# BRX-VDSL2

## Broadband Reach eXtender – VDSL2

## User Guide

June 2019

**Publication Information**



**BRX-VDSL2**
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Publication date: June 2019
Printed in Canada

**Published By**
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**Disclaimer Notice**
Although Positron Access Solutions Corp. has made every effort to ensure the accuracy of the information contained herein, this document is subject to change.

# Regulatory Compliance and Safety

**FCC Declaration of Conformance**

All of the BRX-VDSL2 models (includes BRX-VDSL2-X models) comply with part 15 class A of the FCC Rules. Operation is subject to the following two conditions (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**Part 15 Class A Information**

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates; uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**Industry Canada**

All of the BRX-VDSL2 models (including BRX-VDSL2-X models) comply with ICES-003 of the Industry Canada Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Tous les produits BRX-VDSL2 (incluant les produits BRX-VDSL2-X) sont conformes à la norme NMB-003 d'Industrie Canada. Leur fonctionnement est sujet aux deux conditions suivantes: (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement indésirable.

**Safety**

The following BRX-VDSL2 models conforms to IEC 60950-1/UL 60950-1/CSA C22.2 #60950-1 and IEC 60950-22/UL 60950-22/CSA C22.2 #60950-22 standards:

- BRX-VDSL2-2, BRX-VDSL2-8, BRX-VDSL2-24 sealed units along with the following factory installation of a BRX-24S chassis in a UL approved pedestal: BRX-VDSL2-24-1SF, BRX-VDSL2-24-1-SPF, BRX-VDSL2-24-1-SXPF, BRX-VDSL2-48-1SF, BRX-VDSL2-48-1-SPF, BRX-VDSL2-48-1-SXPF.
- BRX-VDSL2-X-2, BRX-VDSL2-X-8, BRX-VDSL2-X-24 sealed units along with the following factory installation of a BRX-24S chassis in a UL approved pedestal: BRX-VDSL2-X-24-1SF, BRX-VDSL2-X-24-1-SPF, BRX-VDSL2-X-24-1-SXPF, BRX-VDSL2-X-48-1SF, BRX-VDSL2-X-48-1-SPF, BRX-VDSL2-X-48-1-SXPF.

- BRX-24S factory installed in UL approved pedestal and ready to accept BRX modules: BRX-24-CS, BRX-24-1S, BRX-24-1SX, BRX-48-1S and BRX-48-1SX.

The BRX-24S conforms to IEC 60950-1/UL 60950-1/CSA C22.2 #60950-1.

Les modèles BRX-VDSL2 suivants sont conformes aux normes IEC 60950-1/UL 60950-1/CAN C22.2 #60950-1 et IEC 60950-22/UL 60950-22/CAN C22.2 #60950-22.

- BRX-VDSL2-2, BRX-VDSL2-8, BRX-VDSL2-24 dans leur boitier scellés ainsi que les configurations incorporant un châssis BRX-24S assemblées en usine dans un piédestal certifié UL: BRX-VDSL2-24-1SF, BRX-VDSL2-24-1-SPF, BRX-VDSL2-24-1-SXPF, BRX-VDSL2-48-1SF, BRX-VDSL2-48-1-SPF, BRX-VDSL2-48-1-SXPF.
- BRX-VDSL2-X-2, BRX-VDSL2-X-8, BRX-VDSL2-X-24 dans leur boitier scellés ainsi que les configurations incorporant un châssis BRX-24S assemblées en usine dans un piédestal certifié UL: BRX-VDSL2-X-24-1SF, BRX-VDSL2-X-24-1-SPF, BRX-VDSL2-X-24-1-SXPF, BRX-VDSL2-X-48-1SF, BRX-VDSL2-X-48-1-SPF, BRX-VDSL2-X-48-1-SXPF.
- BRX-24S installé en usine dans un piédestal certifié UL et prêts à recevoir des modules BRX: BRX-24-CS, BRX-24-1S, BRX-24-1SX, BRX-48-1S and BRX-48-1SX.

Le BRX-24S est conforme aux normes IEC 60950-1/UL 60950-1/CSA C22.2 #60950-1.

### Precautions and warnings

Always use a circuit that provides POTS sealing current to the copper pair to power a BRX-VDSL2 unit. When deploying a BRX-VDSL2 on a copper pair without sealing current, always make sure to use power injector devices approved by Positron Access Solutions for that use. Using power injectors with voltage higher than 48V nominal may create risk of damaging the unit and void its warranty.

There are no user-serviceable parts in BRX-VDSL2 devices. Do not attempt to open the unit. Doing so may damage the seals and prevent the unit from meeting its IP rating. Damaged seals may lead to rain water leaking into the unit and damage to its electronics resulting into its malfunction or its total failure. The BRX-VDSL2 devices should only be opened by a technician trained and certified to service the product.

All wiring external to the product should follow the local wiring codes.

Be careful when splicing the BRX-VDSL2 pairs to the twisted telephone cable pairs. Dangerous voltage can be present on the pairs. Splicing should be done by a qualified person. Never splice pairs during a lightning storm.

The equipment must be connected to a protective ground in accordance with the instructions provided in this manual. Always ensure that BRX-VDSL2 units are connected to a chassis ground path of 25 ohms or less to avoid damage to the equipment from lightning strikes and other electrical surges.

Use of this product in a manner other than defined in this installation guide may cause damage to equipment or injury to personnel.

All fuses on the unit are located in non-accessible areas and are not field serviceable. Please return the unit to Positron Access Solutions for repair.

The BRX-VDSL2 products are intended for installation in Restricted Access Locations only whether installed indoor or outdoor.

## Table of Contents

# 1 General Description

The Broadband Reach eXtender – VDSL2 (BRX-VDSL2) is a fully integrated solution that increases the bandwidth and/ or extends the reach of DSLAMs or MSANs to deliver higher bandwidth services to underserved or unserved markets. For example, it extends the reach of a 25 Mbps downstream / 3 Mbps upstream service from 4,000 feet (1.2 km) to 6,000 feet (1.8 km) on 24 AWG / 0.51mm gauge copper, an increase of almost 50%, and the same level of increase is achieved for larger size cables. Furthermore, this 50% increase in reach results in an estimated 100% increase in CSA (Customer Serving Area) since the area served is proportional to the square of the lineal distance.

It is important to note that these benefits are obtained without the need to change the DSLAM/MSAN or the user CPE. By significantly increasing the effective bandwidth and reach of existing xDSL lines, operators can deliver true broadband speeds to each of their subscribers, even those located in remote areas or currently located too far from the DSLAM to receive any service.

The BRX-VDSL2 comes in two (2) versions. While they perform the same amplification function and can be used for most of the same applications, their design is optimized as per the following table.

| FEATURE | BRX-VDSL2 | BRX-VDSL2-X |
|---|---|---|
| **Amplification Range** | 4000-8500 feet (24 AWG) | 4000 – 10000 feet (24 AWG) |
| **Max Loop Length for 25 / 3 Mbps on single pair (24 AWG)** | 6000 feet (Non-Vectored and Vectored) | 6500 feet (Non-Vectored and Vectored) |
| **Max Distance for 50 / 8 Mbps on bonded pairs (24 AWG)** | 6000 feet (Non-Vectored and Vectored) | 6500 feet (Non-Vectored) and Vectored) |
| **VDSL2 range extension** | Up to 1500 feet | Up to 2250 feet |
| **CSA Expansion** | 77% | 200% |
| **Amplification ratio** | Up to 1.2 Downstream / up to 4.0 Upstream | 1.2 to 1.9 Downstream / up to 4.1 Upstream |
| **Form Factor** | Same form factor, each pair has 2 LEDs to indicate presence of current and loop status | |
| **Enclosure Options** | Available in 1, 2, 8, 24 and 48 pairs enclosures | |
| **Management** | Manageable (Detection, Location, Alerting, Troubleshooting) with integration with ASSIA DSL Expresse and with Nokia Network Analyzer Copper (NAC) | |
| **Operation over POTS pairs** | 100% compatible with presence of active POTS line. Limited current consumption to guarantee 100% compliance with POTS devices | Requires BRX Power Injector to guarantee 100% compliance with POTS devices |
| **Operation over Dry pairs** | BRX Power Injector can be used to power the BRX-VDSL2 devices when operating on dry pairs (no -48Vdc sealing current present) | |

Table 1: Summary feature comparison of BRX-VDSL2 and BRX-VDSL2-X

# 2 BRX-VDSL2 Main Advantages

- Extends the VDSL2 Customer Serving Area (CSA) by 77-200%.
- Improve effective bandwidth of VDSL2 loops.
- The BRX-VDSL2 uses the -48V sealing current of the POTS line. When deployed over dry pairs (no POTS sealing current), it can be powered from the Positron BRX Power Injector.
- The BRX-VDSL2-X requires slightly more power than the BRX-VDSL2. It can operate over standard POTS sealing current when there is no POTS (dial tone) service. Otherwise, when operated jointly with a POTS service (dial tone) or when deployed over a dry pair, it requires the use of the Positron BRX Power Injector
- Flexible Shelf design allows more subscribers to be added in the future.
- Turnkey pedestal option available.
- Auto calibration, no software to configure or dip switch.
- Easy to install, deploy, and maintain.

# 3 Bandwidth Performance and Placement Flexibility

## 3.1 Expected Bandwidth Improvement with BRX-VDSL2 and BRX-VDSL2-X

Both versions of the BRX-VDSL2 automatically adapt their operation to the actual line conditions to optimize performance. They provide gain amplification of the signal in the downstream (D1 and D2 bands) and upstream (U0 and U1 bands) direction making sure that the amplified signal is always within the acceptable spectrum mask and signal strength allowed by the VDSL2 standards. BRX-VDSL2 devices significantly improve the signal to noise ratio seen by the CPE (in the downstream direction) and the DSLAM (in the upstream direction).

The table below illustrates a few examples of the bandwidth increases one can expect with the insertion of a BRX-VDSL2 or BRX-VDSL2-X:

| **BRX-VDSL2 Downstream Performance Increase (Typical Lines) NO Vectoring** | | | | | | |
|---|---|---|---|---|---|---|
| **Total Loop Length (24 AWG / 0.51 mm)** | | **Not Amplified** | **BRX-VDSL2** | | **BRX-VDSL2-X** | |
| **Feet** | **Meters** | **DS / US (Mbps)** | **DS / US (Mbps)** | **Improvement Ratio** | **DS / US (Mbps)** | **Improvement Ratio** |
| 5000 | 1524 | 26.3 / 2.8 | 33.2 / 6.4 | 1.26 / 2.29 | 34.5 / 6.2 | 1.31 / 2.21 |
| 6000 | 1829 | 24.1 / 1.3 | 25.7 / 4.3 | 1.07 / 3.31 | 27.8 / 4.2 | 1.15 / 3.23 |
| 6500 | 1981 | 21.1 / 1.3 | 21.8 / 2.7 | 1.03 / 2.08 | 25.0 / 3.3 | 1.18 / 2.54 |

Table 2: Downstream Performance Increase Examples (Typical Lines) – NO Vectoring

The graph below illustrates the amplified downstream bandwidth resulting from the use of BRX-VDSL2 and BRX-VDSL2-X devices compared to the non-amplified (raw) bandwidth (24 AWG / 0.51mm copper gauge) with profile 17a in Non-Vectored mode. Profiles 8a, 8b and 8d achieve very similar bandwidth amplification results.

