POSITRON
Access Solutions

BRX-XLR

Broadband Reach eXtender – Extra Long Reach

User Guide

July 2019

Publication Information

BRX-XLR
User Guide

Publication date: July 2019
Printed in Canada

Published By
Positron Access Solutions Corporation
5101 Buchan Street, Suite 220
Montreal, Quebec, Canada
H4P 2R9
Telephone US and Canada: 1-888-577-5254
International: +1-514-345-2220

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

The BRX-XLR 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.

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

The BRX-XLR 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.

Les produits BRX-XLR 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.

Europe - EU Declaration of Conformity

The BRX-XLR models comply with the essential requirements of the EMC Directive 2014/30/EU and Low Voltage Directive 2014/35/EU. The following test methods have been applied in order to prove presumption of conformity with the essential requirements of the EMC Directive 2014/30/EU and Low Voltage Directive 2014/35/EU:

CSA C22.2#60950-1: Issued: 2007/03/27 Ed: 2 (R2012) Information Technology Equipment Safety Part 1: General Requirements; Amendment 1: 2011, Amendment 2: 2014

UL 60950-1: Issued: 2007/03/27 Ed: 2 Rev: 2014/10/14 Information Technology Equipment Safety Part 1: General Requirements

IEC 60950-1: Issued: 2013/05/28 Ed: 2.2 Information Technology Equipment - Safety - Part 1: General Requirements; Consolidated Edition. Ed. 2: 2005

IEC 60950-22 Issued: 2005/10/20 Ed: 1 Information Technology Equipment -Safety -Part 22: Equipment to be Installed Outdoors

CSA 22.2 No. 60950-22-07 (R2016) Issued: 2007/04/23 Ed: 1 Information Technology Equipment - Safety -Part 22: Equipment to be Installed Outdoors (Bi-National standard, with UL 60950-22)

UL 60950-22 Issued: 2007/04/23 Ed: 1 Information Technology Equipment -Safety -Part 22: Equipment to be Installed Outdoors

EN 55022: 2010: Information technology equipment - Radio disturbance characteristics Limits and methods of measurement

EN 55024: 2010: Information technology equipment - Immunity characteristics - Limits and methods of Measurement

EN 55032: 2012: Electromagnetic compatibility of multimedia equipment - Emission Requirements

English	Hereby, Positron Access Solutions Corp. declares that the BRX-XLR models are in compliance with the essential requirements and other relevant provisions of Directive 2014/30/EU and 2014/35/EU.
Français	Par la présente Positron Access Solutions Corp. déclare que les modèles BRX-XLR sont conformes aux exigences essentielles et aux autres dispositions pertinentes selon les normes 2014/30/EU and 2014/35/EU.

Safety

The following BRX-XLR 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-XLR-2, BRX-XLR-8, BRX-XLR-24 sealed units along with the following factory installation of a BRX-24S chassis in a UL approved pedestal: BRX-XLR-24-1SF, BRX-XLR-24-1-SPF, BRX-XLR-24-1-SXPF, BRX-XLR-48-1SF, BRX-XLR-48-1-SPF, BRX-XLR-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-XLR 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-XLR-2, BRX-XLR-8, BRX-XLR-24 dans leur boitier scellés ainsi que les configurations incorporant un châssis BRX-24S assemblées en usine dans un piédestal certifié UL: BRX-XLR-24-1SF, BRX-XLR-24-1-SPF, BRX-XLR-24-1-SXPF, BRX-XLR-48-1SF, BRX-XLR-48-1-SPF, BRX-XLR-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 the BRX-XLR models. Never use power injector devices not 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-XLR-2 devices. Do not attempt to open the unit. Doing so may damage the seals and prevent the unit from meeting IP65. Rain water may leak into the unit and damage its electronics leading into either its malfunction or its total failure. The BRX-XLR-2 units 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-XLR 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-XLR 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-XLR 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 – Extra Long Reach (BRX-XLR) is a fully integrated solution that extends the reach of deployed ADSL / ADSL2+ DSLAMs or MSANs to deliver higher bandwidth services to underserved or unserved markets. For example, it extends the reach of a 10 Mbps downstream service from 9,100 feet (2.8km) to 12,500 feet (3.8 km) on 26 AWG / 0.40mm gauge copper, an increase of almost 40%, and the same level of increase is achieved for larger size cables. Furthermore, this 40% 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.

Another way to look at the benefits of this same function is that a client that is situated at 12,500 feet (3.8 km) from the DSLAM, on a 26 AWG (0.40mm) copper pair will see the downstream bandwidth increase from approximately 5 Mbps to over 10 Mbps. Over longer distances, the bandwidth improvement ratio is between 2 and 5. 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.

2 BRX-XLR Main Advantages

- Extends up to 100% the ADSL/ADSL2/ADSL2+ Customer Serving Area (CSA)
- Improve effective bandwidth typically by a ratio of 2 to 5 for ADSL/ADSL2/ADSL2+ loops
- No extra power required. The BRX-XLR uses less than 2mA from the -48V sealing current of the POTS line.
- 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-XLR

The BRX-XLR automatically adjusts itself to optimize performance. The BRX-XLR provides gain (amplification) of the signal (in the xDSL band only) in the downstream and upstream direction, always within the acceptable signal strength allowed by the xDSL standards for the Spectrum Mask of ADSL2+ and ADSL. As such, the amplification gain is higher on longer loops (i.e. loops where the attenuation of the signal is greater due to the longer loop length). A key factor in its performance is that the BRX-XLR significantly improves the signal to noise ratio seen by the CPE (in the downstream direction) and the DSLAM (in the upstream direction).

The following chart illustrates how the performance gain increases over the length of copper loops. For clarity, we are using the notion of a Bandwidth Improvement Ratio to illustrate the benefits of installing a BRX-XLR device on a copper pair. The ratio is calculated as the bandwidth using the BRX-XLR divided by the RAW bandwidth (i.e. without BRX-XLR). For instance, improving a pair from 5 Mbps to 10 Mbps would represent a Bandwidth Improvement Ratio of 2.0 (10 divided by 5).

Note: The curve is based on the use of 26 AWG (0.40mm gauge) copper wire. To convert to larger cables sizes, multiply the loop length by 1.374 for 24 AWG (0.51mm) and 1.844 for 22 AWG (0.64mm) cables.

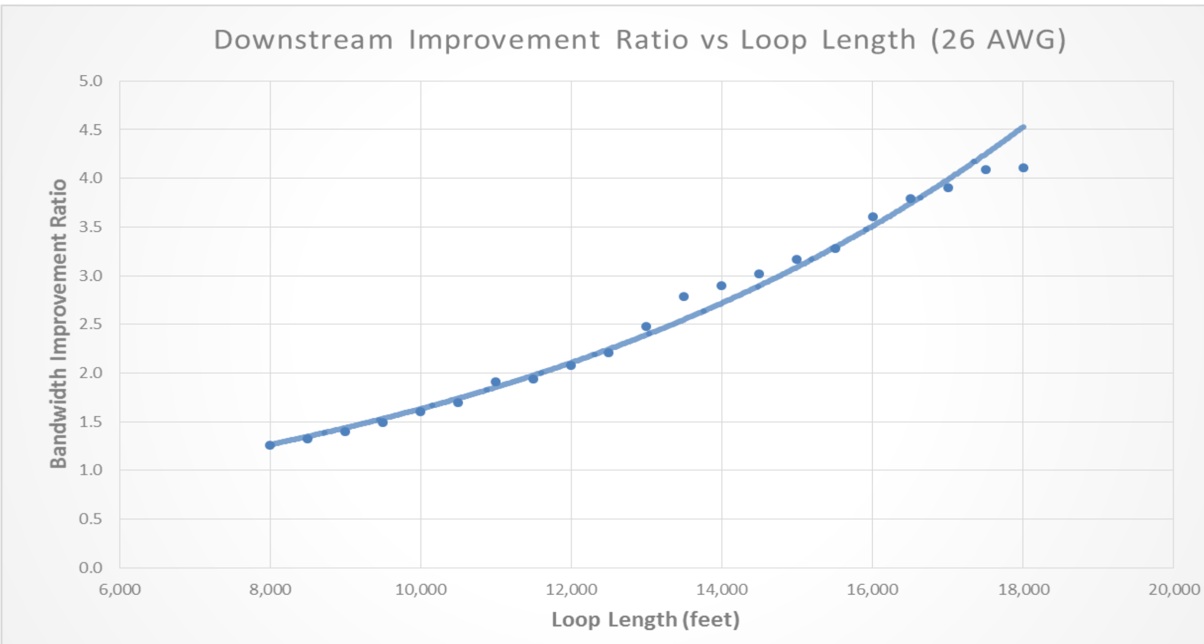

Figure 1: Downstream Improvement Ratio vs Loop Length (feet)

