (-24 Vdc)	-20° to 65° C	-4° to 149°F
		2.4 W avg at -48 Vdc	2 W at (-48 Vdc)	-20° to 65° C	-4° to 149°F
	751325	1.8 W at -24 Vdc	1 W (-24 Vdc)	-20° to 65° C	-4° to 149°F
		2.4 W at -48 Vdc	2 W (-48 Vdc)	-20° to 65° C	-4° to 149°F
	751329R2	N/A	0.75W	-20° to 65° C	-4° to 149°F
	751329SP	3 W at -48 Vdc	2.5W	-20° to 65° C	-4° to 149°F
	751333A	10.6 W at -24 Vdc	3 W (-24 Vdc)	-20° to 65° C	-4° to 149°F
		11 W at -48 Vdc	3.5 W (-48 Vdc)	-20° to 65° C	-4° to 149°F
	751339R2	N/A	4W	-20° to 65° C	-4° to 149°F
	751339SP	10 W at -48 Vdc	5W	-20° to 65° C	-4° to 149°F
	751340R2	N/A	2W	-20° to 65° C	-4° to 149°F
	751340SP	7 W at -48 Vdc	3W	-20° to 65° C	-4° to 149°F
Note: 1	**These cards are designed for indoor applications due to their temperature range**				
Note: 2	**Power Supply Card**				

Table 23: Worksheet for Shelf 1

Slot #	Model #	Power Consumption	Power Dissipation	Max. Operating Temperature
1				
2				
3				
4				
5				
6				
7				
8				
-24 Vdc Plug-in Power Supply				
-48 Vdc Plug-in Power Supply				
Total Power Consumption in shelf				
Total Power Dissipation in shelf				
Highest Allowable Temperature in shelf				
Shelf temperature rise =				

Table 24: Worksheet for Shelf 2

Slot #	Model #	Power Consumption	Power Dissipation	Max. Operating Temperature
1				
2				
3				
4				
5				
6				
7				
8				
-24 Vdc Plug-in Power Supply				
-48 Vdc Plug-in Power Supply				
Total Power Consumption in shelf				
Total Power Dissipation in shelf				
Highest Allowable Temperature in shelf				
Shelf temperature rise =				

6.2 HVI Backboard (751956/05) Temperature Considerations

The 8-card Shelf CCC model 751109/15 enclosure is made of an insulating material, which under normal operating conditions (i.e., shelf closed) results in a higher temperature internally than externally (room temperature). Therefore, special care must be taken to ensure that the internal temperature never exceeds the operating temperature of each card.

This section provides a procedure for the calculation of the temperature inside both shelves. An example follows the procedure.

For a list of the thermal specifications for Teleline cards designed for use with the shelves, at the time of writing, refer to Table 22 on page 91.

6.2.1 HVI Backboard (751956/05) Thermal Calculations

1. Photocopy and complete the worksheet in Table 23 on page 92 and Table 24 on page 93. You must complete a separate worksheet for each shelf.

NOTE | If there are no -24 Vdc plug-in power supplies in the shelves, omit the next step.

2. Add the power consumption of all the cards powered by -24 Vdc in shelf 1 and in shelf 2. This value represents the “Total Power Consumption” at -24 Vdc in each shelf. This value is required for the calculation of the power dissipation of the internal power supplies.

NOTE | If there are no -48 Vdc plug-in power supplies in the shelves, omit the next step.

3. Add the power consumption of all the cards powered by -48 Vdc in shelf 1 and in shelf 2. This value represents the “Total Power Consumption” at -48 Vdc in each shelf. This value is required for the calculation of the power dissipation of the internal power supplies.
4. To calculate the power supply dissipation in each shelf, add the “Total Power Consumption” at -24 Vdc and -48 Vdc for shelf 1 and divide it by 4. Repeat for shelf 2.