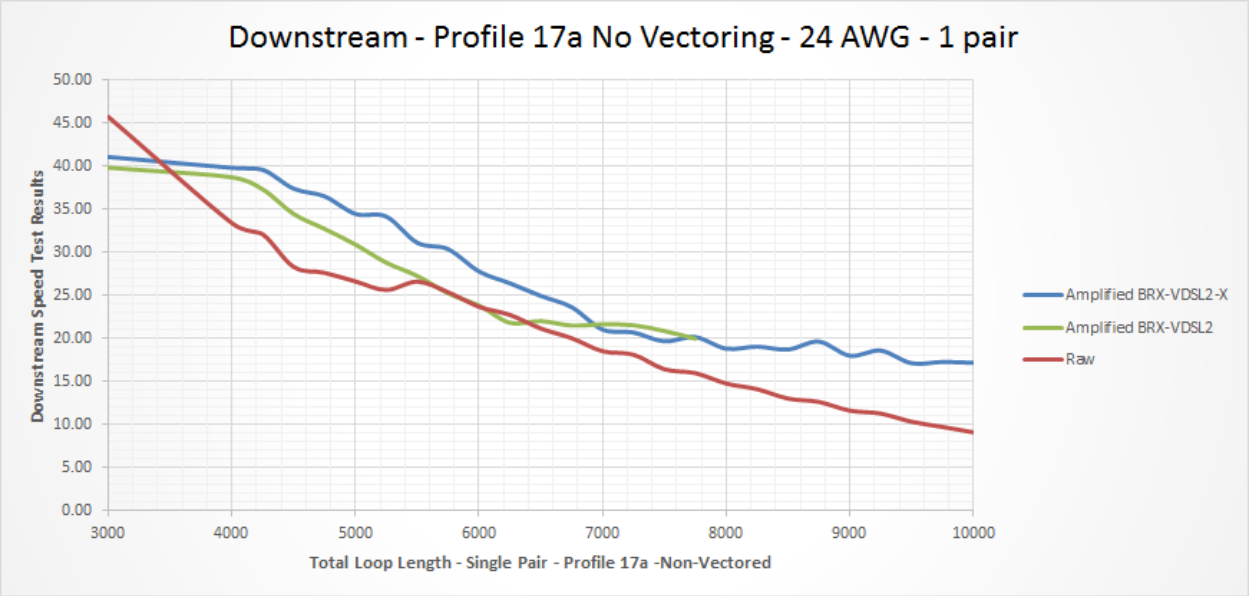


Figure 1: Amplified Downstream VDSL2 Bandwidth vs non-amplified (raw) loops (distance in feet)

The amplified upstream bandwidth resulting from the use of BRX-VDSL2 and BRX-VDSL2-X devices compared to the non-amplified (raw) bandwidth (24 AWG / 0.51mm copper gauge) with profile 17a in Non-Vectored mode are shown below. Profiles 8a, 8b and 8d achieve very similar bandwidth amplification results.

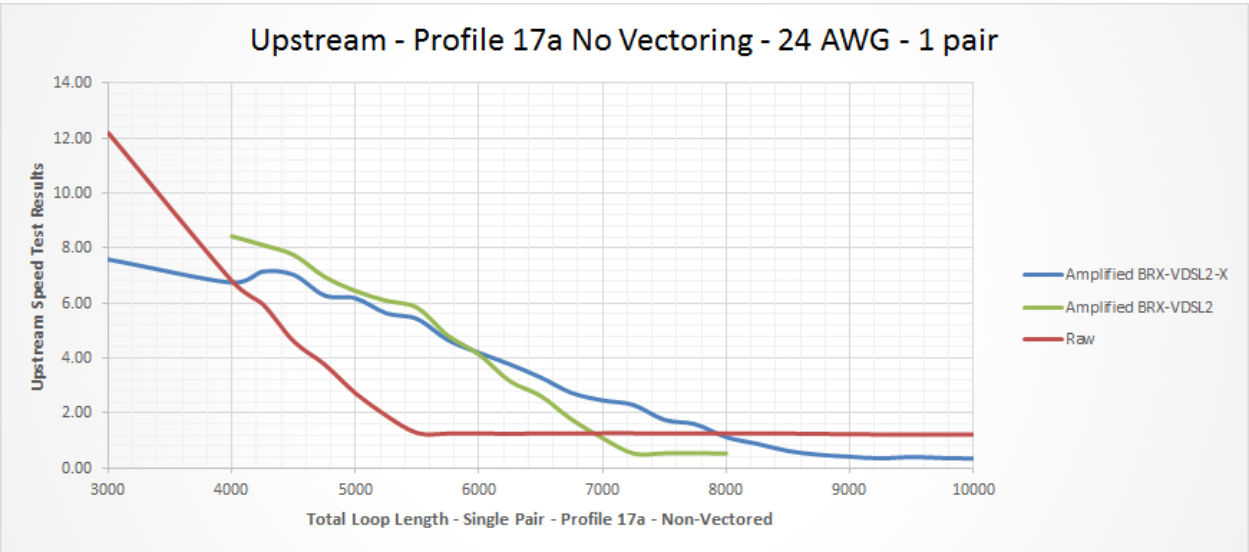


Figure 2: Amplified Upstream VDSL2 Bandwidth vs non-amplified (raw) loops (distance in feet)

It should be noted that the Downstream and Upstream Bandwidth Performances above (both in the graphs and in the table) are conservative as they are based on tests performed with traffic on the other pairs of the cable binder (i.e. with crosstalk) and with otherwise typical copper line conditions. Field experience has shown that the BRX-VDSL2 devices provide even better Improvement Ratios (i.e. Bandwidth Enhancement) when faced with “less than ideal” line conditions where the bandwidth is negatively impacted by bridge taps, influence from power lines and/or disturbances from other pairs or the use of other protocols in the same binder such as T1/E1, HDSL, and G.SHDSL.

## 3.2 BRX-VDSL2 Placement Flexibility

Over and above the performance gains, one of the major advantages of the BRX-VDSL2 devices over other products is that their placement along the loop is flexible and does not impose hard constraints when choosing the location where they should be installed. For instance, on a 24 AWG (0.51mm) loop of 6000 feet / 1.8 km, placing the BRX-VDSL2 anywhere between 3000 feet / 0.9 km and 3750 feet / 1.15 km (2750 feet / 0.84 km and 3750 feet / 1.15 km) away from the DSLAM will deliver a 25 / 4 Mbps service to the customer. The BRX-VDSL2-X will typically provide higher performance in both the downstream and upstream when compared to the BRX-VDSL2 version.

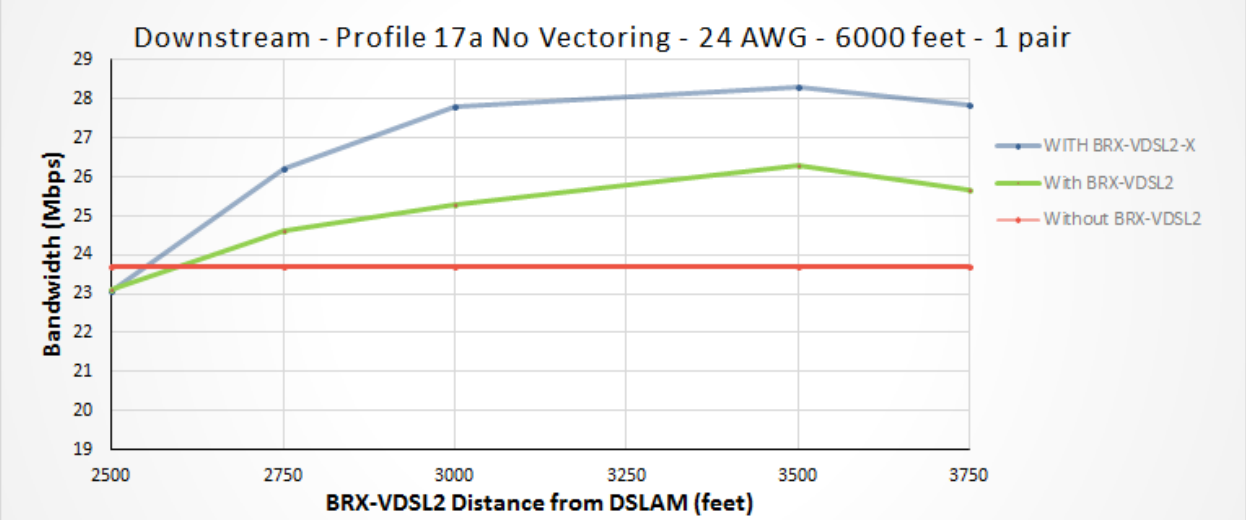


Figure 3: Downstream Placement flexibility of BRX-VDSL2 on a 6000 feet loop

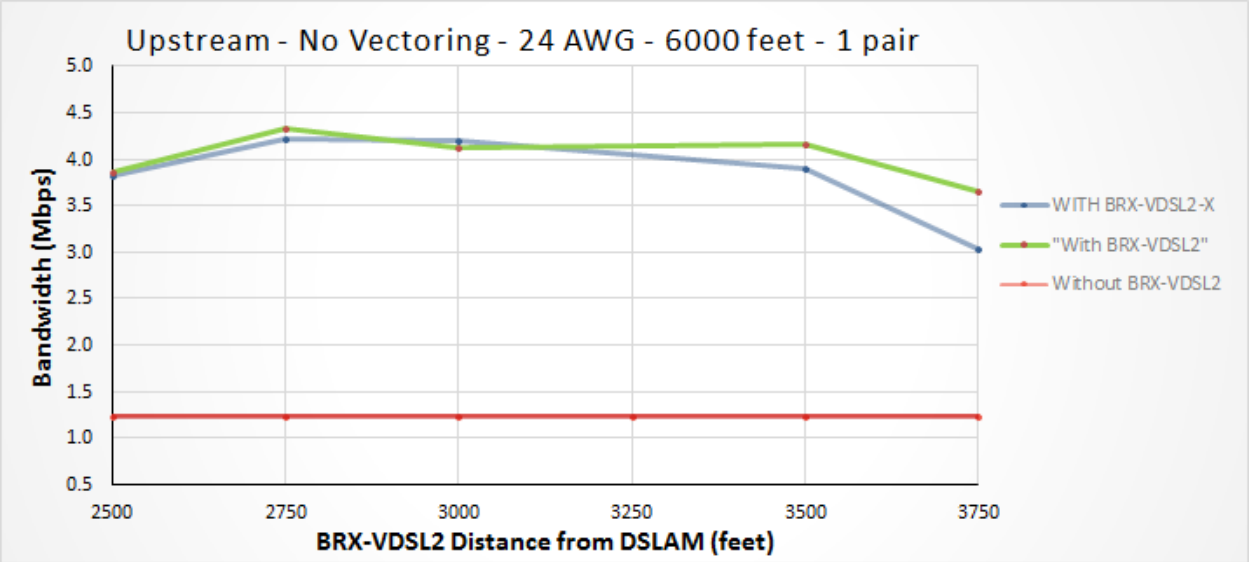


Figure 4: Upstream Placement flexibility of BRX-VDSL2 on a 6000 feet loop

BRX-VDSL2 devices are designed to offer very similar performance gains whenever they are deployed at a distance that ranges from 45-60% of the total loop distance (away from the DSLAM).

## 3.3 Optimum Placement

Although the placement of BRX-VDSL2 devices is flexible, the curves in section 3.2 above demonstrate that there is value in properly planning the placement to optimize performance. The following curve demonstrates the optimum placement of the BRX-VDSL2 relative to total loop length.

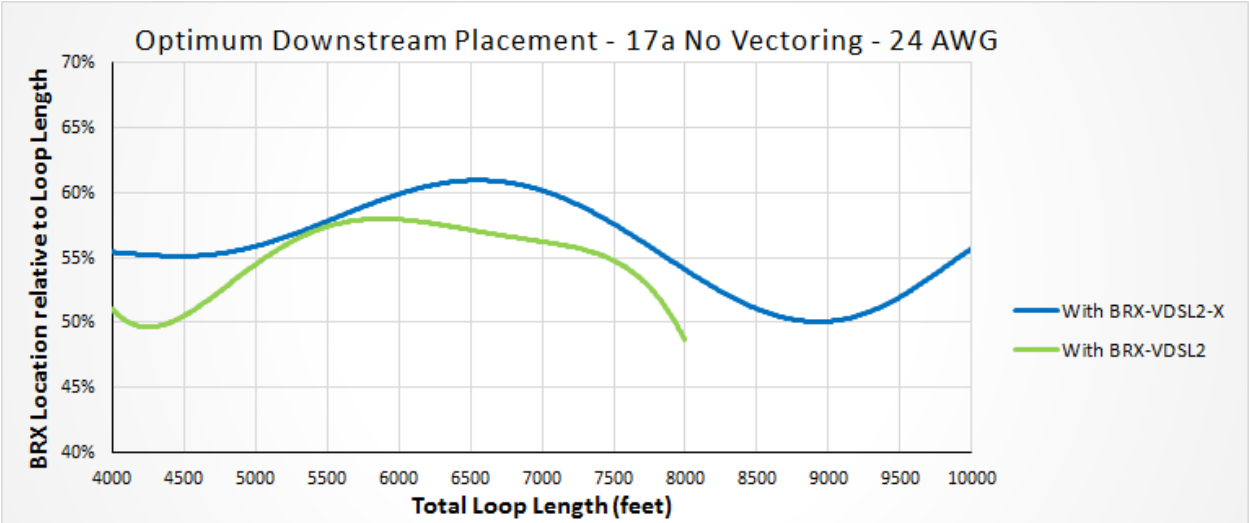


Figure 5: Optimum Downstream BRX-VDSL2 / BRX-VDSL2-X Placement vs Loop Length (feet)