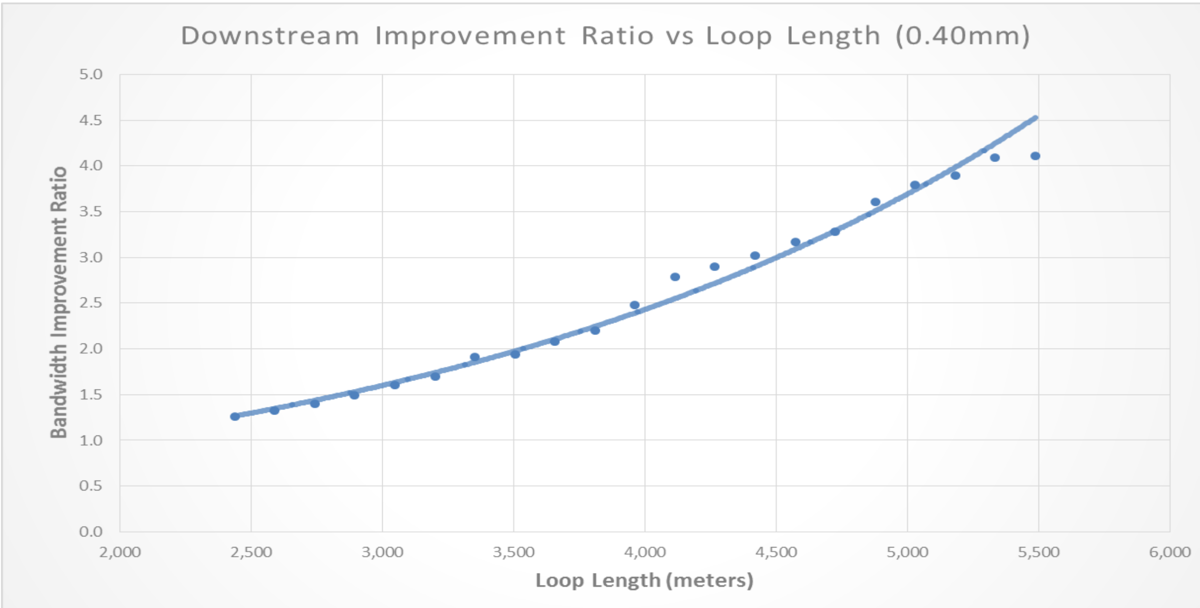

Figure 2: Downstream Improvement Ratio vs Loop Length (meters)

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

BRX-XLR Downstream Performance Increase (Typical Lines)					
Loop Length (feet)	Loop Length (meters)	Gauge AWG / (mm)	Without BRX-XLR (Mbps)	With BRX-XLR (Mbps)	Improvement Ratio
10,000	3,048	26 / 0.40	8.98	14.42	1.61
12,000	3,658	26 / 0.40	5.87	12.20	2.08
14,000	4,267	26 / 0.40	3.30	9.57	2.90
16,000	4,877	26 / 0.40	1.93	6.96	3.61
18,000	5,486	26 / 0.40	1.07	4.40	4.11

Table 1: Downstream Performance Increase Examples (Typical Lines)

Another way to view the benefits of the BRX-XLR is to look at the graph below which demonstrates the actual bandwidth performances (with and without BRX-XLR) as it relates to loop length using 26 AWG / 0.4mm copper gauge. Again, to convert to larger cable sizes, multiply the loop length by 1.374 for 24 AWG (0.51mm) and 1.844 for 22 AWG (0.64mm) cables.

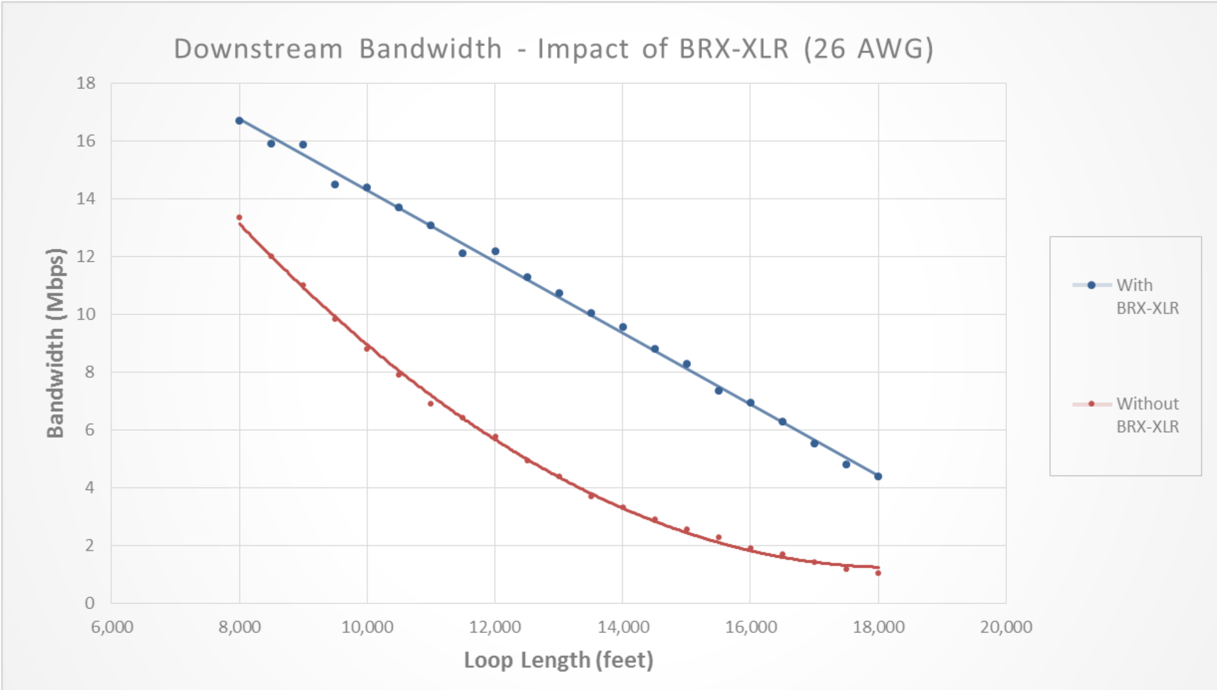

Figure 3: Bandwidth vs. Loop Length (feet) with and without BRX-XLR

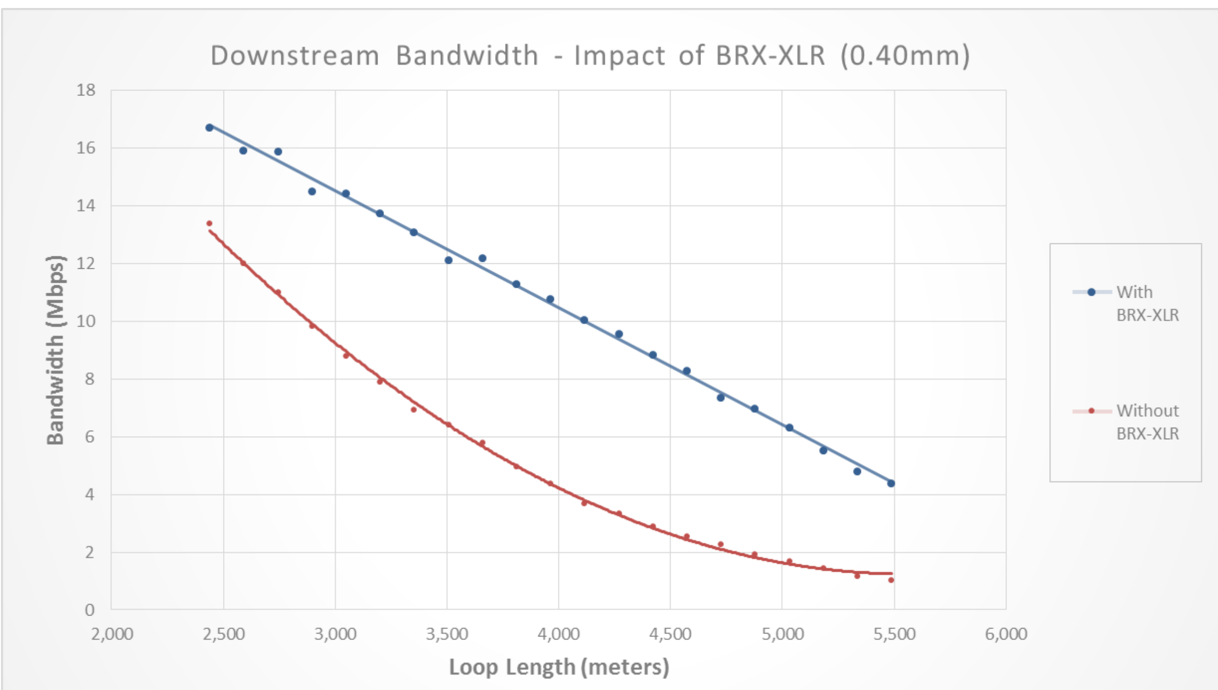

Figure 4: Bandwidth vs. Loop Length (meters) with and without BRX-XLR

It should be noted that the 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. Our field experience has shown that the BRX-XLR provides 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 Typical Increases in Customer Serving Area

The following table provides the maximum distance extension to support a 10 Mbps downstream target bandwidth on a single copper pair for the three most popular cable sizes.