5. Add the power dissipation of all the cards as shown in table 26 for shelf 1 and add to it the power supply dissipation of shelf 1. This represents the “Total Power Dissipation in shelf 1". Repeat for shelf 2.
6. The “Maximum Operating Temperature” of a card represents the highest temperature at which a card is guaranteed to operate within specifications. At the bottom of the maximum operating temperature column, enter the lowest of the maximum operating temperatures for each shelf. This temperature is referred to as the “Highest Allowable Temperature” of a shelf.
7. Multiply the “Total Power Dissipation in shelf 1" by the shelf thermal resistance to obtain the temperature rise inside shelf 1. The thermal resistance of the shelves is 0.31ºC/W (0.56ºF/W). Repeat for shelf 2.
   $T_{rise\ shelf\ 1}$ = (Total Power Dissipation in shelf 1) x 0.31ºC/W (0.56ºF/W)
   $T_{rise\ shelf\ 2}$ = (Total Power Dissipation in shelf 2) x 0.31ºC/W (0.56ºF/W)
8. To calculate the temperature inside each shelf, add the temperature rise of that shelf to the maximum ambient temperature.
   $T_{shelf\ 1} = T_{maximum\ ambient} + T_{rise\ shelf\ 1}$
   $T_{shelf\ 2} = T_{maximum\ ambient} + T_{rise\ shelf\ 2}$

NOTE If the room where the HVI is installed does not have air conditioning, use 50ºC as the maximum ambient temperature.

9. Compare the calculated temperature inside each shelf with the “Highest Allowable Temperature” for that shelf. The temperature inside the shelf should not exceed the “Highest Allowable Temperature”.

➤ **To reduce the temperature inside a shelf:**

1. Reduce the number of cards in the shelf by distributing the cards between the two shelves if the second shelf has a lower temperature.
2. Move the cards between the two shelves to replace a card that dissipates heat with one that does not, for example, model 7501-24.
3. Lower the temperature of the room where the equipment is installed.
4. Use an external power supply to power the shelf. This will reduce the internal power dissipation.
5. Replace SP cards with R2 cards, for example a 751339SP with a 751339R2. This will require the HTU-R to be locally powered instead of span powered.

6.2.2 HVI Backboard (751956/05) Thermal Calculations Example

Below is an example of a dual 8-card shelf HVI Backboard, model 751956/05 populated with different cards, see Table 25 on page 97 and Table 26 on page 98 for the list of cards. The Backboard in the example is powered from 120 Vac. Each shelf is equipped with a 751318MC plug-in power supply. The Backboard is installed in a room without air-conditioning, so the maximum room temperature used is 50ºC (122ºF).

➤ **To calculate the temperature inside a shelf**

1. See Table 23 on page 92 and Table 24 on page 93 for the worksheets of the two shelves.
2. Not applicable (no -24 Vdc power supply).
3. “Total Power Consumption” at -48 Vdc for shelf 1 = 29.6 W.
   “Total Power Consumption” at -48 Vdc for shelf 2 = 37.6 W.
4. Power supply dissipation for shelf 1 = 29.6W ÷ 4 = 7.4 W.
   Power supply dissipation for shelf 2 = 37.6W ÷ 4 = 9.4 W.
5. “Total Power Dissipation in shelf 1" = 27.2 W
   “Total Power Dissipation in shelf 2" = 30.1 W
6. “Highest Allowable Temperature” of a shelf 1 is 65ºC (149ºF).
   “Highest Allowable Temperature” of a shelf 2 is 65ºC (149ºF).
7. $T_{rise\ shelf\ 1}$ = 27.2 W x 0.31ºC/W (0.56ºF/W) = 8.4ºC (15.2ºF).
   $T_{rise\ shelf\ 2}$ = 30.1 W x 0.31ºC/W (0.56ºF/W) = 9.3ºC (16.9ºF).
8. $T_{shelf\ 1} = T_{maximum\ ambient} + T_{rise\ shelf\ 1}$ = 50ºC (122ºF) + 8.4ºC (15.2ºF) = 58.4ºC (137.2ºF).
   $T_{shelf\ 2} = T_{maximum\ ambient} + T_{rise\ shelf\ 2}$ = 50ºC (122ºF) + 9.3ºC (16.9ºF) = 59.3ºC (138.9ºF).
9. Because the temperature in both shelves is below the Maximum Allowable Temperature of both shelves, this system is viable and no changes are required.