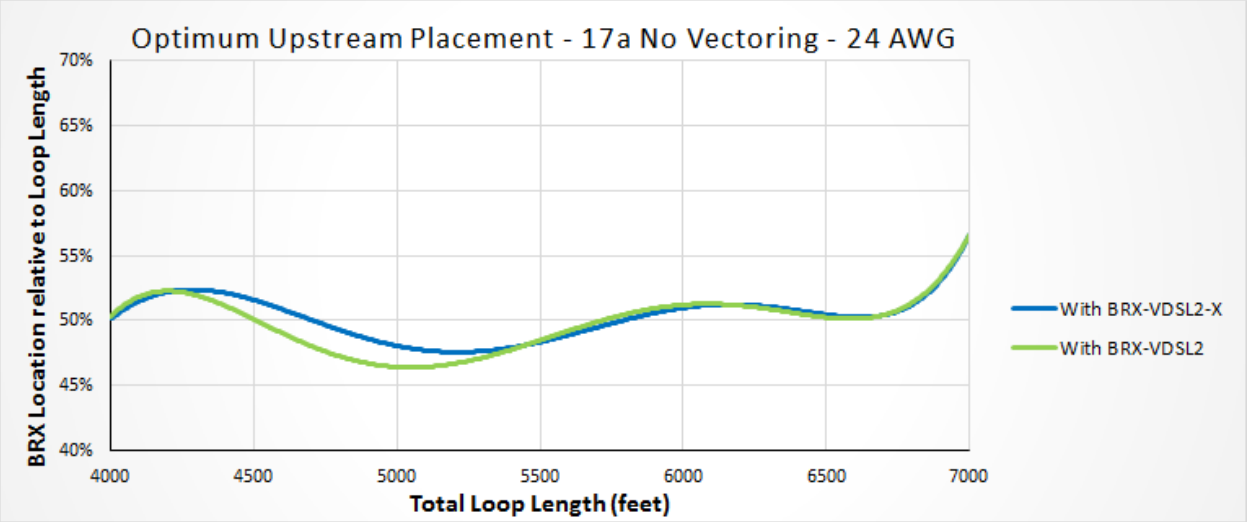


Figure 6: Optimum Upstream BRX-VDSL2 / BRX-VDSL2-X Placement vs Loop Length (feet)

As can be seen, there is a general trend that drives towards the midpoint of the loop as the total loop length increases. Having said that, service providers have a finite amount of locations per loop where they can install a BRX-VDSL2 device which will not always be at the optimum point. Positron Access has designed the BRX Cloud Calculator tool to assist in determining the optimum location for any given loop along with many suggested alternative placements with predicted performances. The BRX Cloud Calculator can also be used to select which version of the BRX-VDSL2 is best for a specific application or loop length.

### 3.4 BRX Cloud Calculator

To view the impact related to the installation of a BRX-VDSL2 unit on a given loop whether it is a 26 AWG (0.40mm), 24 AWG (0.51mm) or a 22 AWG (0.64mm) copper pair, a cloud-based BRX Calculator is available. All you need to do is request access via the Positron Access Portal at http://www.positronaccess.com/Portal.php. You will then be sent a username and password to access the Portal. The BRX Calculator can then be accessed directly at http://brx.calculator.positronaccess.com/.

The BRX Cloud Calculator has three tabs at the bottom that can be used for the following objectives:

- Calculate the achievable bandwidth based on the location of the BRX-VDSL2 device (from the DSLAM) and the distance to the subscriber CPE;
- Calculate the optimal bandwidth for a specific total loop length and gauge of wire and recommend the location where the BRX-VDSL2 device should be installed (usually a range of distances from the DSLAM) to achieve the target bandwidth;
- Calculate the best placement of a BRX-VDSL2 device to achieve a target bandwidth to multiple subscribers over a total loop length from a single location. For instance, the BRX-VDSL2-8 / BRX-VDSL2-X-8 is ideal to serve up to 8 subscribers on a single pair (or 4

subscribers with pair bonding) from the recommended location. This is useful to determine the Customer Serving Area (CSA) for a given access speed tier.

Please feel free to request a copy of our BRX-VDSL2 Calculator User Guide (180-0171-001) for any assistance with using this tool.

## 3.5 Miscellaneous Other Placement Guidelines

### 3.5.1 Bonded Pairs

For convenience, the BRX Cloud Calculator does include an option (checkbox) for pair bonding. This feature assumes that the two loops are essentially identical and therefore doubles the resulting bandwidth for both downstream and upstream. In reality, bonded pairs are often not the same length. It is recommended to enter the longest loop in the calculator in order to optimize placement for this loop. Since the other loop is shorter, the resulting bandwidth resulting from the bonded pairs should be slightly better than what the calculator will predict.

### 3.5.2 Vectoring and VDSL2 Profile Selection

The BRX-VDSL2 devices fully support vectoring. They also support the following VDSL2 profiles: 17a, 8a, 8b and 8d. When using the BRX Cloud Calculator, you should make sure to set the vectoring and profile values that match the DSLAM settings for more accurate calculations.

### 3.5.3 Actual Raw Throughput is Different from Predicted Values

There will be times when actual raw throughput will be significantly different (>10%) from predicted values from the calculator. This may be caused by a number of factors. One of the most likely reason is that the Target SNR default value in the BRX Cloud Calculator (default set to 8 dB), is not the same as the one provisioned in the DSLAM. If that is the case, change the value in the Target SNR box to match the DSLAM setting. If this does not resolve the issue, then it may be because you are faced with “less than ideal” line conditions where the bandwidth is negatively impacted by bridge taps, influence from power lines and/or disturbances from other pairs or the use of other protocols in the same binder such as T1/E1, HDSL, and G.SHDSL. As a result, it is difficult to predict what the expected bandwidth will be but we recommend that you still follow the optimal placement recommended by the BRX Cloud Calculator for the actual loop length and gauge.

**Note**: In order to predict the expected bandwidth as accurately as possible, it is recommended to use the “Optimized Bandwidth Analysis” button in the lower right corner of the calculator and increase the loop length (and recalculate) until the “Raw Downstream Bandwidth” in column 4 is equal to what you are measuring. Once that is achieved, the amount indicated in column 6 entitled “With BRX-VDSL2 Downstream Bandwidth” should be a good estimate of what you can obtain.

**Note:** please refer to the BRX-VDSL2 Calculator Quick Start Guide (180-0171-001) for more details.

### 3.5.4 Minimum and Maximum Distance Values for the BRX Cloud Calculator

To facilitate the planning process, the BRX Cloud Calculator will provide a warning in red whenever a distance or loop length value entered does not meet the proper range of allowed values to ensure proper and useful performance. These criteria, for 24 AWG (0.51 mm) cables, are:

1) Minimum Loop Length from DSLAM to BRX-VDSL2 (L1) should be no less than: 2,000 feet (600 meters).
2) Minimum Loop Length from CPE to BRX-VDSL2 (L2) should be no less than: 500 feet (150m).

In addition, a red warning will pop up if the Total Loop Length is less than 4000 feet (1.2 km) or more than 8,000 feet (2.4 km) for the BRX-VDSL2 or 10,000 feet (3.0 km) for the BRX-VDSL2-X. It is important to note that the product is still operational but the amplification results will not be optimal outside of the recommended operating range.

1) Maximum distance for 25 / 4 Mbps service: 6000 feet (1.8 km) with BRX-VDSL2 or BRX-VDSL2-X
2) Maximum distance for 10 / 1 Mbps service: 8,000 feet (2.4 km) with BRX-VDSL2-X

# 4 Technical Specifications

| | BRX-VDSL2-2<br>BRX-VDSL2-X-2 | BRX-VDSL2-8<br>BRX-VDSL2-X-8 | BRX-VDSL2-24<br>BRX-VDSL2-X-24 |
|---|---|---|---|
| Subscribers | **2** | **8** | **24** |
| Dimensions | 9.25” x 5.5” x 1.5”<br>235mm x 140mm x 38mm | 11.5” x 5.5” x 4.7 “<br>(285 mm x 140 mm x 118 mm) | 21.3” x 13.5” x 10.6”<br>(541 mm x 343 mm x 269 mm) |
| Weight | 0.8 kg / 1.75 lbs. | 2.15 kg / 4.7 lbs. | 10.45 kg / 23 lbs. |

Table 3: Dimensions and weight

| | |
|---|---|
| Operating Temperature | -40°C to +65°C |
| Relative Humidity | 5% to 95% (Non-condensing) |
| xDSL Standards | ITU-T G.993.2 VDSL2<br>ITU-T G.993.5 (G.Vector)<br>ITU-T G.997.1 (G.ploam)<br>ITU-T G.998.4 (G.INP)<br>ITU-T G.992.5 ADSL2+ Annex A<br>ITU-T G.992.3 ADSL2 Annex A<br>ITU-T G.992.1 ADSL Annex A |
| PSD Mask | Compliant with ANSI T1.413 and ETSI TS 101 830-1 |
| Power Draw | • BRX-VDSL2: Maximum is 250 mW per pair<br>• BRX-VDSL2-X: Maximum is 650 mW per pair |
| Regulatory Compliance | UL/CSA, FCC part 15 Class A |
| Tip/Ring Over-voltage Protection | 2/10 µsec, 1 kA<br>8/20 µsec, 800A<br>10/160 µsec, 400A<br>10/700 µsec, 350A<br>10/560 µsec, 250A<br>10/1000 µsec, 200A |

Table 4: Technical specifications

# 5 Packaging Information and Port Density

The BRX-VDSL2 devices are available in 1, 2, 8 and 24 pair configurations.

## 5.1 BRX-VDSL2 1-pair & 2-pair packaging

The **BRX-VDSL2-1 / BRX-VDSL2-2** and **BRX-VDSL2–X-1 / BRX-VDSL2-X-2** share the same enclosure and can easily be mounted on a pole, attached to a strand wire or even installed in an existing cabinet or pedestal. These units share the following features:

- Sealed (IP65 / NEMA 4) enclosure
- Integrated Solid-State Primary Lightning Protection
- #6 Lug for grounding
- Gel-filled shielded cables
- Status LEDs: 2 LEDs per pair (DS = downstream / US = upstream)
    - (requires -48Vdc sealing current to turn on LEDs)

| | |
|---|---|
| **OFF** | No power |
| **RED: flashing** | Power too low, card reboot |
| **RED: on** | Power present but no DSL signal |
| **GREEN: flashing** | Auto- calibration acquiring gain |
| **GREEN: on** | Gain acquired |

- End-plate incorporates Pole Mount Bracket (also used to attach the strand mounting fixture kit
- Strand-Mount Fixture (Optional kit)

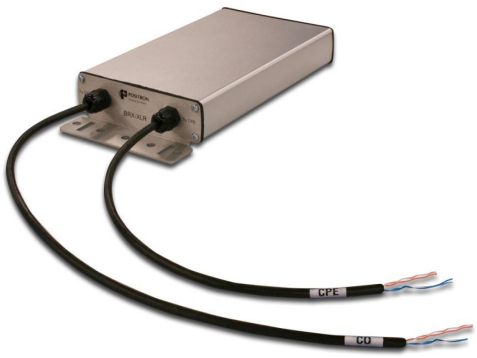

Figure 7: 1 and 2 pair BRX-VDSL2 devices.

Figure 8: Strand-mount option

In areas where more than 2 pairs need amplification, an 8-pair and a 24-pair enclosure can be used.

## 5.2 BRX-VDSL2 8-pair packaging

The BRX-VDSL2-8 / BRX-VDSL2-X-8 comes equipped with an IP65 enclosure that houses four (4) two-pair modules (as per image on the right below) for a total of eight (8) subscriber loops. Each BRX-VDSL2-M / BRX-VDSL2-X-M card has solid-state primary lightning protection for both pairs. In

cases where more than 2 but less than 8 pairs are required, it is possible to order an empty enclosure (BRX-8C) and the required number of 2-pair modules (BRX-VDSL2-M / BRX-VDSL2-X-M) that are required. Any empty slots in the BRX-8C may be filled with BRX-BYPASS-TEST modules to allow for the pre-wiring of all the pairs in and out of the BRX-8C enclosure.