Maximum Distance for 10Mbps Service with 1-Pair							
Cable Gauge		Without BRX-XLR		With BRX-XLR		% Increase	
AWG	mm	k feet	km	k feet	Distance	Distance	Serving Area
26	0.40	9.1	2.8	12.5	3.8	38%	91%
24	0.51	12.5	3.8	17.0	5.2		
22	0.64	16.8	5.1	23.0	7.0		

Table 2: Maximum Distance for 10 Mbps Service with 1-pair

Similarly, the following table provides the maximum distance extension to support a 5 Mbps downstream target bandwidth on a single copper pair for the three most popular cable sizes. The same distances can provide a 10 Mbps service over two pairs.

Maximum Distance for 5 Mbps Service with 1-pair or 10Mbps with 2-Pairs							
Cable Gauge		Without BRX-XLR		With BRX-XLR		% Increase	
AWG	mm	k feet	km	k feet	Distance	Distance	Serving Area
26	0.40	12.5	3.8	17.0	5.2	38%	91%
24	0.51	16.8	5.1	23.0	7.0		
22	0.64	22.5	6.9	31.0	9.4		

Table 3: Maximum Distance for 5Mbps Service with 1-pair or 10 Mbps with 2-pairs

3.3 BRX-XLR Placement Flexibility

Over and above the performance gains, one of the major advantages of the BRX-XLR over other products is that its placement along the loop is very flexible and does not impose hard constraints when choosing the location where it should be installed. For instance, on a 26 AWG (0.4mm) loop of 12,500 feet / 3.8 km, placing the BRX-XLR anywhere between 6,000 feet / 1.8 km and 9,000 feet / 2.7 km away from the DSLAM will deliver 10 Mbps to the customer.

In fact, the BRX-XLR is designed to offer very similar performance gains whenever it is deployed at a distance that ranges from 45-75% of the total loop distance (away from the DSLAM). The graph below illustrates the **minimum** performance gain that can be expected when the BRX-XLR is placed anywhere in this range.

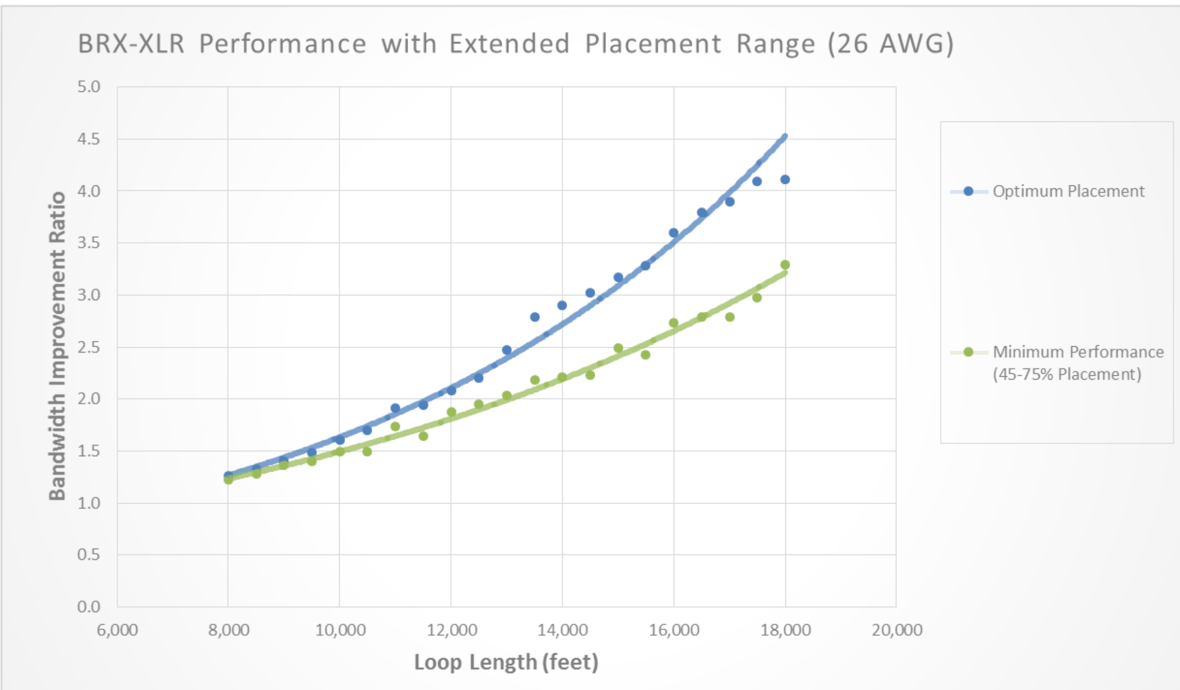

Figure 5: BRX-XLR Performance Improvement with Extended Placement Range (feet)

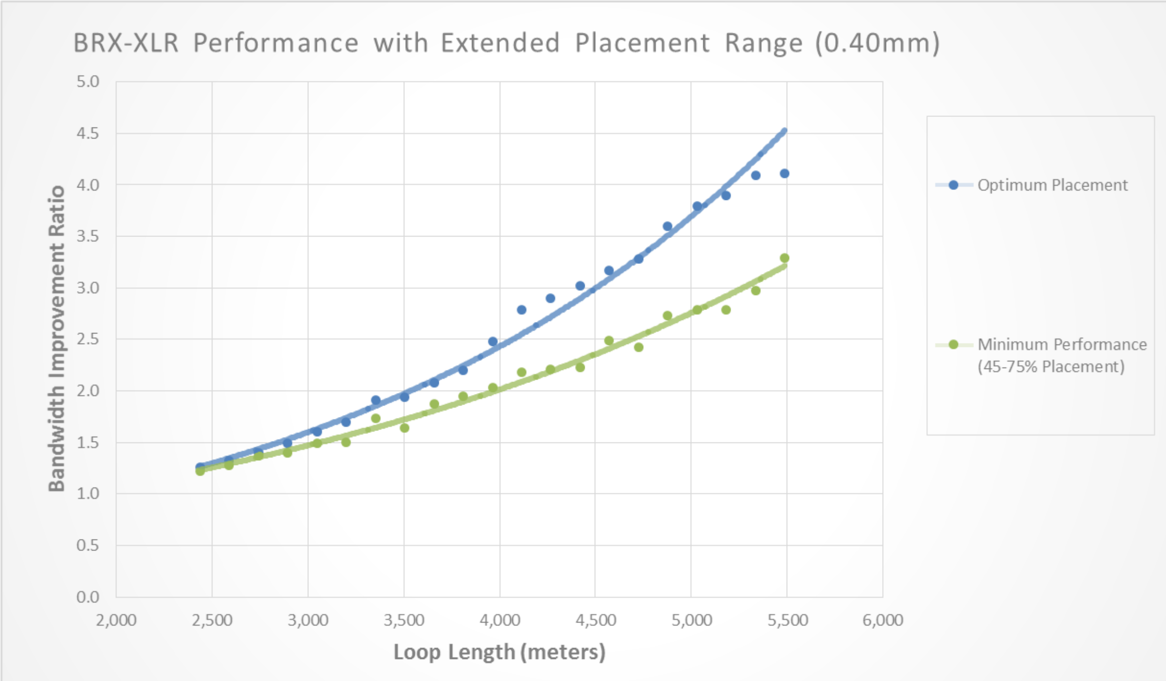

Figure 6: BRX-XLR Performance Improvement with Extended Placement Range (meters)

Note: The above diagrams are based on 26 AWG (0.40mm) copper gauge. To convert to larger cables sizes, multiply the loop length by 1.374 for 24 AWG (0.51mm) and 1.844 for 22 AWG (0.64mm) cables.

The following table summarizes the Optimum placement for BRX-XLR devices for typical loop lengths in 26 AWG (0.4mm) and 24 AWG (0.5 mm) gauge copper loops.

Loop Length (k feet / km)	Raw Downstream Bandwidth (Mbps)	Amplified Downstream Bandwidth (Mbps)	Improvement Ratio	Optimum Placement distance from DLSAM (k feet / km)
26 AWG (0.40mm) Cable				
9.8 / 3.0	9	14	1.56	6.6 / 2.0
13.1 / 4.0	4	10.5	2.63	7.9 / 2.4
16.4 / 5.0	1.7	6.3	3.71	9.2 / 2.8
24 AWG (0.51mm) Cable				
13.1 / 4.0	10	14.5	1.45	8.5 / 2.6
18.0 / 5.5	4	10.5	2.63	10.8 / 3.3
23.0 / 7.0	1.5	6	4.00	12.8 / 3.9

Table 4: Optimum Placement of BRX-XLR for Typical Loop Lengths

3.4 Optimum Placement

Although the placement of the BRX-XLR is very flexible, the curves in section 3.3 above demonstrate that there is value in properly planning the placement to optimize performance. The following curve demonstrates the optimum placement of the BRX-XLR relative to total loop length.