Table 25: Example Worksheet for Shelf 1

Slot #	Model #	Power Consumption	Power Dissipation	Max. Operating Temperature
1	751339SP	10 W at -48 Vdc	5 W	65°C (149°F)
2	751339SP	10 W at -48 Vdc	5 W	65°C (149°F)
3	751329R2	0	0.75 W	65°C (149°F)
4	7501-24	0	0	65°C (149°F)
5	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
6	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
7	Empty	N/A	N/A	N/A
8	751323	2.4 W at -48 Vdc	2 W	65°C (149°F)
-24 Vdc Plug-in Power Supply	N/A	N/A	N/A	N/A
-48 Vdc Plug-in Power Supply	751318MC	N/A	29.6 W ÷ 4 = 7.4 W	65°C (149°F)
Total Power Consumption in shelf		-24 Vdc: N/A -48 Vdc: 29.6 W		
Total Power Dissipation in shelf			27.2 W	
Highest Allowable Temperature in shelf				65°C (149°F)
Shelf temperature rise = 27.2 W x 0.31°C/W (0.56°F/W) = 8.4°C (15.2°F)				

Table 26: Example Worksheet for Shelf 2

Slot #	Model #	Power Consumption	Power Dissipation	Max. Operating Temperature
1	7501-24	0	0	65°C (149°F)
2	7501-72	0	0.2 W	65°C (149°F)
3	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
4	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
5	751333A	11 W at -48 Vdc	3.5 W	65°C (149°F)
6	751325	2.4 W at -48 Vdc	2 W	65°C (149°F)
7	751339SP	10 W at -48 Vdc	5 W	65°C (149°F)
8	751340SP	7 W at -48 Vdc	3 W	65°C (149°F)
-24 Vdc Plug-in Power Supply	N/A	N/A	N/A	N/A
-48 Vdc Plug-in Power Supply	751318MC	N/A	37.6 W ÷ 4 = 9.4 W	65°C (149°F)
Total Power Consumption in shelf		-24 Vdc: N/A -48 Vdc: 37.6 W		
Total Power Dissipation in shelf			30.1 W	
Highest Allowable Temperature in shelf				65°C (149°F)
Shelf temperature rise = 30.1 W x 0.31°C/W (0.56°F/W) = 9.3°C (16.9°F)				

6.3 HVI Cabinet (751956/15) Temperature Considerations

The 8-card enclosures and cabinet are made of insulating materials, which under normal operating conditions (i.e. shelves and cabinet closed) results in a higher temperature internally than externally (ambient room temperature). Therefore, special care must be taken to ensure that the internal temperature never exceeds the operating temperature of each card.

This section provides a procedure for the calculation of the temperature inside the shelf. An example follows the procedure.

For a list of the thermal specifications for all Teleline cards designed for use with the 8-card Shelf, see Table 22 on page 91.

6.3.1 HVI Cabinet (751956/15) Thermal Calculations

➤ **Calculating the temperature inside the HVI Cabinet**

NOTE The numbers given below are for a cabinet operating with a fan. In case of a fan failure, the temperature will be higher; numbers are provided in notes or parenthesis to calculate the temperature to expect in case of a fan failure.

1. Photocopy and complete the worksheets in Table 23 on page 92 and Table 24 on page 93. You must complete one for shelf 1 and another one for shelf 2.

If there are no -24 Vdc plug-in power supply in the shelves, omit the next step.