Figure 9: 8 pair BRX-VDSL2 enclosure.

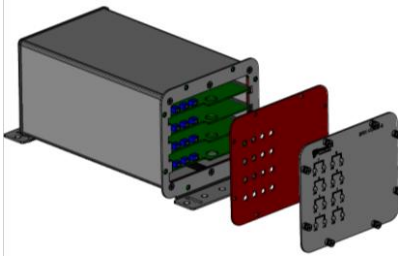

Figure 10: Opened 8-pair BRX-VDSL2 enclosure

The BRX-VDSL2 8-pair enclosure can be pole-mounted or strand-mounted using the same accessories as with the 1-pair and 2-pair BRX-VDSL2 enclosures described above (figure 8).

## 5.3 BRX-VDSL2 24-pair packaging

The BRX-VDSL2-24 / BRX-VDSL2-X-24 comes equipped with an IP65 enclosure that houses up to twelve (12) two-pair modules using the BRX-24S shelf (as per image on the right below) for a total of twenty-four (24) subscriber loops. Each BRX-VDSL2-M / BRX-VDSL2-X-M card has solid-state primary lightning protection for both pairs; where required, an optional 24-pairs IN and 24-pairs OUT protection module that can house standard 5-pin protector modules can be inserted as per figure 12 when it is standard practice to always use on additional gas tube protection for any OSP device. In cases where more than 2 but less than 24 pairs are required, it is possible to order an empty enclosure (BRX-24CS) and the required number of 2-pair modules (BRX-VDSL2-M / BRX-VDSL2-X-M) that are required. Any empty slots in the BRX-24CS may be filled with BRX-BYPASS-TEST modules to allow for the pre-wiring of all the pairs in and out of the BRX-24CS enclosure.

Figure 11: 24 pair BRX-VDSL2 enclosure

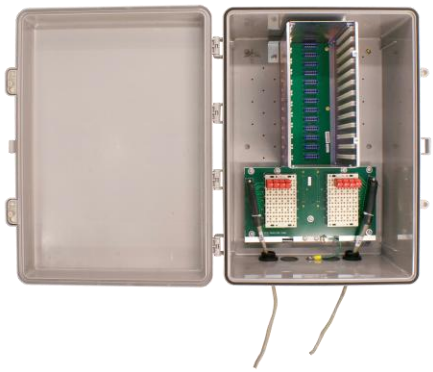

Figure 12: Opened 24-pair BRX-VDSL2 enclosure

**Note:** The BRX-24S can also be inserted in suitable 3rd party pedestal and enclosures with an IP65 or higher environmental rating. For instance, you can order the BRX-VDSL2-24-1SXPF (or BRX-VDSL2-24-

X-1SXPF) where an Emerson CAD-12 pedestal is factory installed with a BRX-24S, 12 BRX-VDSL2 modules and an optional cross-connect and protection module (figure 13). The Emerson CAD-12 pedestal can also be fitted with two (2) BRX-24S to amplify up to 48 pairs when you select the BRX-VDSL2-48-1SXPF (or BRX-VDSL2-X-48-1SXPF) version as per figure 14. Please refer to the BRX Product Selection Guide for more details.

Figure 13: BRX-VDSL2-24-1SXPF.

Figure 14: BRX-VDSL2-48-1SXPF

# 6 Installation and Operating Guidelines

## 6.1 General Requirements for the Outside Plant (OSP)

The BRX-VDSL2 devices are designed to be installed and operated as per the same guidelines and standard operating procedures used for typical VDSL2 loops.

- **Qualify/Condition the Line:** the copper loops must be qualified and conditioned for VDSL2 installations according to standard operator guidelines
- **Loaded/Non-loaded Loops.** Loops should be non-loaded although the BRX-VDSL2 device can operate with VDSL2-compliant loading coils
- **Bridged Taps**: all bridged taps should be removed for optimum performance
- **Insulation Resistance:** Tip-Ring, Tip-Ground and Ring-Ground Insulation Resistance should be greater than 5 Meg-Ohms
- **Longitudinal Balance.** Longitudinal balance should be greater than or equal to 60 dB
- **System Ground:** perform system ground per local company policies and practices
- **Loop Resistance:** the actual loop resistance between the DSLAM and the BRX-VDSL2 device should be verified at the time of the splicing
- **No Split Pairs:** ensure that the path does not have "split pairs" (tip on one pair and ring on the other) as it will induce plenty of crosstalk.

You should follow established standards for pair validation. The following check list can also be used to validate the pair(s).

| Test & Pass / Fail Criteria | Results |
|---|---|
| Power Influence - ≤ 80 dBrnC | |
| Noise - ≤ 20 dBrnC | |
| Tip to Ground, ≤ \|1.0 VDC | |
| Tip to Ring: 0 VDC | |
| Tip to Ground: < 5 VAC (should match Ring to Ground AC Voltage) | |
| Ring to Ground: : < 5 VAC (should match Tip to Ground AC Voltage) | |
| Tip to Ground Insulation Resistance Ohms ≥ 5 MΩ | |
| Ring to Ground Insulation Resistance Ohms ≥ 5 MΩ | |
| Tip to Ring Insulation Resistance Ohms ≥ 5 MΩ | |
| Longitudinal Balance ≥ 60 dB | |
| Load coils - If required, only use SMART Loading Coils | |
| Bridge Tap: No bridge tap should be found | |
| **Important Note: Please make sure the Test Set is set to VDSL2 Mode** | |

Table 5: Pre-installation checklist

## 6.2 POTS / Voice Lines

Voice (POTS) signal, when present, is transparently handled by the BRX-VDSL2. The BRX-VDSL2 incorporates a POTS splitter function to allow the POTS traffic to flow normally while the VDSL2 signals is amplified to obtain the best possible performance over the Outside Plant (OSP). When using a BRX-VDSL2-X version of the device, you will need to install a Positron BRX Power Injector to allow for proper POTS (dial tone) operation on the pair amplified by the BRX-VDSL2-X device if support for a POTS dial tone is required.

## 6.3 Equipment Connection Diagram

BRX-VDSL2 devices are typically deployed adjacent to a splice point facilitating the selection of the VDSL2 pair(s) requiring bandwidth amplification.

The following diagram illustrates how a BRX-VDSL2 device can be inserted between a DSLAM or MSAN and the subscribers it serves. Looking at the diagram below, the BRX-VDSL2 device is typically installed at a distance of 2,000-4,000 feet (0.6 to 1.2 km) from the DSLAM and provides increased bandwidth to a remote subscriber located up to 8,000 feet away (2.4 km) when using a BRX-VDSL2 version and (10,000 feet away (3.0 km) when using a BRX-VDSL2-X) on a 24 AWG (0.51 mm) copper loop.


Figure 15: inserting a BRX-VDSL2 device on a VDSL2 loop

*Where L1: BRX-VDSL2 connection to the DSLAM and L2: BRX-VDSL2 connection to the CPE Modem.*

BRX-VDSL2 devices are typically powered from the POTS sealing current (-48V) originating from the DSLAM or the Central Office (CO). This is illustrated by Figure 16 below:

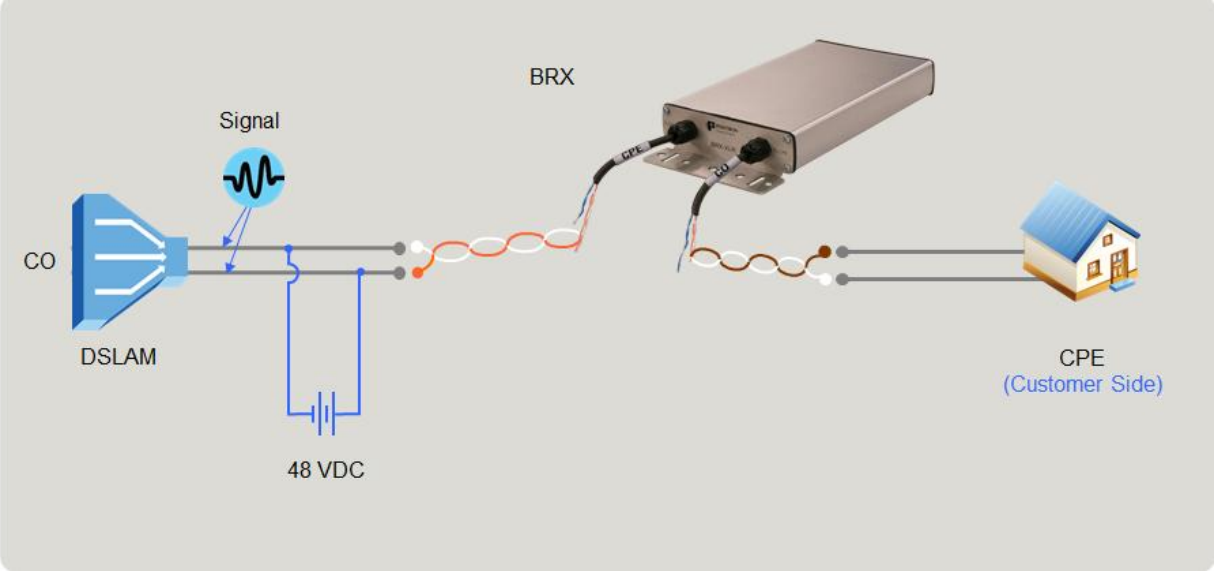


Figure 16: Using Sealing Current to power the BRX-VDSL2

The BRX-VDSL2 devices can also be powered from a Positron BRX Power Injector providing the required -48Vdc sealing current via the POTS combiner circuitry of the DSLAM. This is illustrated by Figure 17 below:

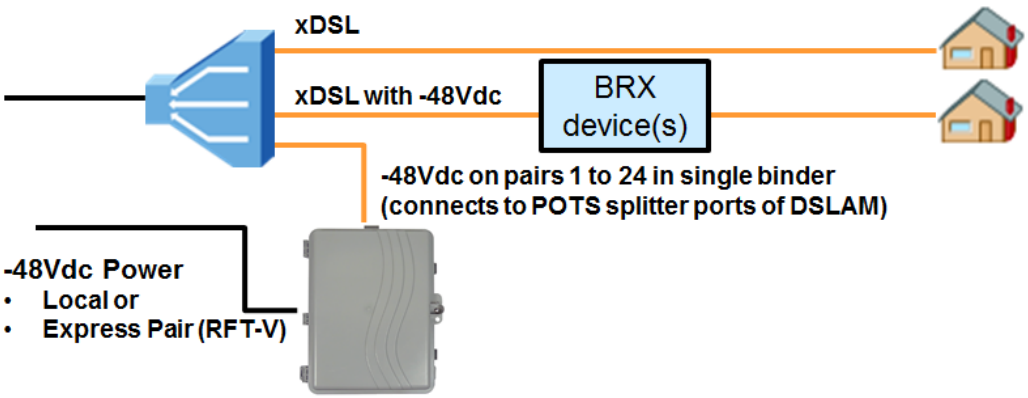


Figure 17: Using a Positron BRX Power Injector to power a BRX-VDSL2 device

# 7 Installation Procedure

## 7.1 Unpack

When unpacking the equipment, be sure to check the contents of the packaging for completeness against your purchase order. Notify your supplier immediately if any items are missing.

**Note: Please save packing material. All equipment returned must be packed with the original packing material.**

Be sure to inspect the equipment for shipping damage, including bent or loose hardware, and broken connectors. If the equipment appears to have been damaged in transit, please contact your delivery company.

## 7.2 Overview of the BRX-VDSL2 / BRX-VDSL2-X-2 enclosure

The BRX-VDSL2-2 / BRX-VDSL2-X-2 is a standalone unit enclosed in an IP65/NEMA 4 weather resistant enclosure. Please refer to the diagram below for a summary of the device.

