BRX-XLR

Frequently Asked Questions

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1 Introduction

The BRX-XLR amplifies the ADSL2+ bandwidth between the DSLAM and the CPE to extend the reach. For example, a 10 Mbps downstream signal can be extended from about 12,500 feet (3.8 km) to more than 17,000 feet (5.2 km) on a 24 AWG (0.51mm) copper pair.

Another way to look at the benefits of this same function is that a client that is situated at 17,000 feet (5.2 km) from the DSLAM on a 24 AWG (0.51mm) copper pair will see his downstream bandwidth increase from approximately 5 Mbps to over 10 Mbps.

It is important to note that these benefits are obtained without the need to change the DSLAM/MSAN or the user CPE at either end, neither the modem in the customer premise nor the operator's DSLAM equipment.

2 Frequently Asked Questions

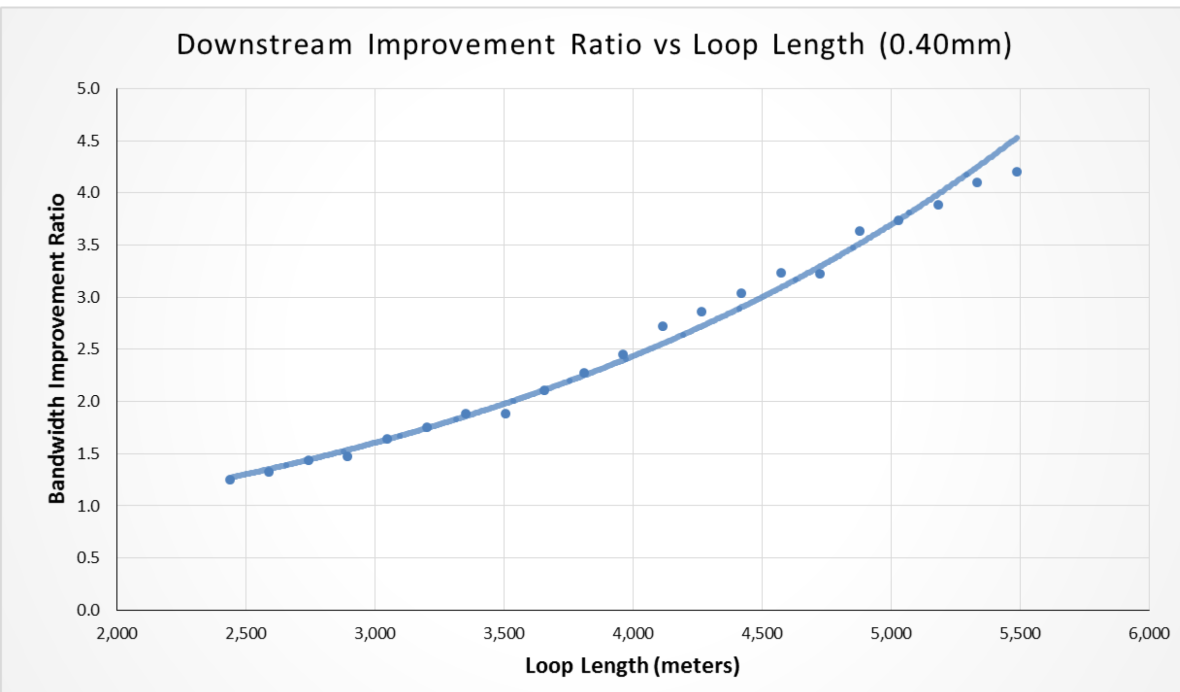
This section covers frequently asked questions about the BRX-XLR features and capabilities. This document will be updated over time as additional questions and answers are added.

Q1: What are the main factors that determine such a significant data spread, i.e. 2x-5x increase of Internet speed being provided by BRX-XLR? Do you have any diagrams describing impact of these main factors on the speed?

ANSWER: The BRX-XLR will provide a gain (amplification) of the signal in the downstream and upstream direction of up to 16 dB and always within the acceptable signal strength allowed by the xDSL standards for the Spectrum Mask of ADSL2+ and ADSL. This amplification gain is typically more significant when it is applied to a copper pair where the total loop length is longer and therefore experiencing a higher attenuation of the signal.

