

Lightvision

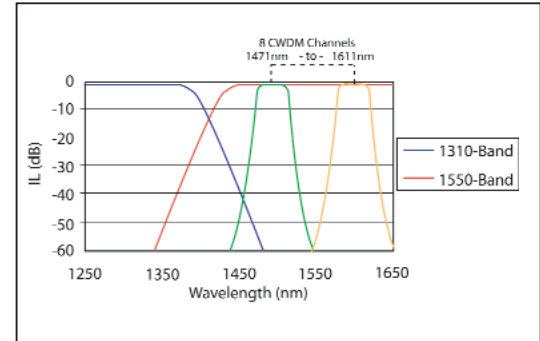
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Save Space and Money With An Ultra-Wide Bandwidth, Ultra-High Isolation Band Separator

Fed up with WDM couplers that all-too-often have a non-flat spectrum and poor isolation? Lightwaves2020's thin film filter (TFF) based Ultra-Wide band, Ultra High Isolation WDM provides greatly improved isolation (> 45dB) and greater operational bandwidth (1310±50nm / 1460~1620nm) than typical WDM couplers without compromising performance.

The TFF based WDM has the same 5.5 x 40mm cylindrical package as conventional 3-port devices, saving on board space. With the addition of the band splitter, an upgrade option is provided for legacy 1310/1550 nm systems in access, CATV and other types of networks that expands their capacity through CWDM technology.



CWDM has the advantage of providing a low-cost entry point into WDM with earlier prove-in than DWDM. By adding up to 8 CWDM channels in the 1550 nm band, the capacity can be easily and cost effectively upgraded eight-fold. Our high isolation separator is a necessary device because it guarantees adequate signal crosstalk block-out throughout the entire 400 nm wavelength range, whereas each of the CWDM channels are only capable of channel isolation around 200 nm. Furthermore, by providing the same high isolation in the 1310 nm band, the high quality signal is obtained.

This innovative 1310/1550 nm WDM can be used in metro access, 10 GbE, CATV, FTTH-PON, and other short-haul point-to-point systems.

Features

- Ultra-wide bandwidth (160 nm for 1550-Band and 100 nm for 1310-Band)
- Ultra-high isolation (> 45dB)
- Low insertion loss (< 1.0dB)
- Standard Ø5.5 x 40mm package
- Highly reliable

Applications

- SONET/SDH legacy upgrade
- Optical gigabit Ethernet
- Access networks
- Video/Telephony overlay

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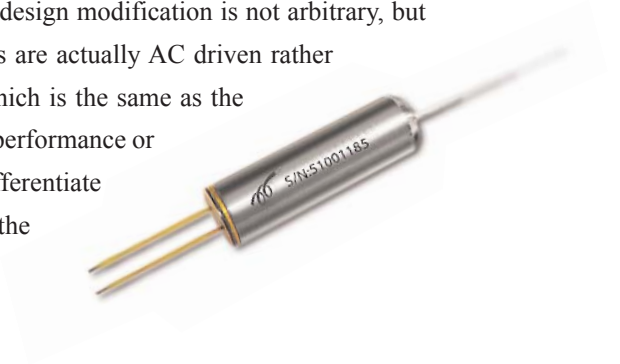
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Lightwaves2020 Liquid Crystal VOA User Tips



Many of you may have noticed that our Liquid Crystal based VOA has changed from three electrical pins to two. This design modification is not arbitrary, but is due to the fact that LC based VOAs are actually AC driven rather than DC. Since the third pin was for the ground, which is the same as the device case, it could be eliminated without affecting performance or reliability. In addition, it is not necessary to differentiate between the two remaining pins when mounting the VOA onto the driver board because AC driving voltage depends only on the voltage difference between the two pins.



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A NOVEL EDFA Module for CATV

Lightwaves2020

1323 Great Mall Drive, Milpitas, CA 95035-8037
Tel. 408-503-8888 Fax. 408-503-8988
www.lightwaves2020.com



A Novel EDFA Module that Dramatically Reduces the Noise Figure Through LC Based Polarization Management

Noise Figure Requirements in CATV

Signal to Noise Ratio (SNR) is one of the most critical performance parameters for analog signals. That is why the noise figure (NF) requirement for optical amplifiers in CATV applications is always a lot stricter than in the telecom industry. At the same time, unstable performance through the wide operating temperature range of -40 to 85°C poses additional obstacles to achieving a low NF. CATV networks require amplification solutions that provide high output power (13 - 23dBm) and a low NF (< 4dB) at an affordable price. Although SOA has a greater operational frequency range (able to operate in 1310 nm band) and low cost to power ratio that facilitates its deployment in CATV systems, it currently faces several limitations that impede its performance. These limitations include non-linear effect, polarization sensitivity, multi-channel interference and, most importantly, a high NF. Compared to SOA, EDFA is more attractive due to its design flexibility and noise figure compensation ability. Major suppliers report a typical NF for CATV EDFA of between 3.5 and 4.0 dB.

Why LC Based Low NF EDFA for CATV?

NF compensation in EDFA does not usually come cheap. Typical methods of achieving a low NF include: stabilizing pump wavelength (TEC), low loss passive components, FBG wavelength locker and high quality EDF fiber. None of the aforementioned methods is cost effective. By making use of liquid crystal's birefringence to manage the state of polarization (SOP) (combined with a polarizer), however, a low-cost solution for reducing the NF can be achieved. Liquid crystal

(LC), popular due to its no-moving part adjustment scheme, high reliability, simple control mechanism and compact size, is easily embedded into the current EDFA package with negligible additional cost.