***Note:*** *the BRX-VDSL2 -1 / BRX-VDSL2-X-1 shares the same enclosure and installation instructions as the 2-pair BRX-VDSL2 devices.*

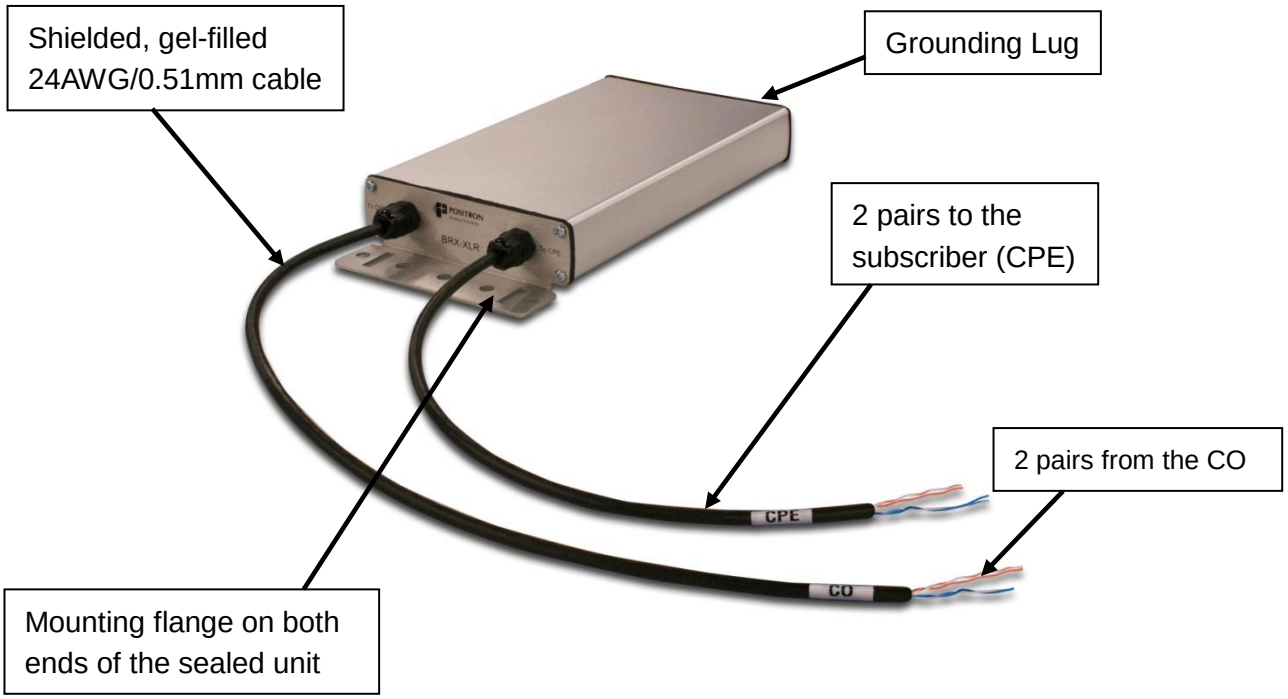


Figure 18: BRX-VDSL2 1 and 2 pair enclosure

## 7.3 Overview of the BRX-VDSL2-8 / BRX-VDSL2-X-8 enclosure

The BRX-VDSL2-8 / BRX-VDSL2-X-8 supports up to 4 BRX-VDSL2 modules enclosed in an IP65 / NEMA 4 weather resistant enclosure. Please refer to the diagram below for a summary of the device.

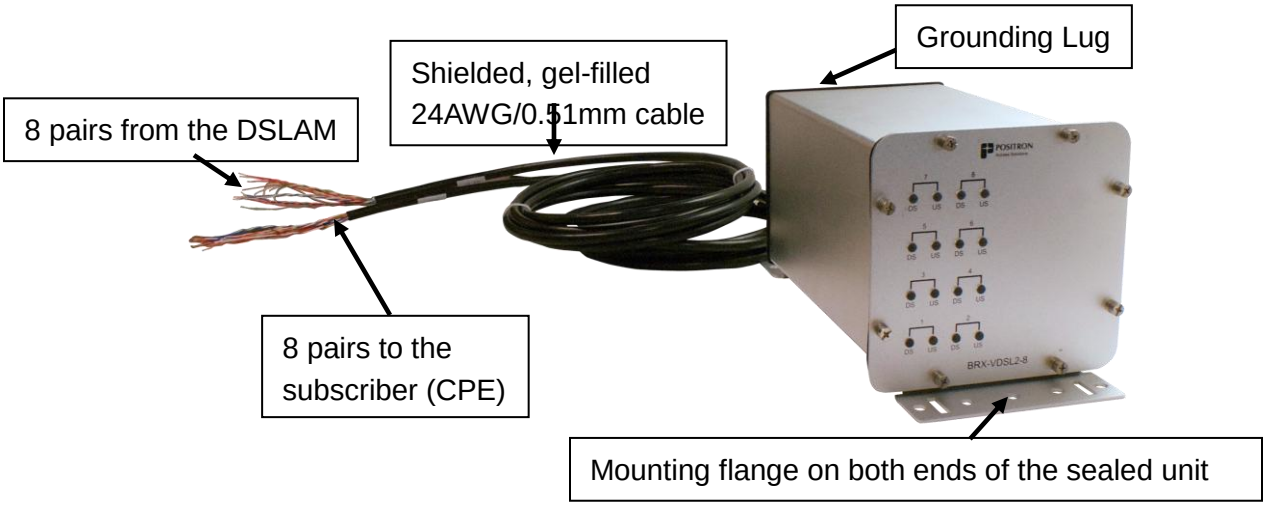


Figure 19: BRX-VDSL2 8-pair enclosure

## 7.4 Overview of the BRX-24S Chassis

The BRX-24S chassis is designed to host up to 12 BRX modules: BRX-VDSL2-M and BRX-VDSL2-X-M. The BRX-24S chassis is designed to be installed into an IP65 (or better) compliant outdoor enclosure such as the BRX-24C or BRX-1 (Emerson CAD-12) pedestal. Please refer to the diagram below for a summary of the chassis.

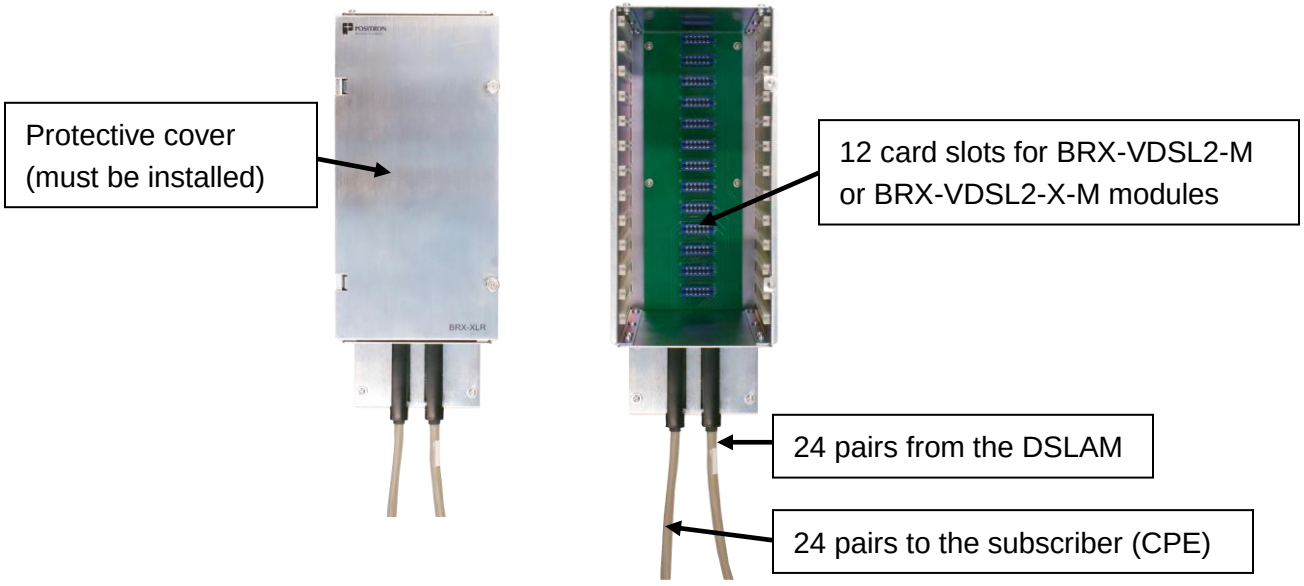


Figure 20: BRX-24S Chassis (with cover and without cover)

## 7.5 Step-by-step Installation Instructions

**Step 1**: select the location where the BRX-VDSL2 device will be inserted as per the guidelines in this document.

**Step 2**: connect the grounding lug of the unit to a proper ground (usually available near a splice point). *Please refer to section 8.1 for more details about bonding and grounding considerations.*

**Step 3:** when using an 8, 24 or 48 pair enclosure, insert the BRX-VDSL2-M or BRX-VDSL2-X-M modules in the slot matching the pair to amplify. The BRX module slots of the BRX-VDSL2-8 / BRX-VDSL2-X-8 enclosure are numbered from bottom to the top as per the following table:

| Slot Number | Pair Assignment | Pair Color (odd / even) |
|---|---|---|
| 4 (topmost slot) | 7 (left side), 8 (right side) | Red-Orange / Red-Green |
| 3 | 5 (left side), 6 (right side) | White-Slate / Red-Blue |
| 2 | 3 (left side), 4 (right side) | White-Green / White-Brown |
| 1 (bottom slot) | 1 (left side), 2 (right side) | White-Blue / White-Orange |

Table 6: BRX-VDSL2-8 / BRX-VDSL2-X-8 slot & pair assignment

The BRX module slots of the BRX-24S chassis are numbered from the top to the bottom as per the following table:

| Slot Number | Pair Assignment | Pair Color |
|---|---|---|
| 1 (topmost slot) | 1 (left side), 2 (right side) | White-Blue / White-Orange |
| 2 | 3 (left side), 4 (right side) | White-Green / White-Brown |
| 3 | 5 (left side), 6 (right side) | White-Slate / Red-Blue |
| 4 | 7 (left side), 8 (right side) | Red-Orange / Red-Green |
| 5 | 9 (left side), 10 (right side) | Red-Brown / Red-Slate |
| 6 | 11 (left side), 12 (right side) | Black-Blue / Black Orange |
| 7 | 13 (left side), 14 (right side) | Black-Green / Black-Brown |
| 8 | 15 (left side), 16 (right side) | Black-Slate / Yellow-Blue |
| 9 | 17 (left side), 18 (right side) | Yellow-Orange / Yellow-Green |
| 10 | 19 (left side), 20 (right side) | Yellow-Brown / Yellow-Slate |
| 11 | 21 (left side), 22 (right side) | Violet-Blue / Violet-Orange |
| 12 (bottom slot) | 23 (left side), 24 (right side) | Violet-Green / Violet-Brown |

Table 7: BRX-24S slot & pair assignment

**Step 4:** connect one of the CO pairs to a pair from the DSLAM

**Step 5**: connect the corresponding CPE pair to the pair toward the subscriber home

In steps 4 and 5, when connecting the pairs of the BRX-VDSL2 device, care should be taken to match the pair numbers as per the color codes in the tables of step 3 above.

***Note**: After step 5, the DSLAM and the CPE will retrain the circuit and bring up the VDSL2 link with the higher bandwidth.*

The pin-out of the RJ21 (Amphenol) cables to be used with the BRX-24S is defined below.

**BRX-24S RJ21 PINOUT**

| PIN NAME | PIN# | PIN# | PIN NAME |
|---|---|---|---|
| TIP1 | 1 | 26 | RING1 |
| TIP2 | 2 | 27 | RING2 |
| TIP3 | 3 | 28 | RING3 |
| TIP4 | 4 | 29 | RING4 |
| TIP5 | 5 | 30 | RING5 |
| TIP6 | 6 | 31 | RING6 |
| TIP7 | 7 | 32 | RING7 |
| TIP8 | 8 | 33 | RING8 |
| TIP9 | 9 | 34 | RING9 |
| TIP10 | 10 | 35 | RING10 |
| TIP11 | 11 | 36 | RING11 |
| TIP12 | 12 | 37 | RING12 |
| TIP13 | 13 | 38 | RING13 |
| TIP14 | 14 | 39 | RING14 |
| TIP15 | 15 | 40 | RING15 |
| TIP16 | 16 | 41 | RING16 |
| TIP17 | 17 | 42 | RING17 |
| TIP18 | 18 | 43 | RING18 |
| TIP19 | 19 | 44 | RING19 |
| TIP20 | 20 | 45 | RING20 |
| TIP21 | 21 | 46 | RING21 |
| TIP22 | 22 | 47 | RING22 |
| TIP23 | 23 | 48 | RING23 |
| TIP24 | 24 | 49 | RING24 |
| TIP25 | 25 | 50 | RING25 |

Table 8: BRX-24S RJ21 (Amphenol) pin-out

### 7.5.1 BRX-VDSL2-2 and BRX-VDSL2-8 Pole Mounting Option

The BRX-VDSL2 devices come with optional kits to facilitate mounting on a pole or to strand-mount the device (in-between 2 telephone poles).