The following chart illustrates how the performance gain increases over the length of copper loops. The data is based on the use of 26 AWG (0.40mm gauge) copper wire. For clarity, we are using the notion of an Improvement Ratio to illustrate the benefits of installing a BRX-XLR device on a copper pair. The ratio is calculated as the BRX-XLR bandwidth divided by the RAW bandwidth (i.e. without BRX-XLR). For instance, improving a pair from 5 Mbps to 10 Mbps would represent an Improvement Ratio of 2.0 (10 divided by 5). The chart below is in meters. This can be converted using 1 meter = 3.2808 feet.

Note: *To convert to larger cables sizes, simply multiply the loop length by 1.374 for 24 AWG (0.51mm) and 1.844 for 22 AWG (0.64mm) cables.*



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

It should be noted that the Improvement Ratios above (both in the graph and in the table) are very conservative as they have been calculated based on lab testing under ideal copper conditions which are not always found in actual outside plant. Our field experience demonstrates even better Improvement Ratios than our lab results as we witness “less than ideal” line conditions caused by bridge taps, crosstalk and influence from power lines. When any of these conditions are present, the performance “without BRX-XLR” is significantly reduced due to an increase in noise which reduces the SNR (Signal-to-Noise Ratio). To help offset this, the BRX-XLR was designed to not only amplify the signal but to also filter as much noise as possible before amplifying the resulting filtered signal. As a result, customers experience even better Improvement Ratios than what we measure in our controlled lab setup. Here is a sample of field results from customers:

BRX-XLR Downstream Performance Increase in Field					
Loop Length (feet)	Loop Length (meters)	Gauge AWG / (mm)	Without BRX-XLR (Mbps)	With BRX-XLR (Mbps)	Downstream Improvement Ratio
10,840	3,304	24 / 0.51	6.00	13.00	2.17
26,187	7,982	24 / 0.51	2.40	6.30	2.63
14,108	4,300	24 / 0.51	3.80	15.01	3.95
18,918	5,766	24 / 0.51	1.80	7.97	4.43
13,780	4,200	26 / 0.40	1.00	5.50	5.50
11,068	3,374	24 / 0.51	1.50	11.00	7.33
14,100	4,298	26 / 0.40	0.70	5.20	7.43

The field performance (before and after insertion of BRX-XLR) varies significantly with the magnitude of impairment suffered by copper loops. For example, looking at the last item in the table above, this copper loop was found to suffer from a high level of impulse noise from nearby power utility lines. Although the BRX-XLR had a tremendous impact on the resulting service and resulted in a very happy customer, one can see that the resulting performance is still only 54% of what it could be if there was no noise present. Indeed, this 5.2 Mb must be compared to the 9.57 Mb that was experienced in lab test results (see table above) for the same distance and cable size.

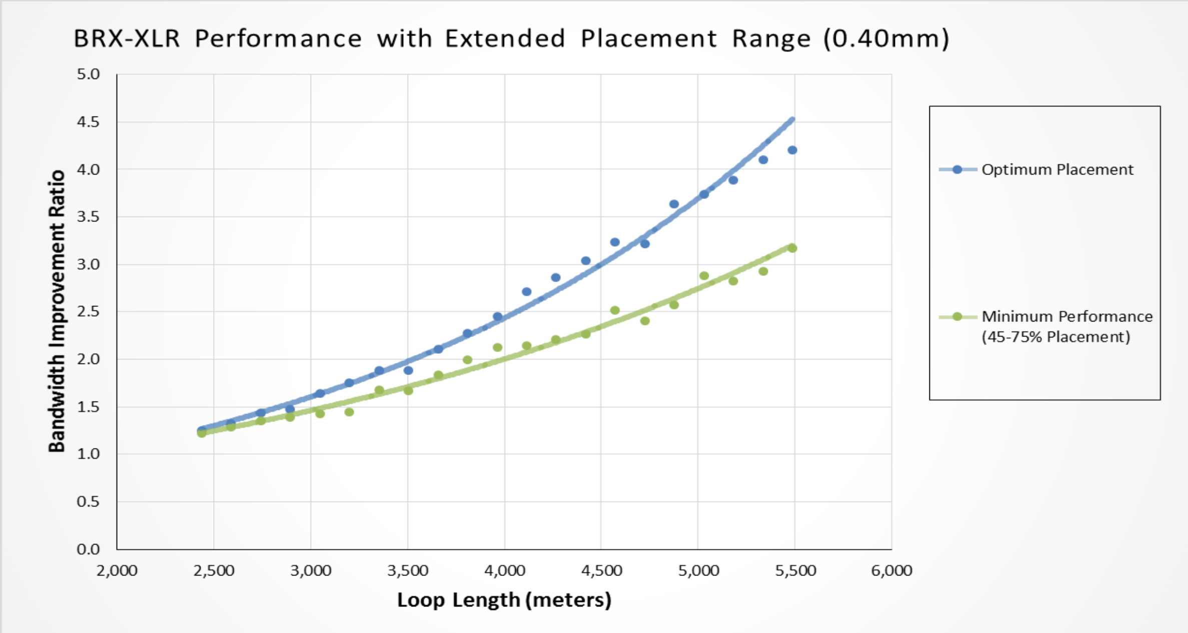
***Note**: following our recommendation, this customer is now experimenting with the Impulse Noise Protection (INP) capabilities of the DLSAM. Early results demonstrate performance much closer to what should be achieved along with an overall improvement in the stability and with the overall SNR. Using the INP capability on its own is very helpful but the use of the BRX-XLR is still required to ensure an acceptable quality of user experience.*

