technetix

Unleashing endless possibilities for cable networks

White paper

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Technetix Inc

THIS AMPLIFIES EVERYTHING

With upstream traffic using lower frequencies and downstream data being carried by higher frequencies, networks have been limited by the inevitable up/down frequency split - a limitation that is about to be removed. The age of flexi-split and full duplex cable networks is arriving courtesy of Technetix. In this White Paper **Jan Ariesen, Technetix' CTO**, explains how he and his team are sparking a quiet revolution that will improve the economics and capabilities of the cable industry for decades.

EXECUTIVE SUMMARY

Since bi-directional traffic over coax commenced, there has always been a clear divide between upstream and downstream data splits. This split has made it possible to upgrade signals in the existing network using by-pass filters and subsequently diplex filters in the active components. The need for greater capacity, or speed over the upstream and downstream, means this separation has become a limiting factor when upgrading the network. Each upgrade requires new filters and addtional labor.

This can change: Technetix has developed a bi-directional amplifier without the need for diplex filters. This technology will significantly reduce OPEX and improve flexibility.

This paper will explain how to create more bandwidth and flexibility within the same infrastructure and how this technology will make 1.8 GHz ESD installations feasible without amplifier respacing.

BACKGROUND

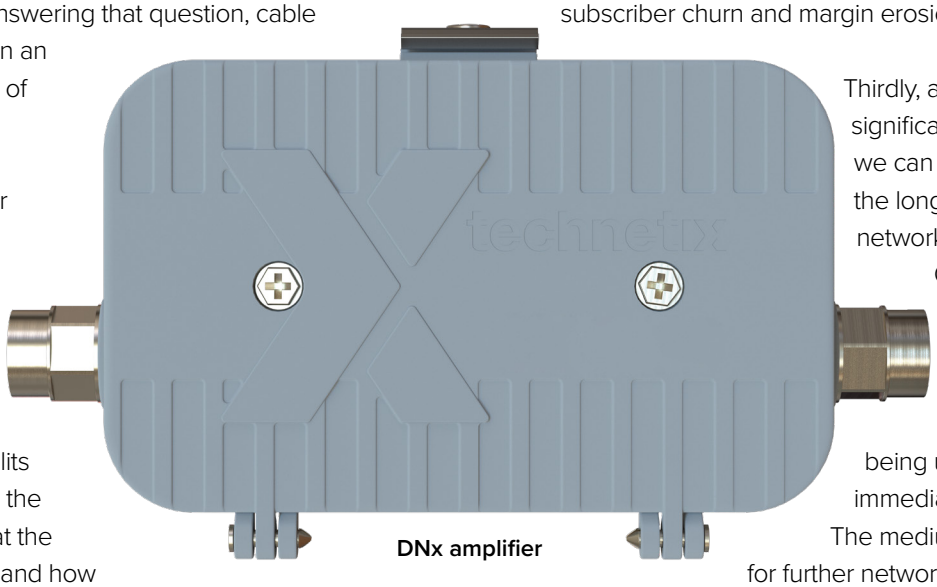
Imagine a world in which the telephone had been limited to push-to-talk functionality. The speed and pattern of global economic development might now look quite different; because limiting the rate at which data can be exchanged is a drag on progress.

Yet similar restrictions across cable networks are generally accepted. The necessary splitting of frequencies for upstream and downstream traffic has imposed a heavy cost, putting a significant chunk of the frequency range beyond use. Today some of your network's theoretical resources are left constantly dark in a 'crossover area', effectively dead. It cannot be accessed...until now.

Technetix has developed and patented an amplifier solution which puts the entire frequency range into play. Not only does the amplifier allow all of the frequencies to be used all of the time, the frequency split becomes so flexible that it can adapt in real time to the live balance of upstream and downstream traffic. Perhaps even more significantly, it opens cable to the world of full duplex networks.

WHAT MOTIVATED THIS INNOVATION?

In the 1990s, bandwidth demand was still dominated by the downstream traffic of broadcast TV. This downstream-hunger was further exaggerated from 2000 onwards with web page downloads, followed by video streaming. Some things do not change. Households and businesses still hunger for more bandwidth - but of a different shape. FaceTime, live Instagramming and TikTok all require a different up/down balance. This made us contemplate - what if we could release the frequencies currently being held captive? In answering that question, cable operators are given an entirely new world of possibilities.



DNx amplifier

Firstly, our amplifier solution has the potential to spark a renewed surge of product innovation. Escaping fixed frequency splits means re-opening the possibilities of what the customer can buy and how households can be billed.