The 2 and 8 pair BRX-VDSL2 enclosures can easily be screwed directly onto a standard telephone pole without the need for an additional mounting bracket. Using a metallic or plastic strap as per the diagrams below is convenient when you want to avoid having to screw the BRX-VDSL2 2-pair or 8-pair enclosure directly into the pole. In this case, insert a metallic or plastic strap into the rectangular slot (0.2" by 0.8" / 5 mm by 20.3 mm) in the mounting flange at both ends of the BRX-VDSL2 enclosure and secure around the pole as per the diagrams below.

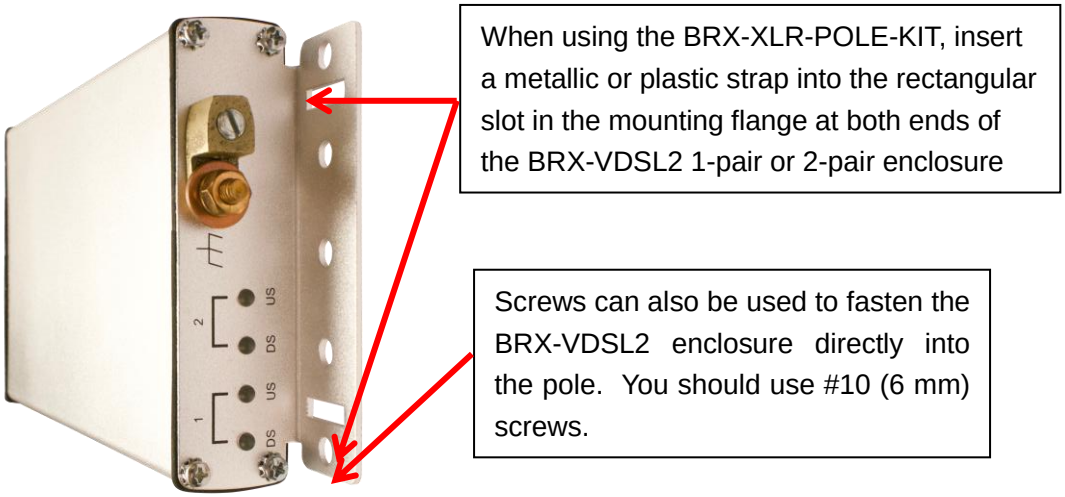


Figure 21: Pole Mount installation for BRX-VDSL2 1-pair and 2-pair enclosures

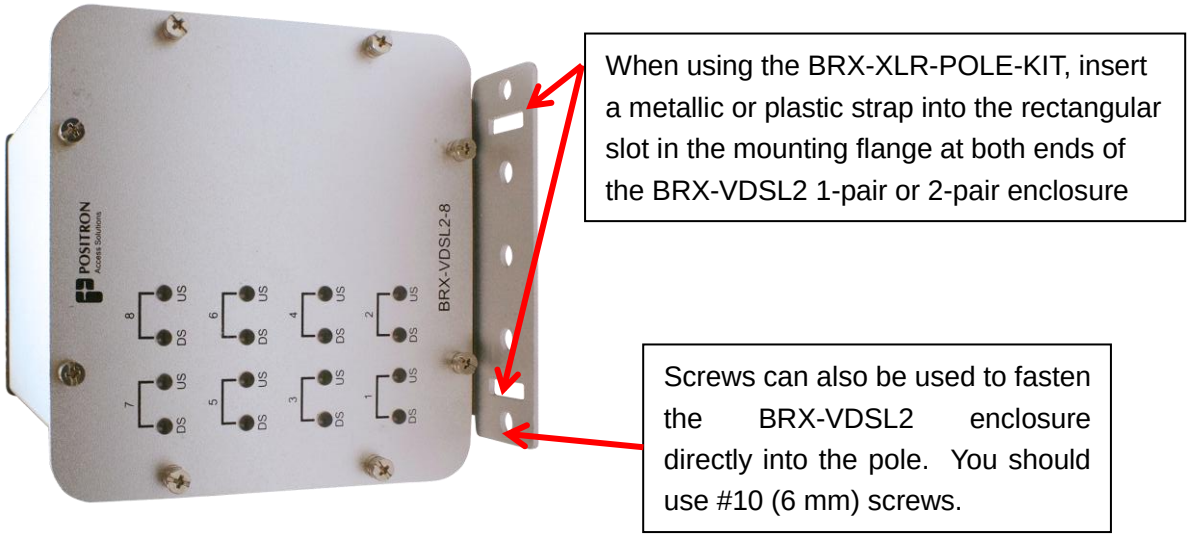


Figure 22: Pole Mount installation for BRX-VDSL2 8-pair enclosures

### 7.5.2 BRX-VDSL2 Strand Mounting Option

When using the BRX-STRAND-K, use the supplied nuts and bolts to affix the strand mount bracket into the circular slots in the mounting flange at both ends of the 1-pair, 2-pair or 8-pair BRX-VDSL2 enclosure as per the diagrams below. You can use any of the slots to adjust the strand mount bracket to clear any cables or devices already present.

- **Span** between the strand and the BRX-VDSL2 enclosure can vary from 3-9" (76 – 228 mm)
- **Strand Diameter** can range from ¼" (6.6 mm) to 3/8" (10 mm)
- **Bracket Material:** stamped from 5052 H34 Aluminum
- **Mounting Bolt:** Grade 2 steel and hot dip galvanized (as per ASTM A153)

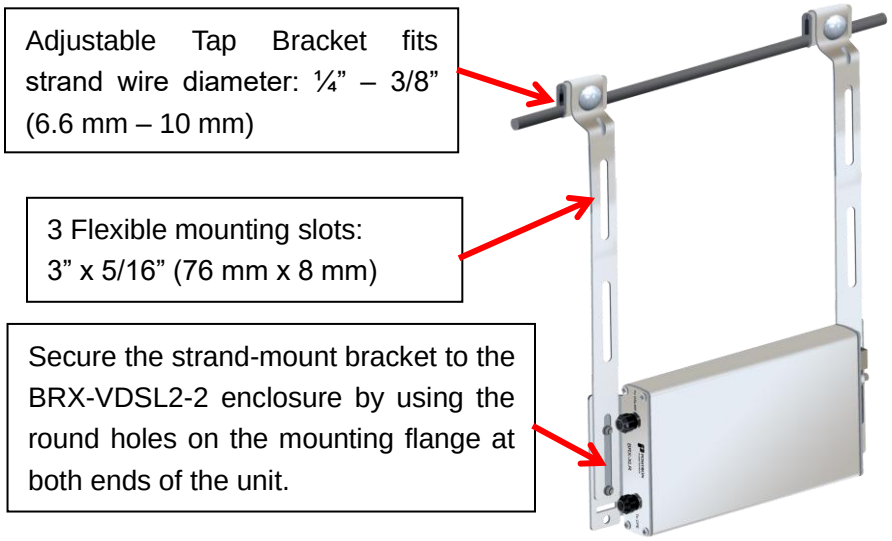


Figure 23: Strand Mount Kit option for 1-pair and 2-pair BRX-VDSL2 enclosures

Figure 24: Strand Mount Kit option for 8-pair BRX-VDSL2 enclosures

### 7.6 Splicing Pairs

When installing a BRX-VDSL2 device, it is important to follow the proper technique to ensure your safety and a good quality splice. You should follow the standard splicing Method and Procedure in place at your organization.

# 8 How to Mitigate the Impact of Disturbers

A number of factors have a negative impact on xDSL performance and will disturb the performance and the quality of service that can be delivered to subscribers.

Actual data rates between the DSLAM and the user CPE may be lower depending on the conditions of the outside plant (OSP) and the location where the BRX-VDSL2 device is installed. Other signals such as T1, E1, ISDN, HDSL and G.SHDSL in the same cable binders will typically reduce the achievable bandwidth on VDSL2 loops. Inserting a BRX-VDSL2 device on these VDSL2 pairs may help to reduce the impact of these disturbers.

## 8.1 Grounding and Bonding

Although grounding is usually observed within the cabinets or pedestal at the splice point, other sections of the cable pairs or binder may not be grounded. Grounding of the sheath also needs to be done properly. Grounding the BRX-VDSL2 devices is not sufficient to mitigate against power induction problems if the cable binder is not bonded or grounded since the noise will enter the pair at the non-grounded section and travel in the sheath and impact all of the pairs in the binder.

When aerial power lines (exceeding 300 volts) other than triplex cables servicing homes are in the same easement or alongside a crossover buried cable, the following grounding procedures are highly recommended. A ground ***with impedance less than 25 Ohms*** is required at both ends of an exposure and at every closure within the paralleling exposure. When the leads have minimal enclosures, additional enclosures may need to be placed so the frequency of grounds does not exceed 300 meters (1,000 feet).

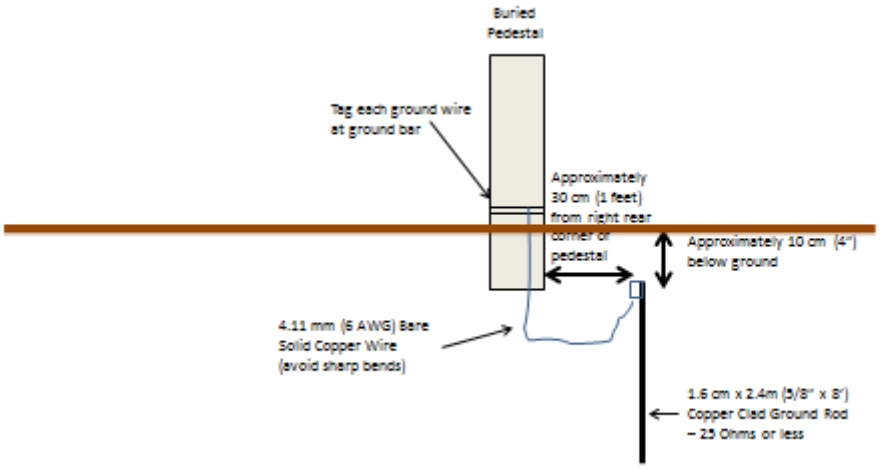


Figure 25: Grounding and Bonding

Whenever a telephone pedestal is placed within 2 meters (6 feet) of a power utility pole having a vertical multi-grounded neutral wire (MGNV) ***with impedance less than 25 Ohms***, it is highly recommended to also bond the enclosure (cabinet or pedestal) to the multi-grounded neutral wire.

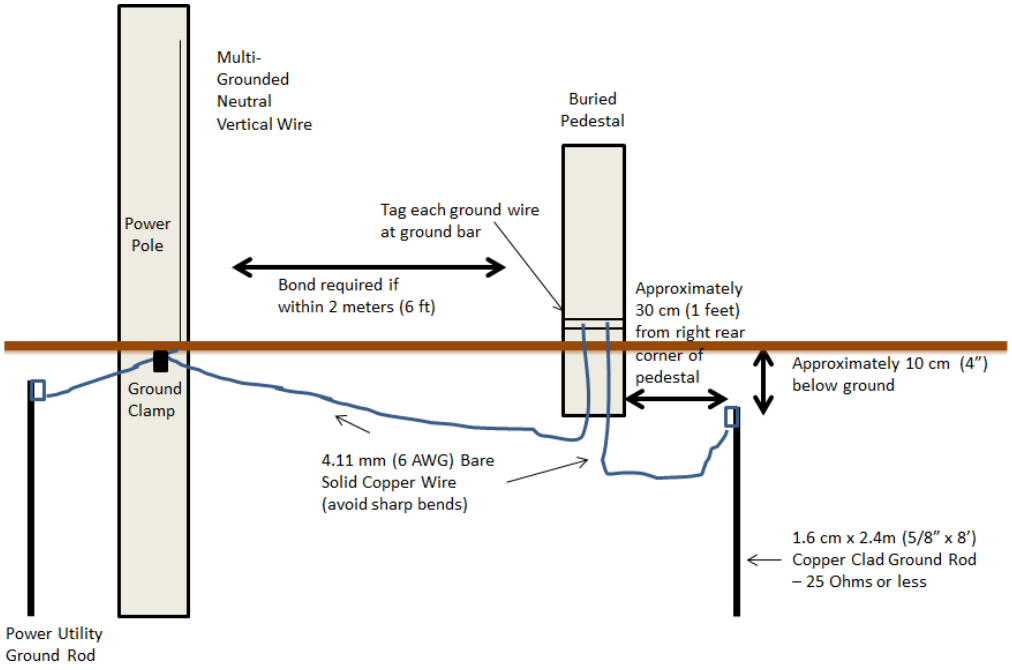


Figure 26: Grounding and Bonding next to Power Utility Pole

Each BRX-VDSL2 device mounted on a pole or installed directly on a strand are to have an effective ground. It is highly recommended to bond all lead sheathed cable and the shields of plastic sheathed cable together and bond to the grounded bonding ribbon.