In summary, it can be said that the main factors that influence the Improvement Ratio are 1) the loop length (well documented above), and 2) any impairments to the loop that cause an increase in the noise floor level. Typical examples of such are: bridge taps, higher than normal crosstalk, and the presence of power lines near the outside plant cabling. Regarding crosstalk, our customers have seen many sources of such impacts: poor quality cabling, poor quality connectors and/or connections, and poor wiring in cable splices. Although the items identified in 2) above are difficult to quantify, they almost always result in increases in Improvement Ratio due to the ability of the BRX-XLR to filter a significant portion of the noise.

Q2: Where can we install the BRX-XLR extender along the loop?

ANSWER: Over and above the performance gains, one of the major differentiators and advantages of the BRX-XLR over past technologies 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 12500 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. In comparison, the optimum placement which varies with loop length is generally somewhere between 55% and 65% of the total loop length.



Q3: How many extenders are required for one copper pair?

ANSWER: The BRX-XLR comes in various configurations (1, 2 and 24 pairs) where each pair of the BRX-XLR handles one pair from the DSLAM toward the user equipment (CPE).

The BRX-XLR is available in 1, 2, 8 and 24 pair configurations. When deploying the BRX-XLR-25 (IP65) cabinet, it can house up to 12 BRX-XLR modules, with each module handling 2 pairs. Alternatively, the BRX-24S chassis supports up to 12 BRX-XLR modules and is designed to be installed inside a standard outside plant pedestal.

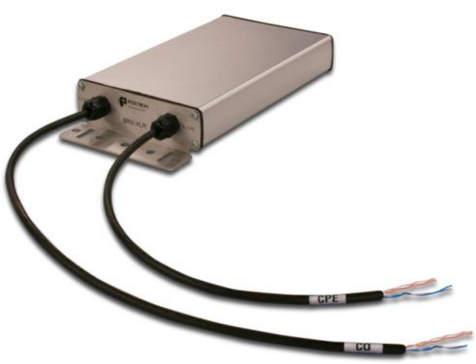
The approximate dimensions of the BRX-XLR enclosure are:

- **BRX-XLR-1**: 9.25" x 5.5" x 1.5" / 235 mm x 140 mm x 38 mm
- **BRX-XLR-2**: 9.25" x 5.5" x 1.5" / 235 mm x 140 mm x 38 mm
- **BRX-XLR-8:** 11.15" x 4.93" x 4.665" / 283 mm x 125 mm x 118 mm
- **BRX-XLR-24:** 16.7.2" W x 21.3" H x 10.6 D" / 425 mm x 541 mm x 269 mm
- **BRX-24-S:** 14.775" x 9.05" x 5.33" / 375 mm x 230 mm x 136 mm
- **BRX-XLR-2P (module)**: 8" x 5" / 200 mm x 125 mm

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)



1 and 2 pair BRX-XLR devices

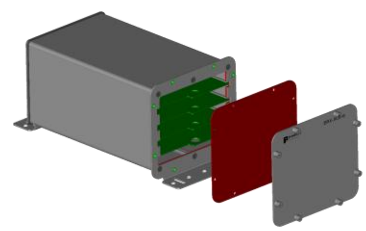
Strand-mount option

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

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.