If the customer will be better served by an up:down ratio of 1:5 rather than the 1:10 commonly baked-into networks today, then the technical restrictions on doing so have been lifted. Even a complete reversal to 5:1 is no longer problematic.

Many a broadband product manager has been bound by what felt like basic physics. Changing these parameters makes market innovation inevitable. Some customers might pay handsomely for unrestricted upload speeds that constantly adapt to actual usage patterns? What could you do with these capabilities?

Secondly, this innovation can create improved market competitiveness for cable networks and the potential for a fresh source of growth in subscribers. An innovative cable product can shift the center of gravity in the market, away from low-cost options towards the premium end. Market momentum, currently shared across a range of competitors, could be tilted in your favor.

With a network constantly adapting to the flows of upstream and downstream traffic, you will be providing a decidedly premium product to your existing customer base as well.

Not only do you have the opportunity to generate additional consumer demand, it is likely to come to you at a higher price point. At the very least it will help you reduce subscriber churn and margin erosion.

Thirdly, and just as significantly, we believe we can help you reduce the long-term cost of network operations. Once upgraded, cable networks become far more efficient. As all frequencies are being used, capacity is immediately increased. The medium-term needs for further network upgrades are diminished, taking cost out of operations.

Meanwhile, the economics of flexibility are transformed. In fact, the financial risk inherent in the potential of the up/down traffic pattern changing over time is solved permanently. Instead of buying new, rolling trucks and upgrading your network - simply update the proportion of bandwidth given to upstream data.

It might be worth running your CFO through the implied long-term savings.

All of this suggests the amplifier innovation presented has the ability to significantly improve the margin profile of cable operators over the next two decades, securing and extending their market relevance for the long-term - as well as offering obvious immediate gains.

That is, after all, what Technetix is here to do.

SO HOW DOES IT WORK?

To make this paper intelligible to a general audience, we'll take this question from first principles and work up. If you're a more technical reader you might want to go to 'Enter the diplex-free amplifier' on page four.

TODAY'S NETWORKS MAKE FOR EVER-INCREASING LOSSES

As everyone in the broadband industry knows, cable networks need amplifiers to increase the 'gain' of downstream signals from the headend to homes and businesses. Equally, they 'boost' the upstream signal from customer premises to the headend.

This, however, poses a problem. How does the amplifier know which signals are going down - and which are going up? Without physical separation, the signals lose all integrity.

Industry convention has solved the issue by using lower frequencies for upstream traffic and higher frequencies for the downstream. This is why your network uses diplex filters (DPFs) - they separate the upstream from the downstream by detecting the frequency of the signals. We can easily isolate the upstream via a low pass filter (LPF) and the downstream via a high pass filter (HPF).

It is the combination of the LPF and HPF that creates the diplex filter, shown in Figure 1.

Once the split has been made, the signals that have been isolated can be amplified. An amplifier with DPFs is represented in Figure 2.

The downstream signal receives gain from the left and it is pushed out to the right. The upstream signal gets its gain from right to left.

So far, so good! Let's complicate things slightly now with a look at the practical implications of frequency separation.