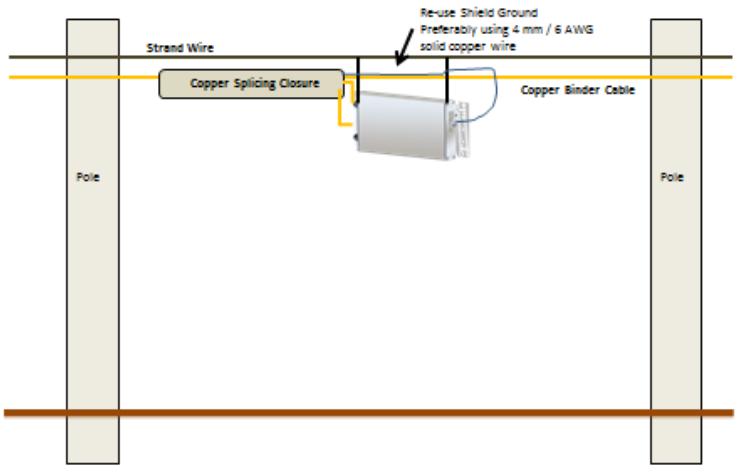


Figure 27: Grounding and Bonding Strand-Mount Units

## 8.2 Impulse Noise Protection

While the BRX-VDSL2 is very effective at mitigating the impact of longer loops and the resulting higher signal attenuation, there are other factors that will negatively impact the performance of a VDSL2 loop. The Impulse Noise Protection (INP) capabilities of the DSLAM help to mitigate the impact of noisy lines. Proper grounding and bonding of the equipment in the copper Outside Plant (OSP) can also help improve the quality and performance stability of copper loops. A symptom of a strong power influence is when AC voltage appears on Tip-Ring or Ring-Ground or Tip-Ground. Another potential problem is that copper pairs may not have been properly balanced. An unbalanced pair is more susceptible to Power induction and noise.

Based on the extensive field testing of the BRX-VDSL2 performed with Operators in very different regions, markets and countries, it has become obvious that the Impulse Noise Protection (INP) characteristic that is included in most DSLAMs (at least those that adhere to the G.993.2 VDSL2 standard) can significantly help to stabilize the bandwidth delivered to subscribers, resulting in an overall better Quality of User Experience.

For more information on this subject, please refer to Annex A, an excerpt from the Broadband Forum TR-176 document entitled “ADSL2Plus Configuration Guidelines for IPTV”.

# 9 Troubleshooting Guidelines

Please use the following table of common issues and suggested resolution whenever you are experiencing issues with a BRX-VDSL2 device.

**Note:** When using a VDSL2 Tester, you should set the test set to the suggested Profiles as per Annex C.

| Problem Description | Possible cause(s) |
|---|---|
| **A. Problem with VDSL2 training** | |
| 1. Upon installing the BRX-VDSL2, the DSLAM and CPE are no longer able to achieve synchronization | • Verify that DSLAM and CPE pairs are not mistakenly swapped. If the DSLAM/CPE pairs are reversed, the BRX-VDSL2 LEDs will still turn on but the VDSL2 loop will not train properly.<br>• Verify that there is POTS voltage on the DSLAM pair to power the BRX-VDSL2. The status LED of each pair of the BRX-VDSL2 provides a quick visual indicator of the presence of POTS voltage on the pairs.<br>• With the POTS circuit in the ON-HOOK state, the voltage measured between TIP and RING on the DSLAM pair at the BRX-VDSL2 should be greater than \|35Vdc\|.<br><br>If any of these measurements are not met, you should make the corrections as per your corporate standard procedure and re-verify. |
| 2. The user CPE loses synchronization with the DSLAM after the link was stable for at least several minutes | You should have the following equipment to help you troubleshoot the problem:<br>- VDSL2 Test Set<br>- Standard Telephone Test set and/or voltmeter<br><br>Follow the procedure below:<br>• Disconnect the subscriber house from the xDSL copper pair(s) at the NID, verify the synchronization with the DSLAM using the VDSL2 test set is achieved and stable.<br>• If the synchronization works well, the problem is likely with the in-house wiring or CPE. You should follow standard company practice for this type of problem.<br>• if the VDSL2 test set fails to establish steady synchronization with the DSLAM, record the following information during synchronization events before contacting the support desk of Positron Access Solutions:<br>- Downstream and Upstream SNR values<br>- Upstream and Downstream Bit Allocation Tables (BAT) |

| | |
|---|---|
| | - Line error status/counts (CES, ES, SES)<br>- Any error messages from the DSLAM and/or the VDSL2 test set |
| 3. The user CPE loses synchronization with the DSLAM when the phone goes off-hook | You should have the following equipment to help you troubleshoot the problem:<br>- Standard Telephone Test set and/or voltmeter<br><br>Verify the following measurements:<br>- Voltage in ON-HOOK state on the pair from the DSLAM and without the BRX-VDSL2 installed should be -40VDC to -60VDC<br>- Voltage in ON-HOOK state on the pair from the DSLAM with the BRX-VDSL2 installed should be -38VDC to -58VDC<br>- Voltage in the OFF-HOOK state on the pair from the DSLAM should be around 30VDC<br>- Loop current in OFF-HOOK state on the pair from the DSLAM should be at least 16 mA<br>- Loop current in the OFF-HOOK state on the pair toward the CPE should be at least 10 mA<br><br>If any of these measurements are not met, you should make the corrections as per your corporate standard procedure and re-verify.<br><br>**Note:** please note that the BRX-VDSL2-X series of VDSL2 amplifiers require the use of the Positron BRX Power Injector to properly support concurrent operation with a POTS service. |
| 4. The user CPE loses synchronization with the DSLAM when the phone goes on-hook | When going on-hook, it may cause a small impulse on the line, make sure you have INP enable in the DSLAM. Recommendation: US= 1 symbol, DS= 2 symbols |
| **B. Performance Problems: not achieving the expected bandwidth gains** | |
| 5. With the BRX-VDSL2 installed on the copper loop, the downstream and/or upstream performance is not meeting the expected improvement | • Verify the anticipated performance using the BRX Cloud Calculator tool (makes sure to properly specify the copper gauge)<br>• Verify that the actual BRX-VDSL2 location matches (more or less) the recommended location from the BRX Cloud Calculator considering the mix of various wire gauges<br>• Verify the Min/Target/Max SNR settings and Actual SNR values in the downstream and in the upstream direction. A Min SNR that is too low or a Max SNR that is too high may prevent SRA from working properly.<br>Verify that SRA is enabled to allow rate adaptation to take place and optimize the use of available bandwidth |

| | |
|---|---|
| | If any of the DSLAM settings are wrong, you should adjust them as per your corporate guidelines and retest. |
| 6. The DSLAM and/or CPE is reporting an unusually high number of CRC errors or Errored Seconds (ES) | • Enable Impulse Noise Protection (INP) and/or increase the number of symbols in the DSLAM impulse noise settings.<br>• Enable G.INP if supported by the modem (CPE)<br>• Increase target SNR by 2-3dB steps until error rate becomes acceptable. If the new SNR is too high (usually above 12 dB), the quality of the line will need to be verified |
| 7. The DSLAM and CPE successfully establish synchronization but the actual SNR is too low | • Adjust the DSLAM configuration for the target and minimum SNR in the downstream and upstream directions to the target SNR you are looking to obtain |
| 8. After inserting a BRX-VDSL2 on a copper loop, the performance of other VDSL2 pairs in the same binder is negatively impacted | The BRX-VDSL2 does impact adjacent copper pairs in the same binder when some pairs downstream from the location of the BRX-VDSL2 are not amplified.<br><br>Although the amplified signal from the BRX-VDSL2 is fully compliant with the allowed spectrum mask defined for VDSL2, the interference is the result of the amplified signal impacting the weaker signal from the DSLAM on adjacent pairs not amplified with a BRX-VDSL2. It is HIGHLY recommended to amplify all pairs beyond the installation point of the BRX-VDSL2. |
| 9. The performance of the pairs is unstable | Check for potential non-DMT signals in the binder such as T1 or E1, HDSL, SHDSL...<br><br>The presence of these disturbers is known to negatively impact the performance of VDSL2 and the disturbance should have been there prior to the installation of the BRX-VDSL2.<br><br>If you believe that the instability is the result of the installation of a BRX-VDSL2, please refer to the other issues covered in this table for the more likely source and the steps to remediate it. |

| | |
|---|---|
| **C. Power issues** | |
| 10. The BRX-VDSL2 unit does not seem to power up | • Verify that DSLAM and CPE pairs are not mistakenly swapped. If the DSLAM/CPE pairs are reversed, the BRX-VDSL2 LEDs will still turn on but the VDSL2 loop will not train properly.<br>• Verify that there is POTS voltage on the DSLAM pair to power the BRX-VDSL2. The status LED of each pair of the BRX-VDSL2 provides a quick visual indicator of the presence of POTS voltage on the pairs.<br>• With the POTS circuit in the ON-HOOK state, the voltage measured between TIP and RING on the DSLAM pair at the BRX-VDSL2 should be greater than \|35Vdc\|.<br><br>If any of these measurements are not met, you should make the corrections as per your corporate standard procedure and re-verify. |
| **D. Pair Bonding issues** | |
| 11. With the BRX-VDSL2 installed on 2 pairs (of the same bonding group), the DSLAM and CPE can't achieve the expected bandwidth (downstream and/or upstream) | • Verify the DSLAM settings for each pair in the bonding group and make sure they are the same<br>• Verify the loop length of each pair. Significant differences between pairs will induce jitter/latency which will impact the achievable total bandwidth<br>• All pairs in the bonding group need to be amplified by a BRX-VDSL2 module/device at the same location<br><br>If any of these measurements are not met, you should make the corrections as per your corporate standard procedure and re-verify. |
| **E. Telephone (POTS) issues** | |
| 12. Dial tone is intermittent or not present | You should have the following equipment to help you troubleshoot the problem:<br>- Standard Telephone Test set<br><br>**Note**: Problems with dial tone is almost always associated with a loop current that is too low. In such case, the DSLAM / CO will not detect the OFF-HOOK state and won't apply dial tone to the line.<br><br>• Disconnecting the house at the NID and with the BRX-VDSL2 device installed on the copper loop, verify the presence of a dial tone in OFF-HOOK state. If there is a steady dial tone, the problem is with the house wiring. Reconnect the NID to |

| | |
|---|---|
| | the house and follow corporate practice to rectify the issue.<br>• Using the telephone test set, verify that the loop current at the DSLAM pair of the BRX-VDSL2 when in the OFF-HOOK state is high enough (>16 mA). If not, verify the cabling between the DSLAM and the BRX-VDSL2.<br>• Using the telephone test set, verify that the loop current at the CPE pair of the BRX-VDSL2 in the OFF-HOOK state is high enough (> 10mA) and that the voltage on the DSLAM BRX-VDSL2 pair is greater than 30VDC. If one of these two conditions is not met, the BRX-VDSL2 is in fault. Please reach out to Positron Access Solutions customer support for assistance.<br>• Using the telephone test set, verify that the loop current at the CPE pair at NID location in the OFF-HOOK state is high enough (> 10mA). If not, there may be issue in the cabling from the BRX-VDSL2 to the NID.<br><br>**Note:** please note that the BRX-VDSL2-X series of VDSL2 amplifiers require the use of the Positron BRX Power Injector to properly support concurrent operation with a POTS service.<br><br>If any of the above measurements are not met, you should make the corrections as per your corporate standard procedure and re-verify. |
| 13. The telephone (POTS) does not ring | • Verify that the correct grade of lightning protectors have been installed at the NID. Improper grade may clip the ringing signal.<br>• Verify that the lightning protectors at the NID are in good working condition. Blown protectors would short the line making the POTS malfunction.<br>• Note the REN number for each phone connected to the line and sum them all. If the sum is higher than 5, the high number of phones is loading the line during ringing phase. Disconnect phones one by one until the number get below 5.<br>• While ringing, measure the AC rms voltage at the NID. The reading should be between 40Vrms to 105Vrms |

| | |
|---|---|
| 14. There is a humming noise on the telephone (POTS) that was not present before installing the BRX-VDSL2 | You should have the following equipment to help you troubleshoot the problem:<br>- VDSL2 Test Set from vendors such as: JDSU, EXFO …<br>- Standard Telephone Test set<br><br>• With the house disconnected at the NID and the BRX-VDSL2 installed on the copper pair, verify if the audible hum noise is still present. If the noise disappears then the problem is with the house wiring.<br>• Verify that the TIP-ground AC voltage matches the RING-ground voltage and that the level is less than 5VAC rms. If not, common 60Hz noise may convert as audible noise on the line.<br>• Verify that the longitudinal balance is greater than 60dB.<br>• Verify that the Power Noise measured on the line is lower than 80dBrnc<br>• Verify that the Circuit Noise measured on the line is lower than 20dBrnc<br>• Verify that the BRX-VDSL2 chassis grounding is properly made. Bad grounding may reduce unit shielding efficiency and translate into higher noise coupling.<br><br>**Note:** please note that the BRX-VDSL2-X series of VDSL2 amplifiers require the use of the Positron BRX Power Injector to properly support concurrent operation with a POTS service.<br><br>If the measurements for the copper pair do not match the above guidelines, please follow the corporate procedure to rectify the situation and verify again if the problem is still present. |