8 pair BRX-XLR-8 enclosure



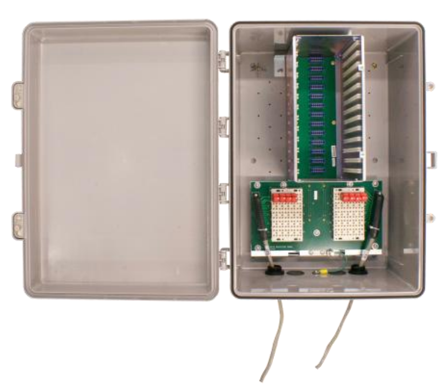
Opened BRX-XLR-8 enclosure

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).

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.

BRX-XLR-24 enclosure



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.

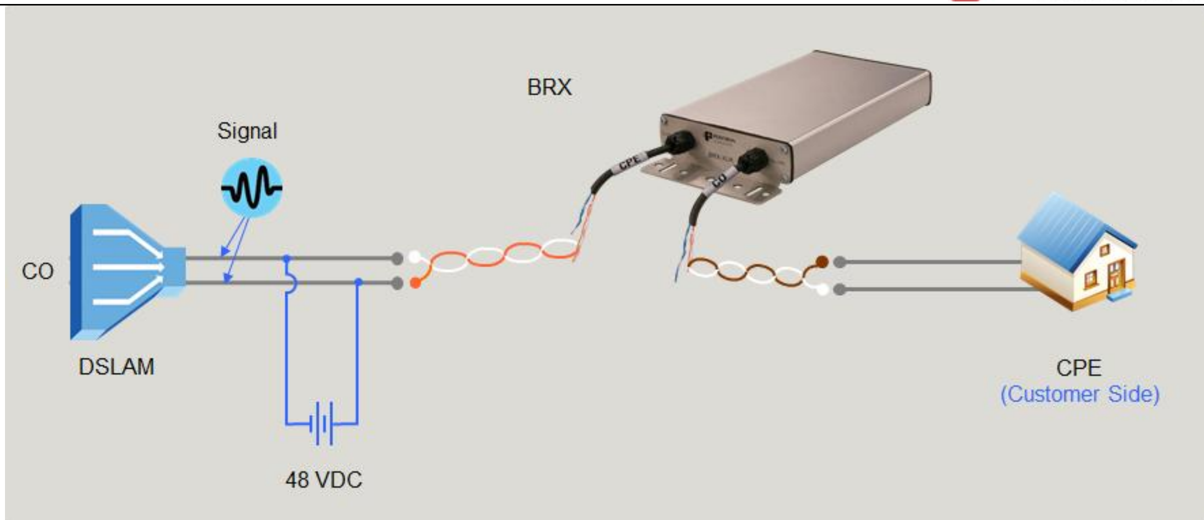
BRX-XLR-24-1SXPF

BRX-XLR-48-1SXPF

__Q4:__ How exactly is the extender "spliced" in the middle of a copper pair?

__ANSWER:__ The BRX-XLR is usually inserted at or near an existing splicing point (where a copper binder is spliced to another copper binder) or cross-connect location. When adding a BRX-XLR onto a copper pair (at an existing splicing point or cross connect), all that is needed is to connect the CO pair to the pair from the DSLAM and connect the CPE pair to the pair serving the remote customer.

__Note:__ The BRX-XLR modules are powered from the -48V DC sealing current found on POTS pairs.If operating on dry pairs (no POTS), the BRX Power Injector can be used to inject the required -48Vdc power on the pairs needing amplifications.



Q5: If the BRX-XLR is installed at the edge of the long lines and near the CPE (approximately 4-5 km away from the DSLAM), what would be the SNR margin?