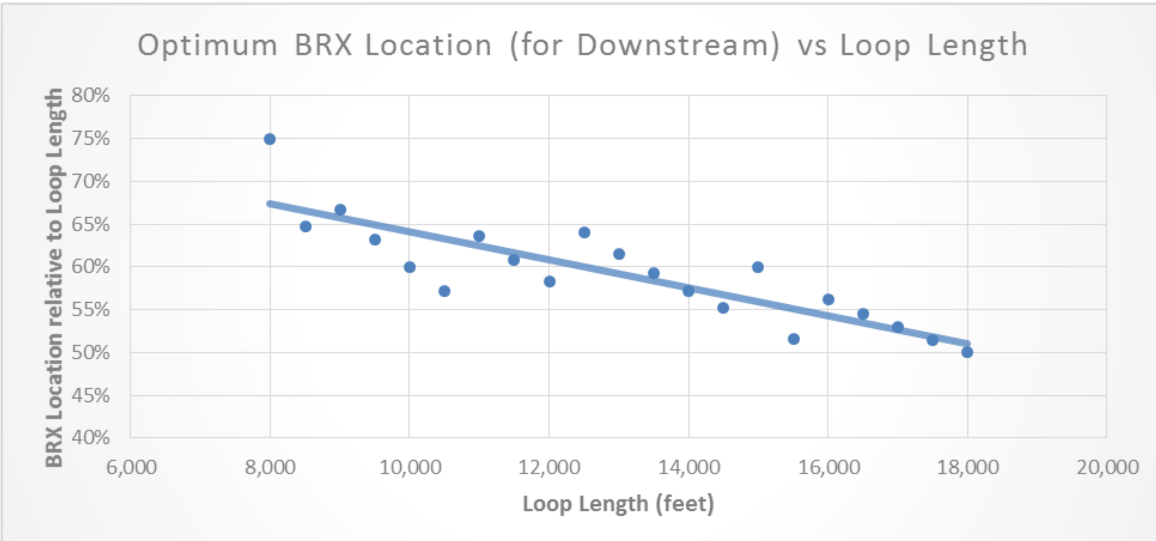

Figure 7: Optimum BRX-XLR Placement vs Loop Length (feet)

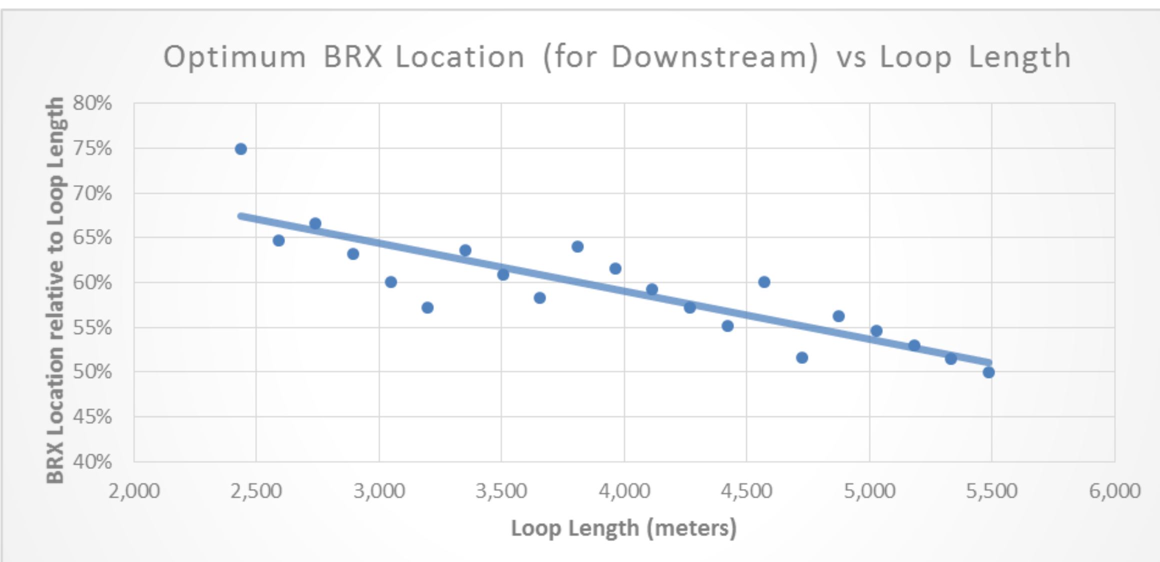

Figure 8: Optimum BRX-XLR Placement vs. Loop Length (meters)

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 the BRX-XLR 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.

3.5 BRX Cloud Calculator

To view the impact related to the installation of a BRX-XLR 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-XLR (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-XLR should be installed (usually a range of distances from the DSLAM) to achieve the target bandwidth;
- Calculate the best placement of a BRX-XLR cabinet to achieve a target bandwidth to multiple subscribers over a total loop length. 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-XLR Calculator Quick Start Guide (180-0157-001) for any assistance with using this tool.

3.6 Miscellaneous Other Placement Guidelines

3.6.1 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.

3.6.2 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 (set to 6dB), 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. Our field experience has shown that the BRX-XLR provides even better Improvement Ratios (i.e. Bandwidth Enhancement) when such conditions are present. 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-XLR Downstream Bandwidth" should be a good estimate of what you can obtain.

3.6.3 Minimum and Maximum Values for the BRX-XLR

To facilitate the planning process, the BRX Cloud Calculator will provide a warning in red whenever a number is entered that does not meet a minimum value that would ensure proper and useful performance. These criteria, for 26AWG (0.4mm) cables, are:

1) Minimum Loop Length from DSLAM to BRX-XLR (L1) should be no less than: 5,000 feet (1.5km).
2) Minimum Loop Length from CPE to BRX-XLR (L2) should be no less than: 500 feet (150m).

In addition, a red warning will pop up if the Total Loop Length is more than 18,000 feet (5.5 km). It is important to note that the product is still operational and useful beyond this distance if a bandwidth below 4 Mbps is acceptable, for instance:

1) Maximum distance for a 2.5 Mbps service (or 5Mbps with pair bonding): 19,000 feet (5.8 km)
2) Maximum distance for a 1.0 Mbps service (or 2Mbps with pair bonding): 20,000 feet (6.1 km)

4 Technical Specifications

	BRX-XLR-2	BRX-XLR-8	BRX-XLR-24
Subscribers	2	8	24
Dimensions	9.25” x 5.5” x 1.5” 235mm x 140mm x 38mm	11.5” x 5.5” x 4.7 “ (285 mm x 140 mm x 118 mm)	21.3” x 13.5” x 10.6” (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 4: Dimensions and weight

Operating Temperature	-40°C to +65°C
Relative Humidity	5% to 95% (Non-condensing)
xDSL Standards	ITU G.992.5 ADSL2+ Annex A ITU G.992.3 ADSL2 Annex A ITU G.992.1 ADSL Annex A
PSD Mask	Compliant with ANSI T1.413 and ETSI TS 101 830-1
Power Draw	Maximum power drawn is 150 mW per pair from the -48V sealing current from the DSLAM/ MSAN
Regulatory Compliance	UL/CSA, FCC part 15 Class A and CE Mark
Tip/Ring Over-voltage Protection	2/10 µsec, 1 kA 8/20 µsec, 800A 10/160 µsec, 400A 10/700 µsec, 350A 10/560 µsec, 250A 10/1000 µsec, 200A

Table 5: Technical specifications

5 Packaging Information and Port Density

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

5.1 BRX-XLR-1 and BRX-XLR-2 packaging

The **BRX-XLR-1** and **BRX-XLR-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
- End-plate incorporates Pole Mount Bracket (also used to attach the strand mounting fixture kit
- Strand-Mount Fixture (Optional kit)

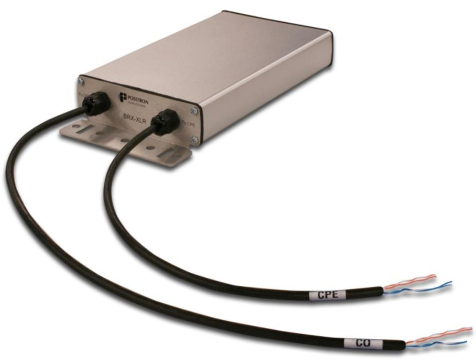

Figure 9: 1 and 2 pair BRX-XLR devices.

Figure 10: 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-XLR-8 packaging

The BRX-XLR-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-XLR-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 BRX-XLR-M 2-pair modules 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.

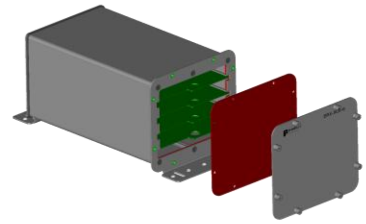

Figure 11: 8 pair BRX-XLR-8 enclosure.

Figure 12: Opened BRX-XLR-8 enclosure

The BRX-XLR-8 enclosure can be pole-mounted or strand-mounted using the same accessories as with the BRX-XLR-1 and BRX-XLR-2 enclosures described above (figure 10).