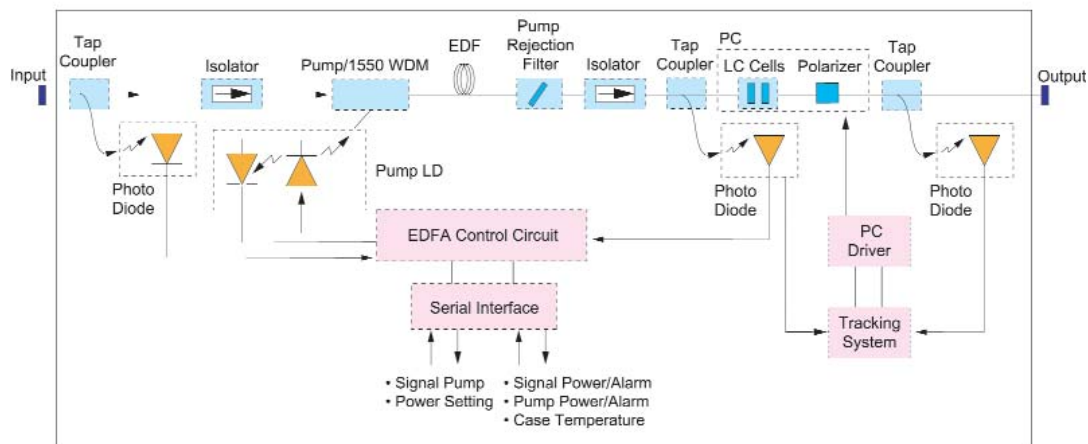
Noise Figure Reduction Mechanism

Amplified spontaneous emission (ASE) is the main source of reduced output SNR in EDFA. The power of ASE, which can occur at any frequency, is emitted isotropically with each of the photons having a random SOP [1]. In contrast, unlike ASE noise the signal normally generated from a laser transmitter is linearly polarized and maintains a coherent signal during transmission [1]. Thus, by putting a PC whose polarization axis is adapted to that of the signal, half of the noise power is immediately blocked without affecting the signal. This forms the solution for reducing the NF in a single channel optical amplifier. LC, well known for its electrically adjustable birefringent characteristics, combined with a polarizer, forms a highly reliable and low cost solution for the polarization controller (PC) in EDFA.

Low NF EDFA Structure

Lightwaves2020's EDFA integrates the amplification unit, isolation units and monitoring units to meet the maximum power needs of CATV networks. The figure below shows the functional diagram of a single stage EDFA using a 980 nm cooled pump. For higher output power, two-stage and backward pump options are available.

The minimum noise level is achieved by integrating two LC cells, both of which have a maximum phase delay of half a



LC based low NF EDFA functional diagram



wavelength, and a polarizer to form a PC. The LC molecular alignment directions of the two cells need to be different (recommended to be normal for maximum trackable SOPs). From the Jones Matrix calculation [2], it is known that the coherent input of any SOP can be converted into a linear SOP through two variable waveplates. By aligning the polarizer direction to the pre-determined linear SOP, the coherent signal will be filtered out with minimal loss while half of the noise is blocked. To monitor the output and control the 2-cell polarization controller, a closed-loop structure is set up by adding the third power monitor after the PC. Combined with the power monitor at the output side of the EDFA, the optical power before and after the PC can be monitored and the desired linear SOP can be achieved and maintained when the power difference reaches the minimum value. The tracking scheme for the 3-cell/4-cell PC is still used for 2-cell LC adjustment, but the tracking speed is much quicker due to the 2-cell PC's simpler structure.

The LC based low NF EDFA is suitable for single channel amplification since the multiple channels may have different SOPs. The allowable polarization state modulation frequency is limited by the tracking speed of the polarization controller.

Applying the LC Based Low NF EDFA

The LC based low NF EDFA has great potential in CATV applications since, as stated previously, NF is the most critical performance parameter for analog signals. Providing single channel CATV EDFA with a significantly lower NF will allow much higher quality signals with a longer reach and dramatically improved system stability. The LC based low NF EDFA can also be used as a high performance pre-amp before the receiver in telecom networks. The negligible additional cost is offset by dramatic improvements in overall system performance, including BER and distance.

We welcome Your Comments and Suggestions

This technical discussion is our forum for brainstorming new ideas for future technologies. We would like to encourage you to participate in this discussion to help move our next generation products forward and facilitate technology breakthroughs in the fiber optic industry.

Reference

- [1] Optical Electronics in Modern Communications, Amnon Yariv, Oxford University Press, New York 1999
 [2] Optics of Liquid Crystal Displays, Pochi Yeh, Claire Gu, John Wiley & Sons, Inc, New York 1999.

- Lightwaves2020 attended InterOpto'03 in Chiba City, Japan from July 15-18 with our distributors, Sun Instruments and NSG. Although over all attendance was down from last year, those who did show were focused mainly on next generation systems and cost reduction, resulting in considerable interest in our intelligent components, especially our intelligent VOA and EDFA.

- Lightwaves2020 will deliver eight technical papers at the OECC 2003 tradeshow in Shanghai, China. The show will be held from Oct. 13th to Oct. 16th. Lightwaves2020's submissions include two papers on narrowband EDFA, two on LC based VOA, two on Fiber Bragg Gratings, one on Gain Flattening Filters and one on the manufacture of dispersion slope compensators based on sampled fiber grating.

- Building on our experience developing MSA compatible EDFAs, Lightwaves2020 introduces an MSA compatible Gain Block EDFA. This product will enable us to benefit from markets where EDFAs with a standardized form factor and functionality are required while also getting excellent gain flattening capability in the same package.

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Art Designer	Roger Kuo