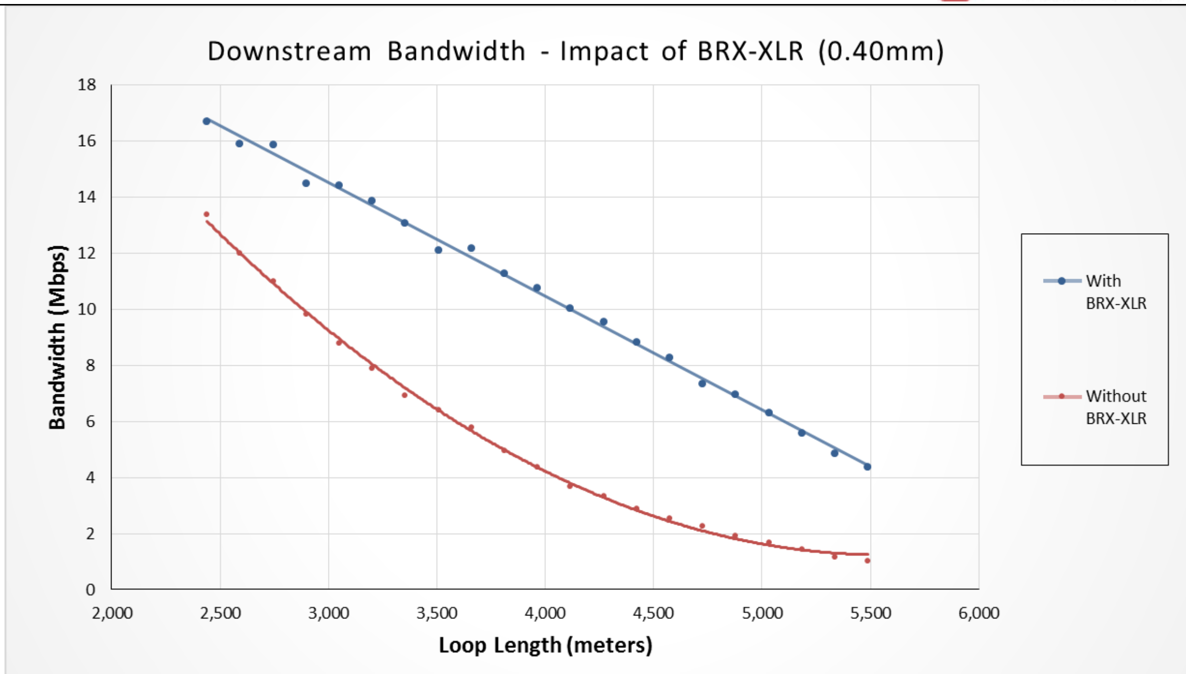
ANSWER: The BRX-XLR is optimally installed in the copper loop between the DSLAM and the CPE between 45% and 75% of the total loop length away from the DSLAM. This flexible placement ensures the BRX-XLR still has a strong enough ADSL2+ signal to amplify.

The BRX-XLR nevertheless amplifies the signal even when it is located very close to the CPE, but in this case the actual gain or improvement will be less since there is little attenuation of the signal toward the CPE (downstream direction) to compensate for. In the upstream direction, there will be little attenuation of the signal from the CPE and the resulting bandwidth toward the DSLAM will therefore be dictated by the loop length between the BRX-XLR and the DSLAM.

The lab measurements taken on real copper used to determine the performances of the BRX-XLR are based on a target SNR of 6dB at the remote CPE.

Q6: What are the typical downstream and performances that can be expected from using the BRX-XLR for various loop lengths?

ANSWER: The graph below demonstrates the performances (with and without BRX-XLR) for downstream bandwidth using 26 AWG / 0.4mm copper gauge.



The graph above is based on 26AWG (0.40mm) cable.

Note: *To convert to larger cables sizes, simply multiply the loop length by 1.374 for 24 AWG (0.51mm) and 1.844 for 22 AWG (0.64mm) cables.*

<u>Q7:</u> By how much is the customer serving area (CSA) increased for the offering of a 10 Mbps downstream service? For a 5 Mbps service?

<u>ANSWER:</u> 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.