5.3 BRX-XLR-24 packaging

The BRX-XLR-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-XLR-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 gas tube modules can be inserted as per figure 14 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 BRX-XLR-M 2-pair modules 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.

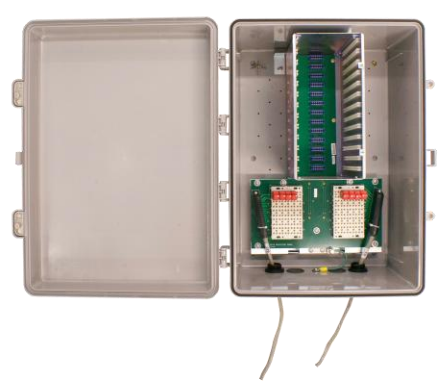

Figure 13: BRX-XLR-24 enclosure

Figure 14: Opened BRX-XLR-24 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-XLR-24-1SXPF where an Emerson CAD-12 pedestal is factory installed with a BRX-24S, 12 BRX-XLR-M modules and an optional cross-connect and protection module (figure 15). 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-XLR-48-1SXPF version as per figure 16. Please refer to the BRX Product Selection Guide for more details.

Figure 15: BRX-XLR-24-1SXPF.

Figure 16: BRX-XLR-48-1SXPF

6 Installation and Operating Guidelines

6.1 General Requirements for the Outside Plant (OSP)

The BRX-XLR is designed to be installed and operated as per the same guidelines and standard operating procedures used for typical ADSL and ADSL2+ lines.

- **Qualify/Condition the Line:** the copper loops must be qualified and conditioned for ADSL/ADSL2/ADSL2+ installations according to standard operator guidelines
- **Loaded/Non-loaded Loops.** Loops should be non-loaded although the BRX-XLR can operate with xDSL-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-XLR 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 ADSL Mode	

Table 6: Pre-installation checklist

6.2 POTS / Voice Lines

Voice (POTS) signal, when present, is transparently handled by the BRX-XLR. The BRX-XLR incorporates a POTS splitter function to allow the POTS traffic to flow normally while the ADSL2+/ADSL signals are amplified to obtain the best possible performance over the Outside Plant (OSP).

6.3 Equipment Connection Diagram

The BRX-XLR is typically deployed adjacent to a splice point facilitating the selection of the xDSL pairs that require having the bandwidth increased or not.

The following diagram illustrates how the BRX-XLR can be inserted between a DSLAM or MSAN and the subscribers it serves. Looking at the diagram below, the BRX-XLR is typically installed at a distance of 5,000-10,000 feet (1.5 to 3 km) from the DSLAM and provides increased bandwidth to a remote subscriber located up to 18,000 feet away (5.5 km) on a 26 AWG (0.40 mm) copper loop.

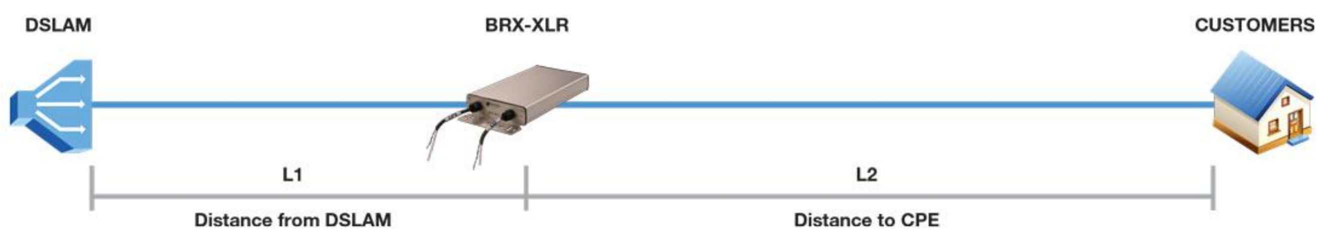

Figure 17: BRX-XLR connection diagram

L1: BRX-XLR connection to the DSLAM.
L2: BRX-XLR connection to the CPE Modem.

The BRX-XLR needs to be powered from the POTS sealing current (-48V) originating from the DSLAM or the Central Office (CO). This is illustrated by Figure 18 below:

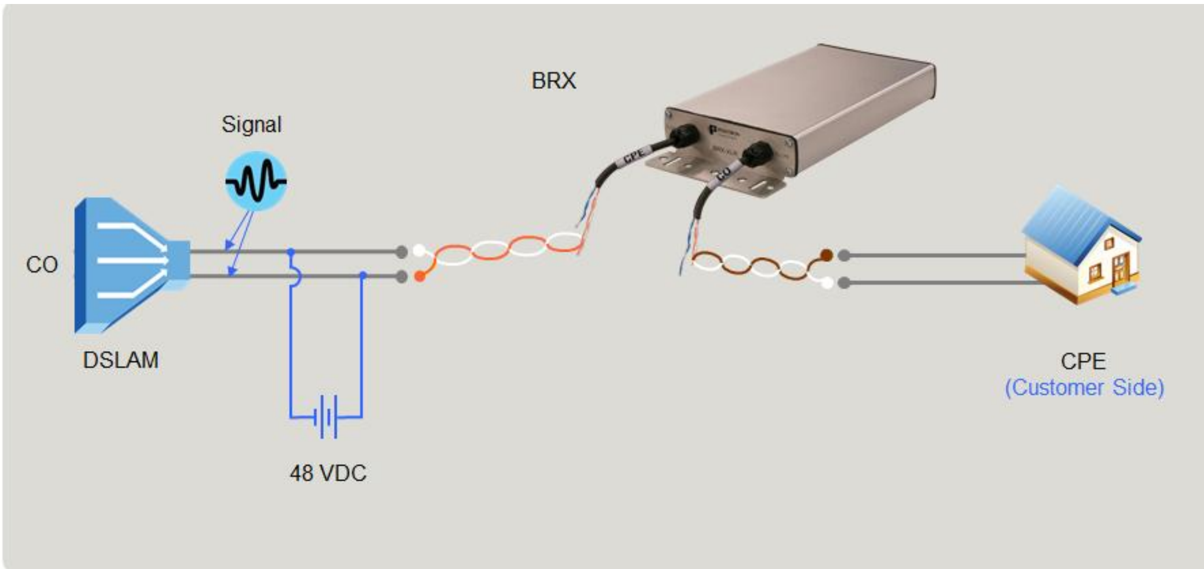

Figure 18: Using Sealing Current to power the BRX-XLR

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-XLR-1 and BRX-XLR-2

The BRX- BRX-XLR-2 standalone units are enclosed in an IP65/NEMA 4 weather resistant enclosure. Please refer to the diagram below for a summary of the device.

Note: *the BRX-XLR -1 shares the same enclosure and installation instructions as the BRX-XLR-2 devices.*