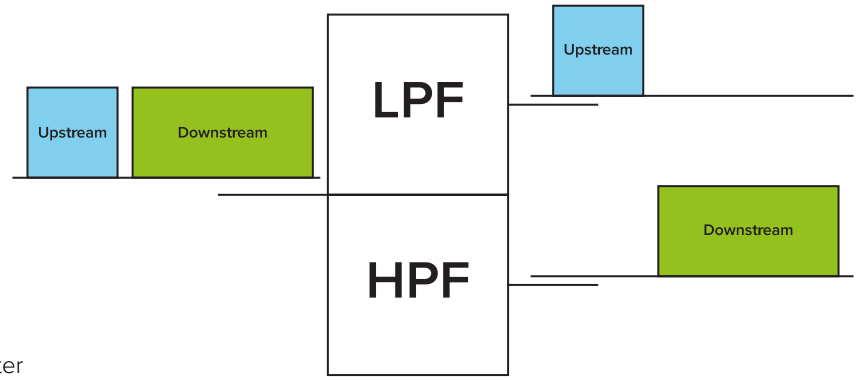


Figure 1_The diplex filter

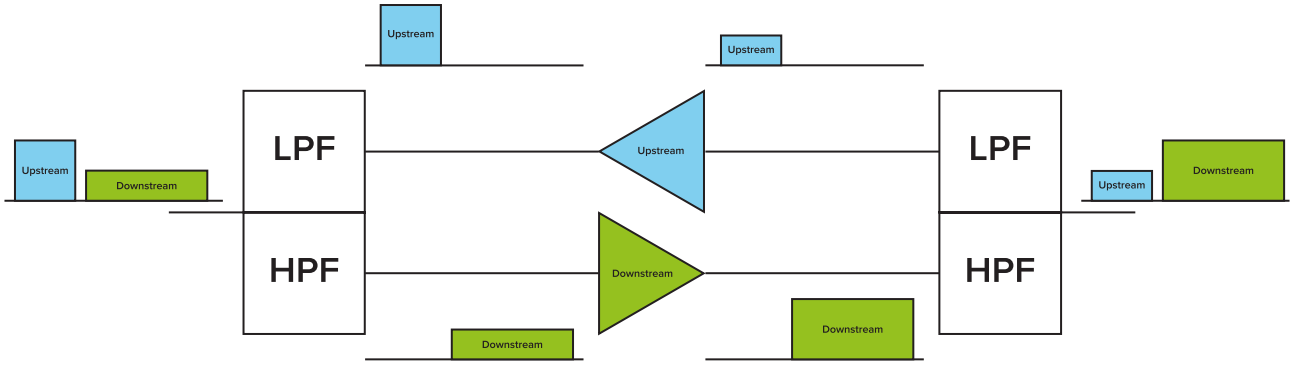


Figure 2_An amplifier with diplex filters

Logic dictates that if different frequencies are allocated, a decision must be made on where the split between them occurs. This also decides the proportion of the signal given to the upstream and downstream.

However, all technology is limited - one of the limitations of this technique is the need to leave a gap between the two separation frequencies. Today's cable network amplifiers require some frequencies to be left unused. There has to be space between the end of the lower frequencies for the upstream signal and the start of the higher frequencies for the downstream.

A common frequency combination is 42/54 MHz for instance. In this example, the upstream uses frequencies up to 42 MHz and the downstream starts at 54 MHz. The gap between the two frequencies is known as the 'crossover area', shown in Figure 3.

The extent of the crossover area is dictated by the steepness of its edges. Normally, the steepness is about 22%. This means that, as a percentage of where the high frequency starts, a crossover area of 22% is needed. In this particular case that means that 12 MHz of the spectrum cannot be used, which is disappointing when trying to optimize network efficiency and capacity.

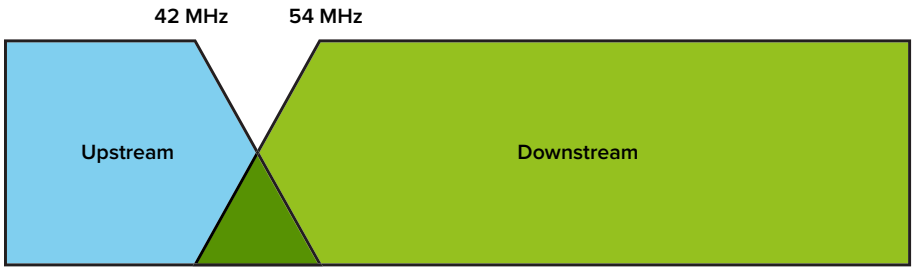
It gets worse - the problem escalates as the split frequency shifts to higher frequencies. As the percentage loss remains constant, the absolute frequency darkness within the crossover area gets larger. For instance, if the downstream frequencies start at 85 MHz, the crossover area is 20 MHz.

Accounting for other network objectives, common channels have emerged and it is easy to see how the crossover area eats into a large proportion of the capacity.

So, the higher the split frequency, the larger the crossover area and the greater frequency loss. This is a real limitation that has added cost to network operations through the inherent inefficiencies. Until now, the losses and the costs were unavoidable, as shown in Table 1.

ENTER THE DIPLEX-FREE AMPLIFIER

While frequency splits enabled by diplex filters were fabulous in making cable networks functional, they have never been a perfect solution. The crossover area delineates the area for improvement. An entirely different approach was required to achieve full frequency use.



Split	LPF (MHz)	HPF (MHz)	Crossover area (MHz)
42/54	42	54	12
65/85	65	85	20
85/105	85	105	20
204/258	204	258	54
684/804	684	804	120

Table 1_Common channels and their crossover areas

Instead of relying on the frequency of the traffic to imply its direction, the Technetix diplex-free amplifier uses a patented isolator to detect it directly.

While conceptually this is a less complex process than splitting frequencies, in practice it was not technically feasible. Figure 4 shows how, now that this has been achieved, it greatly simplifies the amplification process. The downstream signal from left to right gets gain from the top amplifier. The upstream gets boosted from the amplifier below.

Note - there is no need for a crossover area - because there is no frequency split and no gap between the lower and higher frequencies. Figure 5 clearly shows the difference between a diplex filter spectrum and a flexi-split/diplex filter free spectrum.