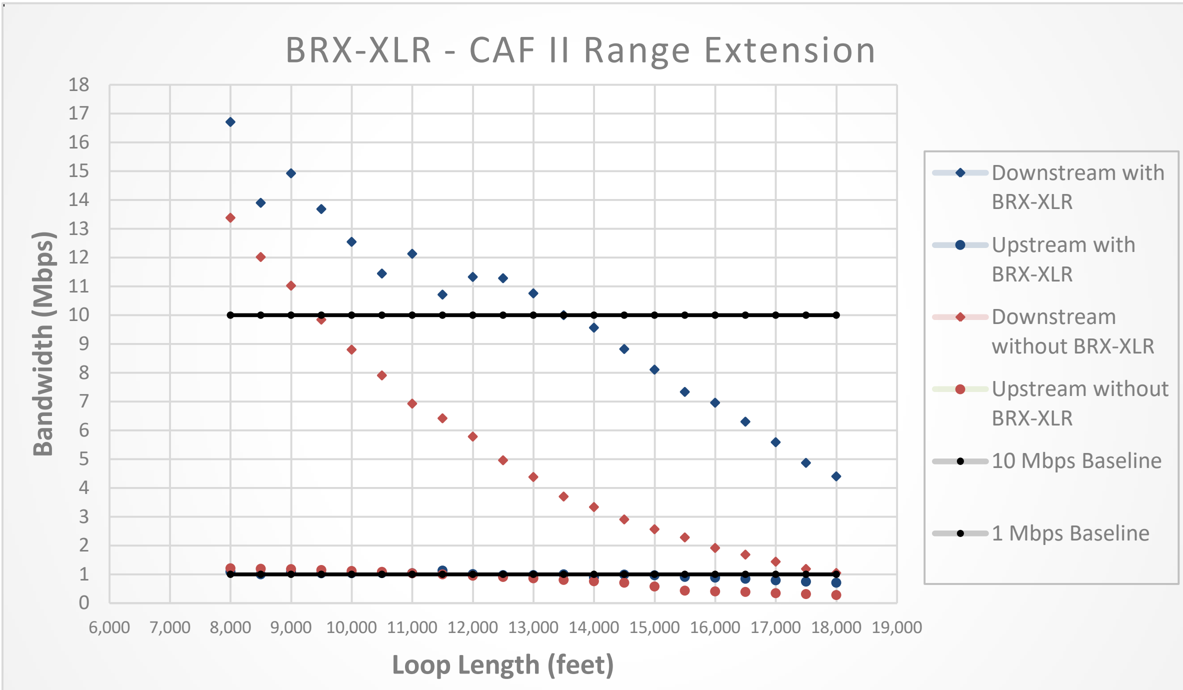
Maximum Distance for 10 Mbps Service with 1-Pair							
Cable Gauge		Without BRX-XLR		With BRX-XLR		% Increase	
AWG	mm	k feet	km	k feet	Distance	Distance	Serving Area
26	0.40	9.1	2.8	12.5	3.8	38%	91%
24	0.51	12.5	3.8	17.0	5.2		
22	0.64	16.8	5.1	23.0	7.0		

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 10 Mbps 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		

Q8: In the US, the federal government's CAF-II program encourages operators to offer a minimum of 10 Mbps downstream with a minimum of 1 Mbps upstream service to all underserved or unserved customers in rural areas. How does the BRX-XLR extend the customer serving area to provide this minimum level of service?

ANSWER: The graph below demonstrates the performances (with and without BRX-XLR) for both downstream and upstream bandwidth using 26 AWG (0.4mm) copper cable. When looking at baseline service levels of 10Mbps for downstream and 1Mbps for upstream, we can conclude that the CSA is approximately 9,400 feet / 2.8 km (without the BRX-XLR)whereas this is extended to approximately 13,500 feet / 4.1 km when using the BRX-XLR. This represents a "linear" increase in reach of almost 44% which represents just over a 100% increase (or doubling) in CSA considering that the area covered is proportional to the square of the distance (i.e. 1.44*1.44 > 2).



<u>Q9:</u> What would be the Installation, diagnostic and troubleshooting mechanism for the module?

<u>ANSWER:</u> The BRX-XLR-1 and BRX-XLR-2 devices can be pole mount, wall mount and even strand mount. The BRX-XLR-24 mounted in an outdoor (IP 65) enclosure provided by Positron Access can be pole mount and wall mount. The BRX-XLR-24 can also be mounted in standard pedestal or cabinets from various manufacturers.

The monitoring of xDSL pairs is not impacted when a BRX device is installed on a loop. The recommended Metrics to Monitor include:

- **Excessive Retrains:** could indicate binder issue, not only single pair
  - **Threshold:** more than one retrain per day
- **Bitrate Variations:** BRX will initially significantly increase bitrates which afterward remain stable. Useful to detect partial degradation
  - **Threshold:** between 64 Kbps and 128 Kbps
- **Operating Margins:** Measured SNR should be stable and within target range. Upon installation, BRX improves SNR which then stabilizes
  - **Threshold:** 1.5 dB (usual DSLAM vendor recommendations)
- **Performance Counters:** excessive LOS & UAS most critical
  - **Threshold:** UAS should not exceed 10 seconds per day and LOS should not exceed 1 per day (will trigger a retrain)

The xDSL performance data and any problems are reported as usual by DSLAM & Dynamic Line Management (DLM) / Network Analyzer platforms.