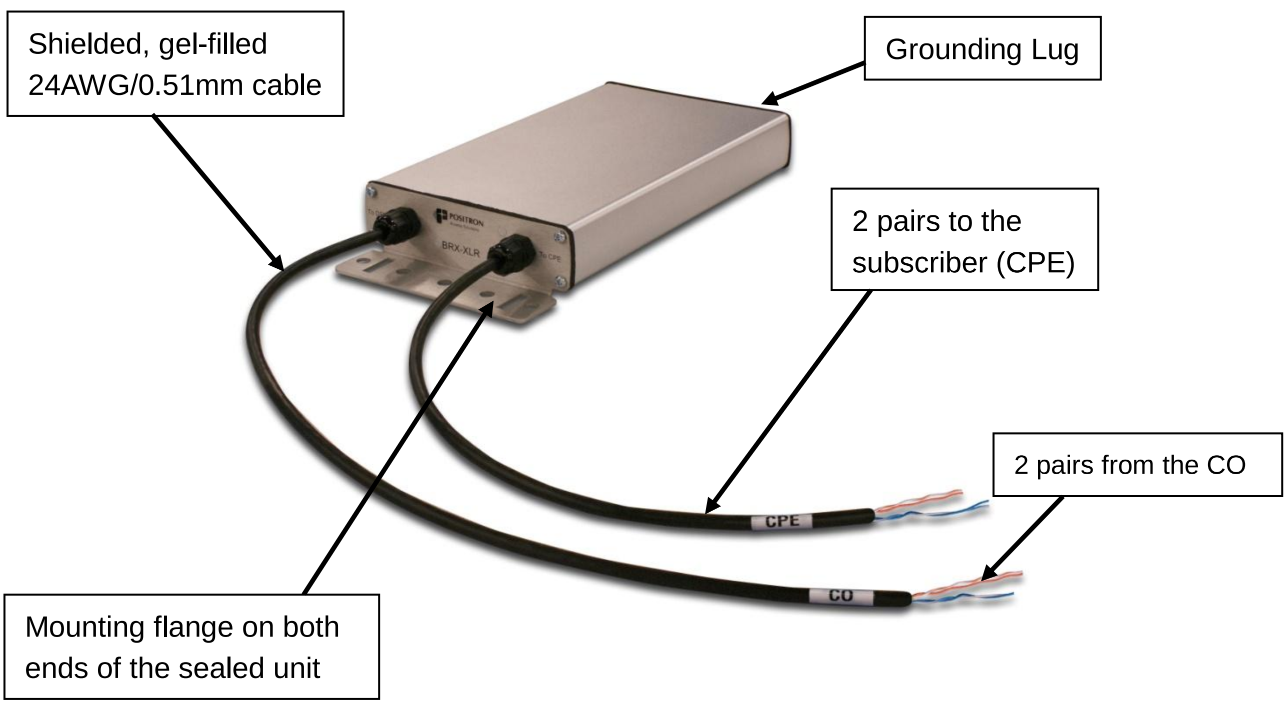

Figure 19: BRX-XLR-1 and BRX-XLR-2 enclosure

7.3 Overview of the BRX-XLR-8 enclosure

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

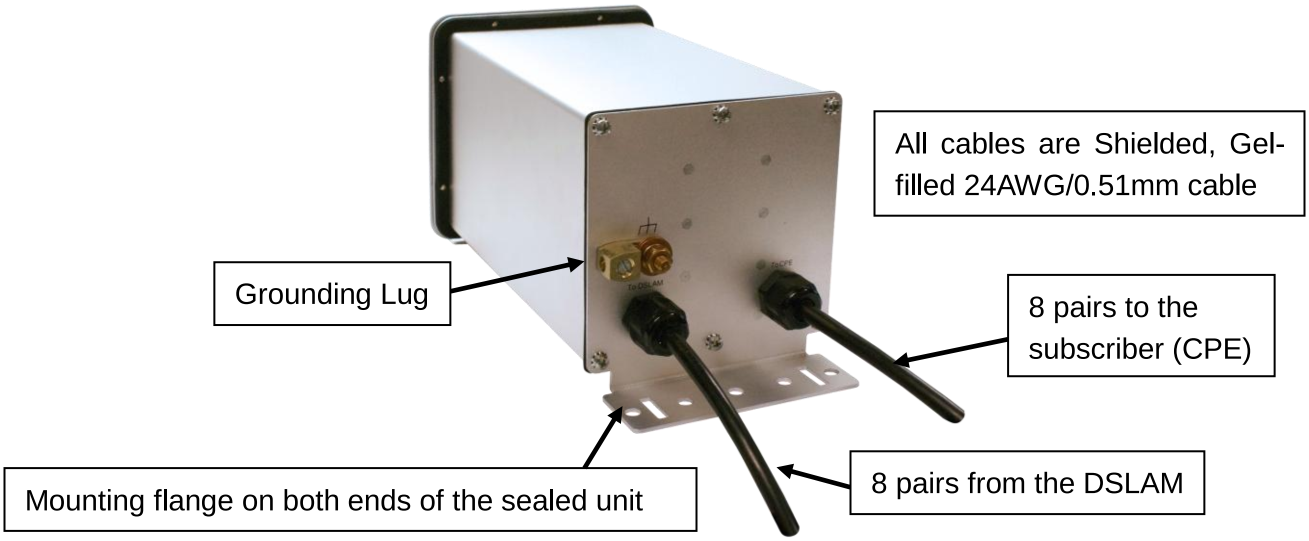

Figure 20: BRX-XLR-8 enclosure

7.4 Overview of the BRX-24S Chassis

The BRX-24S chassis is designed to host up to 12 BRX-XLR-M modules. 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.

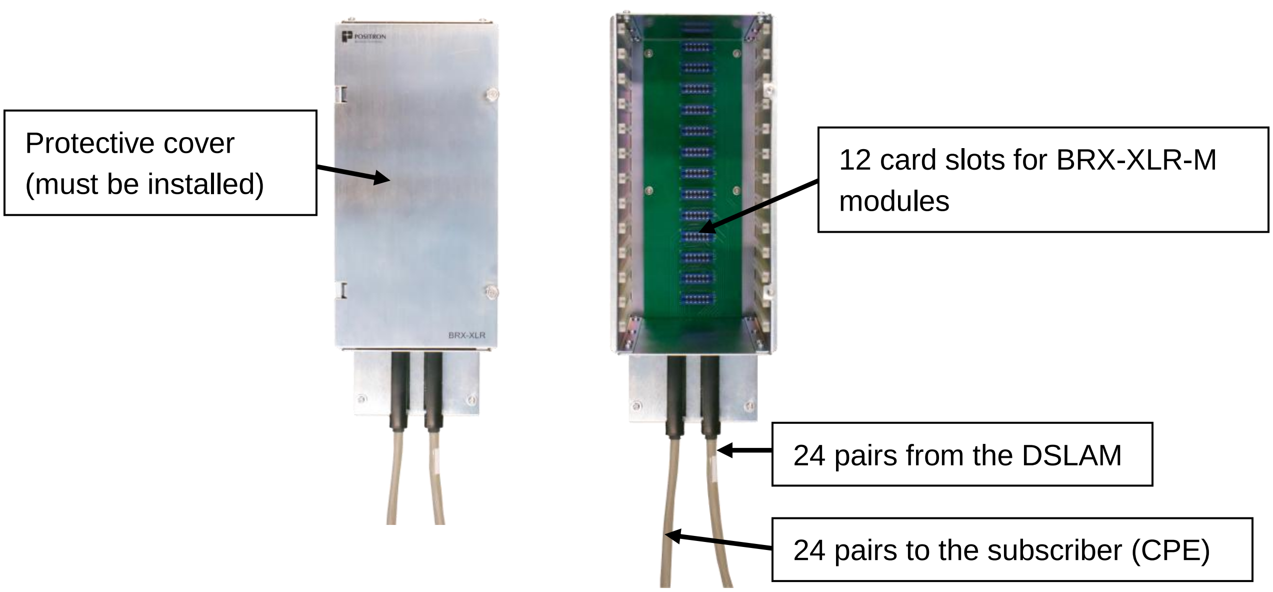

Figure 21: BRX-24S Chassis (with cover and without cover)

7.5 Step-by-step Installation Instructions

Step 1: select the location where the BRX-XLR 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-XLR-M modules in the slot matching the pair to amplify. The BRX module slots of the BRX-XLR-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 7: BRX-XLR-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 8: 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-XLR 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 ADSL2+ or ADLS2 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 9: BRX-24S RJ21 (Amphenol) pin-out

7.5.1 BRX-XLR-2 and BRX-XLR-8 Pole Mounting Option

The BRX-XLR-2 and BRX-XLR-8 devices come with optional kits to facilitate mounting on a pole or to strand-mount the device (in-between 2 telephone poles).

The BRX-XLR-2 and BRX-XR-8 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 screwing the BRX-XLR-2 or BRX-XLR-8 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-XLR enclosure and secure around the pole as per the diagrams below.