As there are no filters the cable network operator can choose where the upstream frequency stops and the downstream frequency starts. There is no frequency gap and it is entirely flexible. In fact, this 'flexi-split' frequency can be changed constantly, in real time, to adapt to changing demand conditions if required.

There is another option: the network no longer requires a frequency split at all. The isolator in the diplex-free amplifier only detects direction of travel, meaning that cable networks can benefit from all the characteristics of being full duplex. Figure 6 shows the upstream can simply be placed right on top of downstream.

The final notable benefit of a filterless network is that it's possible to add a downstream signal in the middle of the upstream. This is very advantageous as some CPE devices need a downstream maintenance carrier at low frequencies. Figure 7 shows an example of such a signal plan.

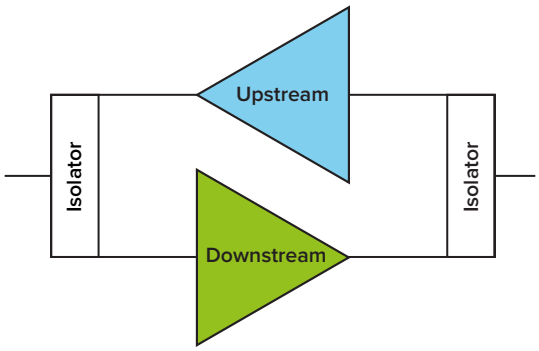


Figure 4_The diplex-free amplifier

Amplifier with diplex filters

Technetix diplex-free amplifier

Figure 5_Comparing frequency use

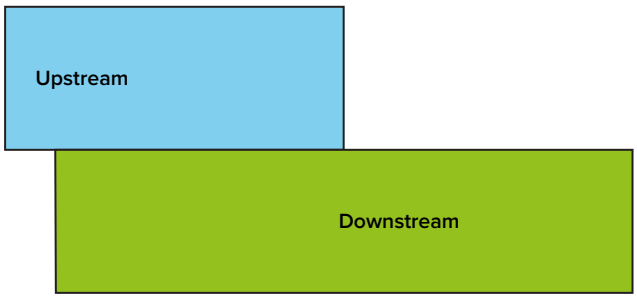


Figure 6_Full duplex frequency use

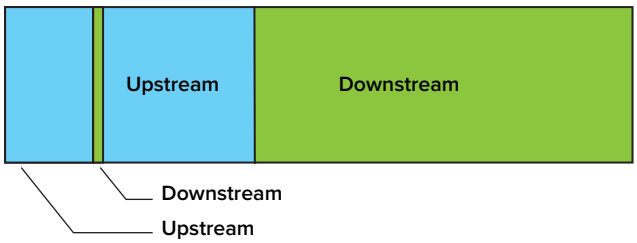


Figure 7_Signal plan with a downstream signal in the upstream band

DNx 1.8 GHz

As a result of the patented technology outlined in this White Paper, Technetix has developed the innovative DNx 1.8 GHz amplifier. This amplifier eliminates the need for diplex filters, the upstream is already 684 MHz and the downstream increases to 1800 MHz. The DNx 1.8 GHz is compatible with full duplex DOCSIS (FDx), extended spectrum DOCSIS (ESD) and frequency division duplexing (FDD). This low power amplifier (< 6 Watt) is the ideal building block for a distributed gain architecture (DGA). It is the perfect fit for every network operator looking to achieve the DOCSIS 4.0 standard.

Features	
Low power	< 6 Watt
Size on an outdoor tap	6"x4"
Upstream	12 - 684 MHz gain @ 684 MHz = 7 dB
Downstream	85 - 1800 MHz gain @ 1800 MHz = 20 dB
Tilted (anti-coax) frequency performance	

IN CONCLUSION

Technetix is enormously excited by this latest innovation. The diplex-free amplifier solves a long-standing problem with so much elegance and simplicity that it is difficult to over-estimate the technical impact. This is an entirely different category of amplifier, unlike anything seen previously and cable networks all over the world are about to be transformed.

The real potential is the impact on your bottom line, with no frequency loss via crossover areas; the flexi-split or full duplex options have the power to change the economics of cable networks.

This flexibility will reduce operating expenditure by reducing labor costs, making it practical to maintain existing CPE devices and increase the reliability of the network. It is the perfect addition to a High Efficiency Low Maintenance (HELM) network.

We expect a wave of product innovations and improvements to lead to more subscribers paying higher average subscription rates. Improvements which will be projected against a lower cost of network provisioning and maintenance over the long-term.

Together these factors have the power to change the industry's margin profile for decades - it amplifies everything.

For more information about the DNx amplifier, please contact:

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