The standard xDSL troubleshooting procedures are used as is with only minimal impact due to the presence of a BRX device (BRX-VDSL2 or BRX-XLR) on a copper loop. The troubleshooting of typical issues is summarized below:

- **CPE issues:** troubleshooting is unchanged as per standard methods and procedures with DELT & TR-069 management
- **Physical Pair issues** troubleshooting methods and procedures require a "relatively simple" update when there is a BRX device on a loop
    - Leverage prior knowledge of Presence and Location of BRX device.
    - **CASE #1: fault is on the L1 segment (DSLAM to BRX)**
        - **No changes needed**, Dispatch Field / OSP Technician to fault location indicated by SELT data
    - **CASE #2: fault is with BRX or on L2 segment (BRX to CPE)**
        - An unpowered or faulty BRX device looks like an OPEN error condition. An OPEN pair condition at the BRX location indicates either a bad splice, the absence of Sealing Current to power the BRX or a faulty BRX device.
        - **Action**: Verify the presence of the sealing current. If needed, Dispatch Field / OSP Technician to the BRX location and use xDSL test set to further locate the pair fault on L2

<u>Q10:</u> Would there be any remote configuration for the BRX-XLR?

<u>ANSWER:</u> The BRX-XLR does not require any configuration. It automatically adjusts the amplification of the ADSL2+ signal based on the distance from the DSLAM and the distance to the CPE to achieve the optimal bandwidth. Furthermore, on longer loops still operating in ADSL2+ mode, the BRX-XLR will amplify the ADSL2+ bands (U0 and D1) based on the specific loop conditions.

<u>Q11:</u> How are the PSD shaping/interference/DPBO/UPBO configuration settings impacted by the use of a BRX-XLR unit?

<u>ANSWER:</u> The BRX-XLR is totally transparent to the PSD shaping and other configuration settings of the DSLAM. For instance, Impulse Noise Protection (INP) will still be negotiated between the DSLAM and the CPE as before the installation of the BRX-XLR.

The amplification of the ADSL2+ signal by the BRX-XLR is always within the allowed PSD values in order to make sure that the CPE (and DSLAM) can maintain the ADSL2+ link even when the BRX-XLR is located near the CPE. This strict adherence to the allowed PSD is also important to help mitigate crosstalk and achieve the optimal SNR in the downstream and upstream directions.

Regarding DPBO and UPBO, the insertion of the BRX-XLR in the binder will actually help the DSLAM to potentially make better use of DPBO to help improve the SNR of the CPEs located closer to the DSLAM and therefore not requiring the installation of the BRX-XLR for those pairs. Some attention in selecting the proper setting for DPBO is recommended to make sure the ADSL2+ signal into the BRX-XLR is still strong enough to achieve the desired bandwidth improvement.

Q12: What would be the powering options/consumption for the BRX-XLR module?

ANSWER: The BRX-XLR devices are powered from the copper pair using the standard POTS sealing current found on these pairs. The BRX Power Injector (8, 16 or 24 pairs) can be used to provide the required -48Vdc current on the amplified pairs when operating on dry pairs (no POTS sealing current).

Q13: What would be the impact on DSLAM configuration and EMS/NMS platform due to introducing the BRX-XLR module between DSLAM and CPE?

ANSWER: Installing a BRX-XLR on a pair between the DSLAM and the CPE is totally transparent to the configuration of the DSLAM other than making sure any bandwidth limits defined at the DSLAM are adjusted to allow for the higher bandwidth arising from the use of the BRX-XLR. The installation of a BRX-XLR does not require any changes to the EMS/NMS platform.

Q14: What happens to the ADSL2+ service if the BRX-XLR module fails for any reason?

ANSWER: Upon a failure of the BRX-XLR module, the current implementation will still allow the POTS service to continue as is. The BRX unit will nevertheless needs to be replaced.

Q15: Is the BRX-XLR transparent to pair bonding?

ANSWER: The BRX-XLR is an ADSL2+ amplifier and does not interfere with the content of the data sent on the ADSL2+ pairs. It is fully transparent to pair bonding.

Q16: Is the BRX-XLR IP67 compliant?

ANSWER: The BRX-XLR-1 (1 pair), BRX-XLR-2 (2 pair) and BRX-XLR-8 sealed enclosures are rated to IP65. An IP67 enclosure is available and has been tested for operation under 3 meters of water for 3 consecutive days.