2. Add the power consumption of all cards powered by -24 Vdc for each of the shelves if they each have a -24 Vdc plug-in power supply. If only one has a -24 Vdc powering both shelves, calculate the sum of all the consumptions in both shelves.

   This value represents the “Total Power Consumption at -24 Vdc” for shelf 1 & shelf 2 (or for the shelf having the plug-in power supply).

If external equipment is powered from a shelf -24 Vdc power supply, add its power consumption (in Watts) to the sum.

NOTE If there are no -48 Vdc plug-in power supply in the shelves, omit the next step.

3. Add the power consumption of all cards powered by -48 Vdc for each of the shelves if they each have a -48 Vdc plug-in power supply. If only one has a -48 Vdc powering both shelves, calculate the sum of all the consumptions in both shelves.

   This value represents the “Total Power Consumption at -48 Vdc” for shelf 1 & shelf 2 (or for the shelf having the plug-in power supply).

   If external equipment is powered from a shelf -48 Vdc power supply, add its power consumption (in Watts) to the sum.

4. Calculate each shelf's power supply dissipation by dividing the power calculated in steps 2 & 3 by four. For example if one shelf had both a -24 Vdc and -48 Vdc plug-in power supplies, with a 2W load on the -24V and 5W load on the -48V, the power dissipation of the power supplies would be 0.5W for -24 Vdc power supply and 1.25W for the -48 Vdc power supply.
5. Calculate the “Total Power Dissipation” for each shelf by adding the power dissipation of every card in a shelf as given in table 26 and the power supply dissipation of that shelf calculated in step 4.
6. The “Maximum Operating Temperature” of a card represents the highest temperature at which a card is guaranteed to operate within specifications. At the bottom of the maximum operating temperature column, enter the lowest of the maximum operating temperatures. This temperature is referred as the “Highest Allowable Temperature”.
7. The temperature rise in the cabinet ($T_{rise\_cabinet}$) is calculated using the rules below (when installed outside, the solar loading has to be taken into account).
   a) If the shelves are fully populated and the HVI is installed inside, use 3ºC (5.4ºF) with the fan operating and 5ºC (9ºF) in case of a fan failure.

   b) If the shelves are half populated and the HVI is installed inside, use 1.5ºC (2.7ºF) with the fan operating and 2.5ºC (4.5ºF) in case of a fan failure.

   c) If the shelves are fully populated and the HVI is installed outside, use 8ºC

(14.4ºF) with the fan operating and 12ºC (21.6ºF) in case of a fan failure.

d) If the shelves are half populated and the HVI is installed outside, use 6.5ºC (11.7ºF) with the fan operating and 12.5ºC (22.5ºF) in case of a fan failure.

NOTE

- If the HVI is installed outdoors with a solar cover for permanent shading to eliminate solar loading, use the numbers given in a) and b) above.

8. To calculate the temperature in the Cabinet ($T_{cabinet}$), add the number obtained in step 7 to the maximum ambient temperature.
   $T_{cabinet} = T_{maximum\ ambient} + T_{rise\_cabinet}$

NOTE

- When the cabinet is installed inside, if the room is not air-conditioned, use 50ºC as the maximum ambient temperature.
- 2. If the cabinet is installed outside, use 46ºC (114.8ºF) as the maximum ambient temperature.

9. To calculate the temperature rise in the shelves, use the “Total Power Dissipation” of shelf 1 and shelf 2 calculated in step 5 and multiply them by 0.3ºC/W (0.5ºF/W) to obtain the temperature rise in each of the shelf.
   $T_{rise\ shelf\ 1}$ = (Total Power Dissipated in shelf 1) x 0.3ºC/W (0.5ºF/W)
   $T_{rise\ shelf\ 2}$ = (Total Power Dissipated in shelf 2) x 0.3ºC/W (0.5ºF/W)
10. The temperature in each shelf is then the cabinet temperature calculated in step 8 ($T_{cabinet}$) plus the temperature rise of that shelf ($T_{rise\ shelf}$) calculated in step 9.