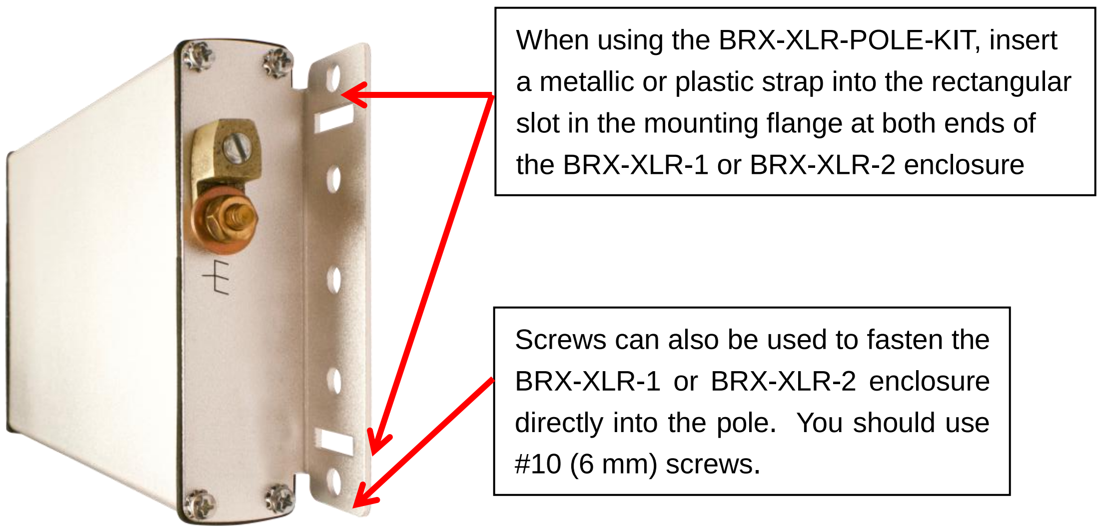

Figure 22: Pole Mount installation for BRX-XLR-1 and BRX-XLR-2 enclosures

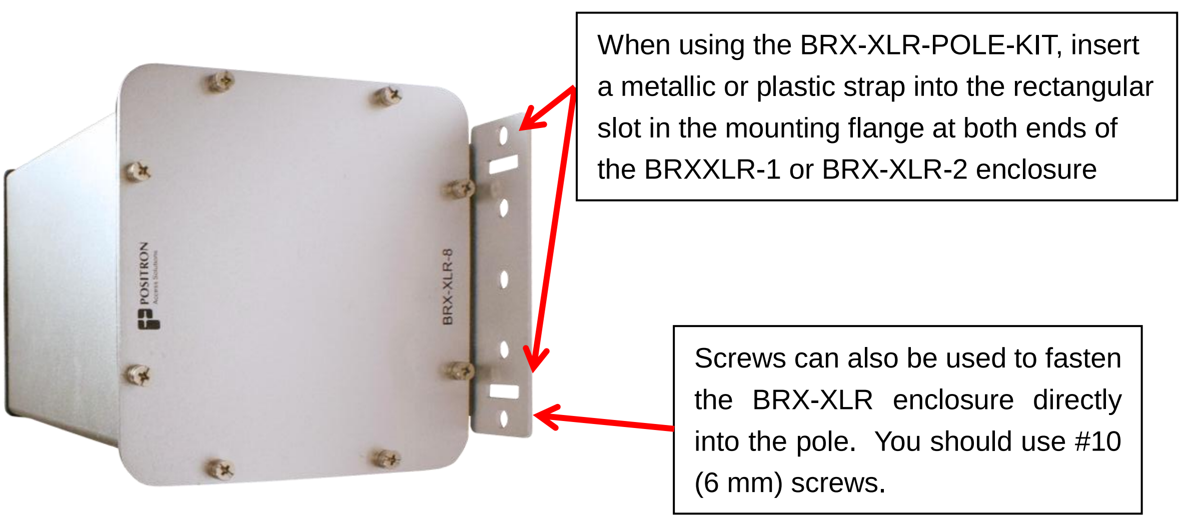

Figure 23: Pole Mount installation for BRX-XLR-8 enclosure

7.5.2 BRX-XLR 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-XLR 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-XLR 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)

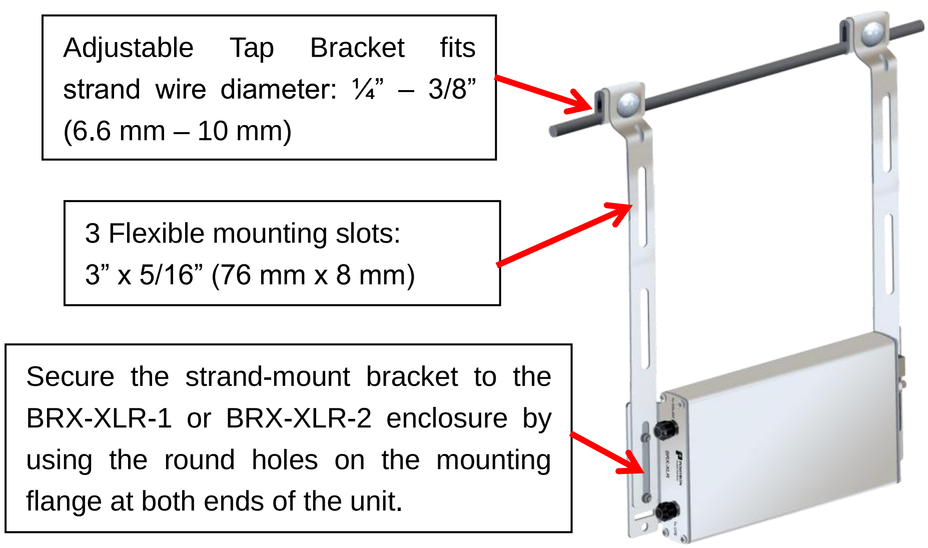

Figure 24: Strand Mount Kit option for BRX-XLR-1 and BRX-XLR-2 enclosures

Figure 25: Strand Mount Kit option for BRX-XLR-8 enclosure

7.6 Splicing Pairs

When installing a BRX-XLR 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-XLR unit 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 ADSL2+/ADSL2 and ADSL. Inserting the BRX-XLR on these 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-XLR units 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).

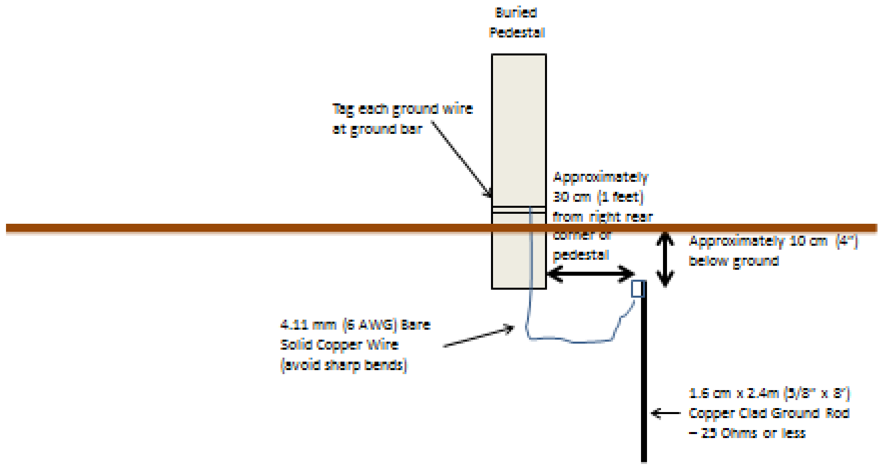

Figure 26: Grounding and Bonding

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.

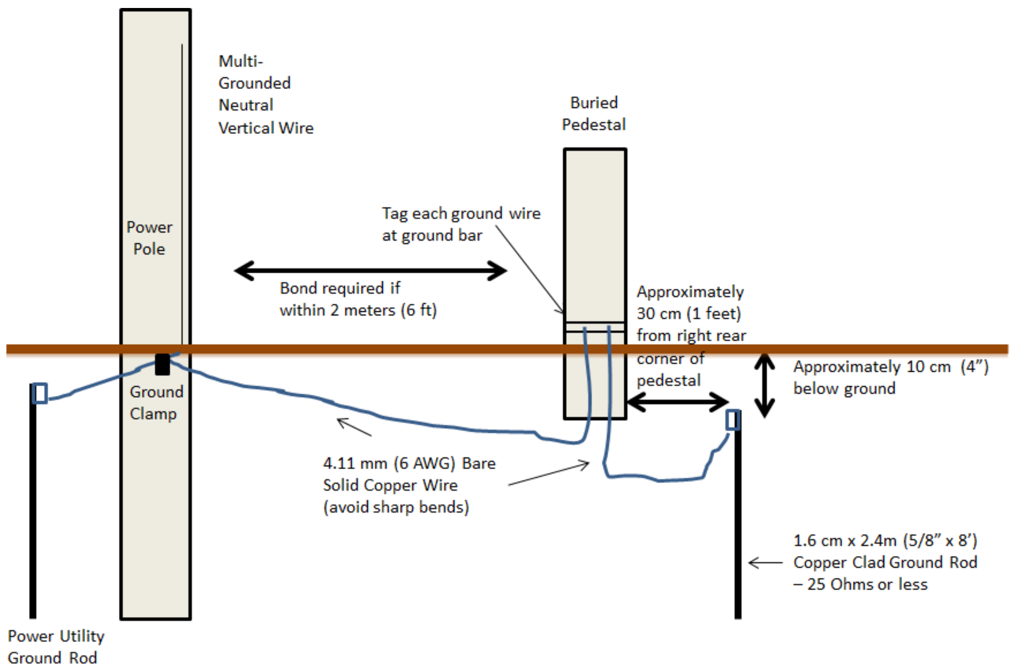

Figure 27: Grounding and Bonding next to Power Utility Pole

Each BRX-XLR unit 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.

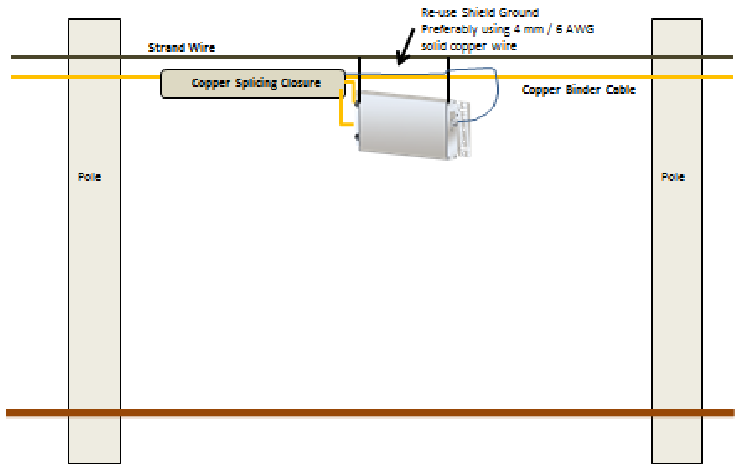

Figure 28: Grounding and Bonding Strand-Mount Units

8.2 Impulse Noise Protection

While the BRX-XLR 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 an xDSL loop. Let's examine in this section how to mitigate the impact of noisy lines by leveraging the Impulse Noise Protection (INP) capabilities of the DSLAM and by providing proper grounding and bonding of the equipment in the copper Outside Plant (OSP). Another 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-XLR 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.995.3 ADSL2+ 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 the BRX-XLR.