Q17: What are the minimum loop lengths to achieve at least double the speed?

ANSWER: In order to obtain Downstream Bandwidth Improvement Ratios of 2.0 or more (i.e. a minimum of double the speed), the BRX-XLR must be placed on a loop with the following minimum length depending on the copper wire gauge:

Wire Size (mm)	Minimum Loop Length (km)
0.40	3.5
0.51	4.8
0.64	6.5
0.90	9.8

Q18: Do you have any recommendations for Over the Top (OTT) video or IPTV Service on long loop lengths?

ANSWER: Each Standard Television (SDTV) requires a minimum of 1.0 Mbps and ideally 1.5 Mbps while each High Definition Television (HDTV) feed requires a minimum of 4 Mbps and ideally 5 Mbps. Depending on how many and what type of television sets are supported, it is common for North American operators where they offer up to 3 HDTV feeds to impose a minimum acceptable Downstream Rate of 25 Mbps representing 15 Mbps (3 HDTV channels @ 5 Mbps each) and an extra 10 Mbps of High Speed Internet (HSI) service. A service with 20 Mbps is also used by some operators when they are OK to guarantee the HDTV service for 2 simultaneous channels (one live and the other recorded).

The newer HDTV / IPTV encoders are very efficient and can compensate for some delays in the downstream direction but they are still susceptible to jitter. DSLAMs can be configured with some advanced settings to improve (minimize) the jitter, especially under conditions where the copper loops experience crosstalk or Impulse Noise (from nearby power lines or other similar sources). Positron therefore strongly recommends that Impulse Noise Protection (INP) and Interleaving are activated to improve the resulting SNR and jitter. Since INP and Interleaving interact with one another, we are providing two potential approaches for consideration.

Approach #1: Select a more conservative INP value of 2.5 symbols and allow operation with a more aggressive (lower) target SNR:

i. Interleaving: ON
ii. SNR Ratio: 6-8dB
iii. INP (Impulse Noise Protection) latency: 2.5 symbols or more

Approach #2: select a less aggressive INP value of 1.0 symbols and rely on a more conservative (higher) target SNR:

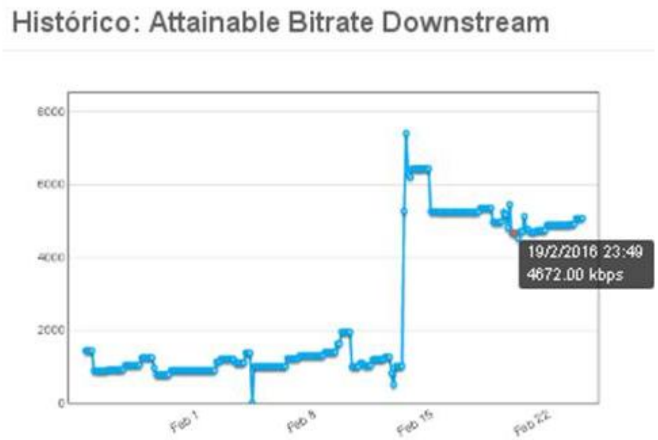
i. Interleaving: ON
ii. SNR Ratio: 10-12dB
iii. INP (Impulse Noise Protection) latency: 1.0 symbols or more

For clients below the minimum HDTV bandwidth rate described above, it is recommended to make use of an available second subscriber pair (if present) and to bond the two pairs in combination with the use of the BRX-XLR to achieve the desired minimum bandwidth or better.

When it is not possible to offer the desired bandwidth for IPTV, subscribers can use video streaming services also known as OTT video which can operate with as little as 3 Mbps and ideally around 5 Mbps.

IPTV Improvement Case:

Positron has encountered an issue with a Latin American Operator that was having problems with their customers experiencing a high jitter rate. The achievable bandwidth was also negatively impacted due to the DSLAM having to retrain the DSL link when Impulse Noise was present. This is shown by the graph below.



Note that the increase of bandwidth that is shown on the date of February 13th is the result of the installation of a BRX-XLR on the copper loop.

The following graph was taken on another customer pair (serving a neighbor of the 1st customer shown above) in the same cable binder and with the same overall distance. In this case, the INP option was not activated and the graph clearly demonstrates the instability of the DSL service which was preventing that customer from using the IPTV service.