$T_{shelf\ 1} = T_{cabinet} + T_{rise\ shelf\ 1}$
$T_{shelf\ 2} = T_{cabinet} + T_{rise\ shelf\ 2}$

WARNING

- If the temperature obtained inside one of the Teleline shelves is higher than the Maximum Allowable Temperature for that shelf, then the installation is not viable and must be redesigned to bring down the temperature.
- This can be done either by reducing the ambient temperature for an indoor application, decreasing the number of cards in the Teleline shelf, changing the model of card in the shelf (for example replacing a 751339SP with a 751339R2) or by swapping cards from one of the shelf to the other if the second shelf temperature is lower.
- For an outdoor installation, one option could be to build a solar cover so that the HVI is permanently in the shade. In this case, the solar loading effect is eliminated, thereby reducing the temperature inside the cabinet.

6.3.2 HVI Cabinet (751956/15) Thermal Calculations Example

Below is an example of a dual 8-card shelf HVI Cabinet, model 751956/15 populated with different cards, see Table 27 on page 104 and Table 28 on page 105 for the list of cards. The Cabinet in the example is powered from 120 Vac. Each shelf is equipped with a 751318MC plug-in power supply. The Backboard is installed outdoors, so the maximum ambient temperature used is 46ºC (114.8ºF).

➤ **To calculate the temperature inside a shelf**

1. See Table 23 on page 92 and Table 24 on page 93 for the example worksheets of the two shelves.
2. Not applicable (no -24 Vdc power supply).
3. ”Total Power Consumption” at -48 Vdc for shelf 1 = 29.6 W.
   “Total Power Consumption” at -48 Vdc for shelf 2 = 37.6 W.
4. Power supply dissipation for shelf 1 = 29.6W ÷ 4 = 7.4 W.
   Power supply dissipation for shelf 2 = 37.6W ÷ 4 = 9.4 W.
5. “Total Power Dissipation in shelf 1" = 27.2 W
   “Total Power Dissipation in shelf 2" = 30.1 W

6. “Highest Allowable Temperature” of a shelf 1 is 65ºC (149ºF).
   “Highest Allowable Temperature” of a shelf 2 is 65ºC (149ºF).
7. The shelves are fully populated; therefore $T_{rise\ cabinet}$ is 6.5ºC (11.7ºF) with the fan operating and 12.5ºC (22.5ºF) with a fan failure.
8. $T_{cabinet}$ = 46ºC (114.8ºF) + 6.5ºC (11.7ºF) = 52.5ºC (126.5ºF) with the fan.
   $T_{cabinet}$ = 46ºC (114.8ºF) + 12.5ºC (22.5ºF) = 58.5ºC (137.3ºF) with a fan failure.
9. $T_{rise\ shelf\ 1}$ = 27.2 W x 0.3ºC/W (0.5ºF/W) = 8.2ºC (13.6ºF)
   $T_{rise\ shelf\ 2}$ = 30.1 W x 0.3ºC/W (0.5ºF/W) = 9.0ºC (15.1ºF)
10. $T_{shelf\ 1}$ = 52.5ºC (126.5ºF) + 8.2ºC (13.6ºF) = 60.7ºC (140.1ºF) with the fan.
    $T_{shelf\ 2}$ = 52.5ºC (126.5ºF) + 9.0ºC (15.1ºF) = 61.5ºC (141.6ºF) with the fan.
    $T_{shelf\ 1}$ = 58.5ºC (137.3ºF) + 8.2ºC (13.6ºF) = 66.7ºC (150.9ºF) with a fan failure.
    $T_{shelf\ 2}$ = 58.5ºC (137.3ºF) + 9.0ºC (15.1ºF) = 67.5C (152.4ºF) with a fan failure.
11. As can be seen, the temperature in both shelves is below the Maximum Allowable Temperature when the fan is operating, but upon a fan failure, the temperature would become higher than the Maximum Allowable Temperature.