Note: When using an ADSL2+ or ADSL Tester, you should set the test set to the suggested Profiles as per Annex C.

Problem Description	**Possible cause(s)**
A. Problem with ADSL2+ / ADSL training	
1. Upon installing the BRX-XLR, the DSLAM and CPE are no longer able to achieve synchronization	• Verify that DSLAM and CPE pairs are not mistakenly swapped. Only the pair labelled DSLAM can be used to power the BRX-XLR device. • Verify that there is POTS voltage on the DSLAM pair to power the BRX-XLR. • With the POTS circuit in the ON-HOOK state, the voltage measured between TIP and RING on the DSLAM pair at the BRX-XLR should be greater than |35Vdc|. 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: - ADSL2+ Test Set from vendors such as: JDSU, EXFO … - Standard Telephone Test set and/or voltmeter • Disconnecting the house from the xDSL copper pair(s) at the NID, verify the synchronization with the DSLAM using the ADSL2+ test set is achieved and stable. • 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 • if the ADSL2+ 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: - Downstream and Upstream SNR values - Line error status/counts (CES, ES, SES) - Any error messages from the DSLAM and/or the ADSL2+ 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: - Standard Telephone Test set and/or voltmeter Verify the following measurements: - Voltage in ON-HOOK state on the pair from the DSLAM and without the BRX-XLR installed should be -40VDC to -60VDC - Voltage in ON-HOOK state on the pair from the DSLAM with the BRX-XLR installed should be -38VDC to -58VDC - Voltage in the OFF-HOOK state on the pair from the DSLAM should be around 20VDC - Loop current in OFF-HOOK state on the pair from the DSLAM should be at least 24 mA - Loop current in the OFF-HOOK state on the pair toward the CPE should be at least 20 mA If any of these measurements are not met, you should make the corrections as per your corporate standard procedure and re-verify.
B. Performance Problems: not achieving the expected bandwidth gains	
4. With the BRX-XLR 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) • Verify that the actual BRX-XLR location matches (more or less) the recommended location from the BRX Cloud Calculator considering the mix of various wire gauges • 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. • 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.
5. 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. • Enable G.INP if supported by the modem (CPE) • Increase target SNR by 2-3dB steps until error rate becomes acceptable. If the new SNR is too high, the quality of the line will need to be verified

6. 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
7. After inserting a BRX-XLR on a copper loop, the performance of other ADSL2+ / ADSL pairs in the same binder is negatively impacted	The BRX-XLR does impact adjacent copper pairs in the same binder when some pairs downstream from the location of the BRX-XLR are not amplified. Although the amplified signal from the BRX-XLR is fully compliant with the allowed spectrum mask defined for ADSL and ADSL2+, the interference is the result of the amplified signal impacting the weaker signal from the DSLAM on adjacent pairs not amplified with a BRX-XLR. It is HIGHLY recommended to amplify all pairs beyond the installation point of the BRX-XLR.
8. The performance of the pairs is unstable	Check for potential non-DMT signals in the binder such as T1 or E1, HDSL, SHDSL. The presence of these disturbers is known to negatively impact the performance of ADSL and ADSL2+ and the disturbance should have been there prior to the installation of the BRX-XLR. If you believe that the instability is the result of the installation of the BRX-XLR, please refer to the other problems covered in this table for the more likely source of the issue and the steps to remediate it.
C. Power issues	
9. The BRX-XLR unit does not seem to power up	• Verify that DSLAM and CPE pairs are not mistakenly swapped. Only the pair labelled DSLAM can be used to power the BRX-XLR device. • Verify that there is POTS voltage (-40VDC to -60VDC) on the DSLAM pair to power the BRX-XLR. • With the POTS circuit in the ON-HOOK state, the voltage measured between TIP and RING on the DSLAM pair at the BRX-XLR should be greater than |35Vdc|. 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	
10. With the BRX-XLR installed on 2 pairs, 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 • Verify the loop length of each pair. Significant differences between pairs will induce jitter/latency which will impact the achievable total bandwidth • All pairs in the bonding group need to be

	amplified by a BRX-XLR module/device at the same location 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	
11. Dial tone is intermittent or not present	You should have the following equipment to help you troubleshoot the problem: - Standard Telephone Test set **Note**: Problems with dial tone if 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. • Disconnecting the house at the NID and with the BRX-XLR 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. • Using the telephone test set, verify that the loop current at the DSLAM pair of the BRX-XLR when in the OFF-HOOK state is high enough (> 20mA). If not verify the cabling between the DSLAM and the BRX-XLR. • Using the telephone test set, verify that the loop current at the CPE pair of the BRX-XLR in the OFF-HOOK state is high enough (> 20mA) and that the voltage on the DSLAM BRX-XLR pair is about 20VDC. If one of these two conditions is not met, the BRX-XLR is in fault. Please reach out to Positron Access Solutions customer support for assistance. • 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 (> 20mA). If not, there may be issue in the cabling from the BRX-XLR to the NID. If any of the above measurements are not met, you should make the corrections as per your corporate standard procedure and re-verify.
12. 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.

	• Verify that the lightning protectors at the NID are in good working condition. Blown protectors would short the line making the POTS malfunction. • 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. • While ringing, measure the AC rms voltage at the NID. The reading should be between 40Vrms to 105Vrms
13. There is a humming noise on the telephone (POTS) that was not present before installing the BRX-XLR	You should have the following equipment to help you troubleshoot the problem: - ADSL2+ Test Set from vendors such as: JDSU, EXFO … - Standard Telephone Test set • With the house disconnected at the NID and the BRX-XLR 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. • 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. • Verify that the longitudinal balance is greater than 60dB. • Verify that the Power Noise measured on the line is lower than 80dBrnc • Verify that the Circuit Noise measured on the line is lower than 20dBrnc • Verify that the BRX-XLR chassis grounding is properly made. Bad grounding may reduce unit shielding efficiency and translate into higher noise coupling. 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 10: BRX-XLR 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

Outdoor IP65 Assemblies	
BRX-XLR-1	BRX-XLR 1-pair module with solid state primary lightning protection enclosed in IP65 enclosure
BRX-XLR-2	BRX-XLR 2-pair module with solid state primary lightning protection enclosed in IP65 enclosure
BRX-XLR-8	BRX-XLR 8-pair enclosure for up to 4 BRX-XLR-M modules with solid state primary lightning protection enclosed in IP65 enclosure
BRX-XLR-24	BRX-XLR 24-pair enclosure for up to 12 BRX-XLR-M modules with solid state primary lightning protection enclosed in IP65 enclosure
Ancillary Parts	
BRX-STRAND-K	Strand-mounting kit; for use with BRX-XLR-1, BRX-XLR-2 and BRX-XLR-8 enclosures

Table 11: 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 $S_p \le 1$ and $D_p = 1$.								

Table 12: 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 $S_p \le 1$ and $D_p = 1$.								

Table 13: 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 14: 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 ADSL Mode

Table 15: Pre-installation checklist

Annex C

Recommended ADSL and ADSL2+ Line Test Profile Parameters

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

Setting	ADSL Line Test Profile	
Transmission System	G.992-1	
Trellis Coding	Enabled	
Reed Solomon	Enabled	
S=1/2	Enabled	
SRA	Disabled	
SRA Downshift Interval	30 seconds	
SRA Upshift Interval	30 seconds	
Parameter	**DOWNSTREAM**	**UPSTREAM**
Maximum Bitrate	8192 Kbps	1024 Kbps
Minimum Bitrate	32 Kbps	32 Kbps
Maximum Delay	8 msec	8 msec
Impulse Noise Protection (INP)	2	1
Maximum SNR Margin	30.0 dB	30.0 dB
Target SNR Margin	6.0 dB	6.0 dB
Minimum SNR Margin	3.0 dB	3.0 dB
SNR Margin Upshift	9.0 dB	9.0 dB
SNR Margin Downshift	3.0 dB	3.0 dB
Bit Swapping	Enabled	Enabled

Table 16: Recommended ADSL Test Set Profile

Setting	ADSL Line Test Profile	
Transmission System	G.992-5	
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	32000 Kbps	1296 Kbps
Minimum Bitrate	32 Kbps	32 Kbps
Maximum Delay	8 msec	8 msec
Impulse Noise Protection (INP)	2	1
Maximum SNR Margin	30.0 dB	30.0 dB
Target SNR Margin	6.0 dB	6.0 dB
Minimum SNR Margin	3.0 dB	3.0 dB
SNR Margin Upshift	9.0 dB	9.0 dB
SNR Margin Downshift	3.0 dB	3.0 dB
Bit Swapping	Enabled	Enabled

Table 17: Recommended ADSL2+ Test Set Profile