Table 9: BRX-VDSL2 Troubleshooting

# 10 Warranty and Customer Service

Positron Access Solutions will replace or repair this product within the warranty period if it does not meet its published specifications or fails while in service. Warranty information can be found in your Positron Access customer web portal: http://www.positronaccess.com/Portal.php

**Positron Access Solutions Sales Pricing/Availability and Technical Support**
US and Canada: 1-888-577-5254
International: +1-514-345-2220
customerservice@positronaccess.com

**Repair and Return Address**
Contact Customer Service prior to returning equipment to Positron.
Telephone US and Canada: 1-888-577-5254 option 6
International: +1-514-345-2220 option 6

# 11 Ordering Information

The BRX-VDSL2 and BRX-VDSL2-X are available in multiple configurations. The table below summarizes the more popular configurations. Please refer to the BRX Product Selection Guide (see document 180-0170-001) for all of the available configuration options as well as ancillary parts.

| Outdoor IP65 Assemblies | |
|---|---|
| BRX-VDSL2-1 | BRX-VDSL2 1-pair module with solid state primary lightning protection enclosed in IP65 enclosure |
| BRX-VDSL2-2 | BRX-VDSL2 2-pair module with solid state primary lightning protection enclosed in IP65 enclosure |
| BRX-VDSL2-8 | BRX-VDSL2 8-pair enclosure for up to 4 BRX-VDSL2-M modules with solid state primary lightning protection enclosed in IP65 enclosure |
| BRX-VDSL2-24 | BRX-VDSL2 24-pair enclosure for up to 12 BRX-VDSL2-M modules with solid state primary lightning protection enclosed in IP65 enclosure |
| BRX-VDSL2-X-1 | BRX-VDSL2-X (high power) 1-pair module with solid state primary lightning protection enclosed in IP65 enclosure |
| BRX-VDSL2-X-2 | BRX-VDSL2-X (high power) 2-pair module with solid state primary lightning protection enclosed in IP65 enclosure |
| BRX-VDSL2-X-8 | BRX-VDSL2-X 8-pair enclosure for up to 4 BRX-VDSL2-X-M modules with solid state primary lightning protection enclosed in IP65 enclosure |
| BRX-VDSL2-X-24 | BRX-VDSL2-X 24-pair enclosure for up to 12 BRX-VDSL2-X-M modules with solid state primary lightning protection enclosed in IP65 enclosure |
| Ancillary Parts | |
| BRX-STRAND-K | Strand-mounting kit; for use with BRX-VDSL2 / BRX-VDSL2-X 2-pair and 8 pair enclosures (see above) |

Table 10: Ordering Information

# Annex A

## Excerpt on Impulse Noise from Broadband Forum
## TR-176: ADSL2Plus Configuration Guidelines for IPTV

*Impulse noise is defined as electrical interference that occurs in short bursts. It may be caused by any number of sources, from large motors to arc welders, improper AC power and grounding to consumer electronic devices not performing to normal EMC design requirements. These types of disturbers cause an electrical impulse that is brief but powerful and may temporarily interfere with transmission on the DSL circuit.*

*ADSL2plus Profiles offer a parameter for defining the minimum amount of Impulse Noise Protection. At the transmission layer, DMT symbols are of fixed duration of 250 microseconds. The INPMin parameter defines the minimum number of DMT symbols that will be protected from impulse noise and thus the minimum duration of impulse noise from which error correction should be able to recover. To provide maximum error protection, INPMin should be set as high as possible without unduly compromising bit-rates and latency. It should be noted that Service Providers have discovered that 8ms delay may not adequately protect against Repetitive Electrical Impulse Noise REIN in 60Hz regions due to sub-optimal conditions including but not limited to imperfect waveforms and variance in the repetition of REIN. Under these circumstances, 7ms may be more appropriate.*

*There is a direct relation between INPMin and symbol rate such that higher values of INPMin will restrict the DSL circuit to a lower maximum bit rate. This relationship is dependent in part on the interleaving capabilities of the DSL chipsets at both ends of the DSL line (S, D, framing parameters and interleaving memory). There is also a relationship between INPMin and the delay incurred as higher INPMin values require more buffering and thus incur longer delay. INP defines the maximum number of successive corrupted DMT symbols that can be corrected within the duration corresponding to the delay. As a result, an INP of 2 can correct up to two successive DMT symbols during one delay period. As an impulse of 250µs duration can occur randomly compared to DMT symbols, it will generally corrupt two DMT symbols. So an INP of 2 will fully protect against 250µs max impulsive noise. An INP of 1 or lower will give some protection but without a guarantee concerning the duration of pulses.*

*As can be expected, there is an interaction between fixed FEC parameters (interleaving depth and delay) and INP setting.* ***Low delay and high INP can actually help stabilize a DSL connection (the low delay being counter intuitive)****. However, such a setting forces the FEC parity ratio (R/N) to values like 1/3 or 1/2, so lots of errors in every code word are corrected (so if the line is not extremely long it is possible to use the extra bits it nominally could carry without impulse to actually counteract the impulse). Alternative ranges of such INP/delay can be useful but should be tested since there can be a wide variation of support between vendors.*

*Changing the value of INP and/or Delay influences the error correction capability of the Reed-Solomon code. The ability to improve the line protection against impulsive noise has to be traded-off against increased FEC parity ratio and hence lower achievable net data rate. More specifically the INP (expressed in symbols) and Delay (in msec) are related to the FEC parity ratio by the following equation:*

***FEC parity ratio = ½ * (INP/Delay)***

*The FEC parity ratio is a component of the total overhead that will exist on the line. The tables below, from ITU-T G.992.5 Annex K, illustrate how the net data rate is affected as the INP Min and Max-delay are varied. The bitrates in these tables represent theoretical maximums which are not necessarily achievable with real DSL equipment but rather provide guidance to theoretical ceilings in bitrates for the corresponding parameters. Service Providers are encouraged to undertake testing on the actual ADSL2plus equipment that they plan to use in order to determine more realistic achievable net data rates.*

| | | INP_min | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | ½ | 1 | 2 | 4 | 8 | 16 |
| delay_max [ms] | 1 (Note) | 24432 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 24432 | 7104 | 3008 | 960 | 0 | 0 | 0 |
| | 4 | 24432 | 15232 | 7104 | 3008 | 960 | 0 | 0 |
| | 8 | 24432 | 22896 | 15232 | 7104 | 3008 | 960 | 0 |
| | 16 | 24432 | 22896 | 15232 | 7552 | 3520 | 1472 | 448 |
| | 32 | 24432 | 22896 | 15232 | 7552 | 3712 | 1728 | 704 |
| | 63 | 24432 | 22896 | 15232 | 7552 | 3712 | 1728 | 704 |
| NOTE – In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$. | | | | | | | | |

Table 11: Maximum Downstream Attainable Rate, no Extended Framing Parameters

| | | INP_min | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | ½ | 1 | 2 | 4 | 8 | 16 |
| delay_max [ms] | 1 (Note) | 29556 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 29556 | 25718 | 20928 | 7616 | 0 | 0 | 0 |
| | 4 | 29556 | 27613 | 25718 | 21093 | 7616 | 0 | 0 |
| | 8 | 29556 | 27809 | 26042 | 22244 | 14455 | 8112 | 0 |
| | 16 | 29556 | 27809 | 26042 | 22244 | 14455 | 8112 | 4024 |
| | 32 | 29556 | 27809 | 26042 | 22244 | 14455 | 8112 | 4024 |
| | 63 | 29556 | 27809 | 26042 | 22244 | 14455 | 8112 | 4024 |
| NOTE – In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$. | | | | | | | | |

Table 12: Maximum Downstream Attainable Rate with 16K Interleaving and Extended Framing Parameters

| | | INP_min | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | ½ | 1 | 2 | 4 | 8 | 16 |
| delay_max (ms) | 1 (Note) | 29556 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 29556 | 25718 | 20928 | 7616 | 0 | 0 | 0 |
| | 4 | 29556 | 27612 | 25718 | 21092 | 7616 | 0 | 0 |
| | 8 | 29556 | 28394 | 27217 | 24703 | 19092 | 8112 | 0 |
| | 16 | 29556 | 28394 | 27217 | 24703 | 19092 | 10844 | 4024 |
| | 32 | 29556 | 28394 | 27217 | 24703 | 19092 | 10844 | 5393 |
| | 63 | 29556 | 28394 | 27217 | 24703 | 19092 | 10844 | 5393 |
| NOTE – In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$. | | | | | | | | |

Table 13: Maximum Downstream Attainable Rate with 24K Interleaving and Extended Framing Parameters

# Annex B

## Positron Access Solutions – Pair Validation Guidelines

| Test & Pass / Fail Criteria | Results |
|---|---|
| **Circuit and Pair ID** | |
| Power Influence - ≤ 80 dBrnC | |
| Noise - ≤ 20 dBrnC | |
| Tip to Ground, ≤ \|1.0 VDC | |
| Tip to Ring: 0 VDC | |
| Tip to Ground: < 5 VAC (should match Ring to Ground AC Voltage) | |
| Ring to Ground: : < 5 VAC (should match Tip to Ground AC Voltage) | |
| Tip to Ground Insulation Resistance Ohms ≥ 5 MΩ | |
| Ring to Ground Insulation Resistance Ohms ≥ 5 MΩ | |
| Tip to Ring Insulation Resistance Ohms ≥ 5 MΩ | |
| Longitudinal Balance ≥ 60 dB | |
| Load coils - If required, only use SMART Loading Coils | |
| Bridge Tap: No bridge tap should be found | |

**Important Note: Please make sure the Test Set is set to VDSL2 Mode**

Table 14: Pre-installation checklist

# Annex C

## Recommended VDSL2 Line Test Profile Parameters

When using a VDSL2 tester, we recommend you set the device as per one of the following profile.

| **Setting** | **VDSL2 Line Test Profile** | |
|---|---|---|
| Transmission System | G.993.2 | |
| Trellis Coding | Enabled | |
| Reed Solomon | Enabled | |
| S=1/2 | Enabled | |
| SRA | Enabled | |
| SRA Downshift Interval | 30 seconds | |
| SRA Upshift Interval | 30 seconds | |
| **Parameter** | **DOWNSTREAM** | **UPSTREAM** |
| Maximum Bitrate | 100 Mbps | 50 Mbps |
| Minimum Bitrate | 32 Kbps | 32 Kbps |
| Maximum Delay | 8 msec | 8 msec |
| Impulse Noise Protection (INP) | 2 | 1 |
| Maximum SNR Margin | 16.0 dB | 16.0 dB |
| Target SNR Margin | 8.0 dB | 8.0 dB |
| Minimum SNR Margin | 2.0 dB | 2.0 dB |
| SNR Margin Upshift | 9.0 dB | 9.0 dB |
| SNR Margin Downshift | 5.0 dB | 5.0 dB |
| Bit Swapping | Enabled | Enabled |

Table 15: Recommended VDSL2 Test Set Profile