WARNING

- Our cards can operate at higher temperatures for brief periods of a couple of hours, but extended duration at high temperatures will reduce the life expectancy of the products and can cause failures. Therefore it is better to try to reduce the shelf temperature to below the Maximum Allowable Temperature.
- To do that, one option could be to replace the SP cards with R2 cards. Those cards require no power to operate and dissipate less power. Using those cards requires HTU-Rs that can be locally powered instead of span powered. In this case the shelves temperature during fan failure would drop to 64.5ºC (147.4ºF) for shelf 1 and 65.7ºC (149.2ºF) for shelf 2. Although at the limit of the operating range, those temperatures are acceptable.
- Another option could be to install a sun cover over the cabinet bringing the temperature down by 5ºC (9ºF) because of the elimination of the solar loading effect.

Table 27: Example Worksheet for Shelf 1

Slot #	Model #	Power Consumption	Power Dissipation	Max. Operating Temperature
1	751339SP	10 W at -48 Vdc	5 W	65°C (149°F)
2	751339SP	10 W at -48 Vdc	5 W	65°C (149°F)
3	751329R2	0	0.75 W	65°C (149°F)
4	7501-24	0	0	65°C (149°F)
5	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
6	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
7	Empty	N/A	N/A	N/A
8	751323	2.4 W at -48 Vdc	2 W	65°C (149°F)
-24 Vdc Plug-in Power Supply	N/A	N/A	N/A	N/A
-48 Vdc Plug-in Power Supply	751318MC	N/A	29.6 W ÷ 4 = 7.4 W	65°C (149°F)
Total Power Consumption in shelf		-24 Vdc: N/A -48 Vdc: 29.6 W		
Total Power Dissipation in shelf			27.2 W	
Highest Allowable Temperature in shelf				65°C (149°F)
Shelf temperature rise = 27.2 W x 0.3°C/W (0.5°F/W) = 8.2°C (13.6°F)				

Table 28: Example Worksheet for Shelf 2

Slot #	Model #	Power Consumption	Power Dissipation	Max. Operating Temperature
1	7501-24	0	0	65°C (149°F)
2	7501-72	0	0.2 W	65°C (149°F)
3	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
4	751322/2	3.6 W at -48 Vdc	3.5 W	65°C (149°F)
5	751333A	11 W at -48 Vdc	3.5 W	65°C (149°F)
6	751325	2.4 W at -48 Vdc	2 W	65°C (149°F)
7	751339SP	10 W at -48 Vdc	5 W	65°C (149°F)
8	751340SP	7 W at -48 Vdc	3 W	65°C (149°F)
-24 Vdc Plug-in Power Supply	N/A	N/A	N/A	N/A
-48 Vdc Plug-in Power Supply	751318MC	N/A	37.6 W ÷ 4 = 9.4 W	65°C (149°F)
Total Power Consumption in shelf		-24 Vdc: N/A -48 Vdc: 37.6 W		
Total Power Dissipation in shelf			30.1 W	
Highest Allowable Temperature in shelf				65°C (149°F)
Shelf temperature rise = 30.1 W x 0.3°C/W (0.5°F/W) = 9.3°C (15.1°F)				

Appendix A

Acronyms

Acronyms

AC	Alternating Current
AWG	American Wire Gauge
CCC	Cable Color Code
CO	Central Office
CPE	Customer Premises Equipment
DC	Direct Current
CSA	Canadian Standards Association
FAC	Facility-Side
GND	Ground
GPR	Ground Potential Rise
HVI	High Voltage Interface
IEEE	Institute of Electrical and Electronics Engineers
MD	Manufacture Discontinued
PBX	Private Branch Exchange
PWR	Power
NIU	Network Interface Unit
NCTE	Network Channel Terminating Equipment
RMA	Returned Material Authorization
RMT	Remote
UL	Underwriters Laboratory
UPS	Uninterruptible Power Supply