

High Speed Tunable Filter

Speed and Resolution: The Recipe for Success

White Paper



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Executive Summary

This white paper discusses the problems facing wavelength tunable optical components for optical communications, sensor, medical, and military applications prior to introducing the opportunity for companies who are in need of the finest solution. Many different technologies offer to select target wavelengths dynamically and they mainly rely on the optical resonant cavity approach where benefits include high resolution and broad tuning range. The Lightwaves2020, Inc. solution is cost-effective and has superior performances that outclass the competition.

The Problem and Opportunity

In today's optical systems for optical communications, sensor, medical, or military applications, accurate control of wavelength channels has become a priority as speed and wavelength channel density demands have increased. In the case of the number of operating wavelengths available in the optical spectrum, high densities facilitate the system's ability to utilize or to communicate a larger information capacity. The challenge is the ability to accurately choose certain wavelengths or channels over others in a broad range that covers from 800nm-1600nm. Using traditional technologies such as fiber resonators, wavelength coverage is simplistic; characteristics such as signal resolution, isolation, and tuning speed on the other hand have been very difficult to improve.

Key Opportunity

If wavelengths can be tuned with superior resolution, optical systems offer extremely high efficient spectral usage for communications. In terms of sensing as another example, this ability offers differentiation of very similar yet different subjects. For instrumentation optics, high resolution abilities in addition to excellent inter-wavelength isolation increase precision for measurement purposes. In any wavelength monitoring applications, this ability is a must have.

Speed of wavelength tuning has not progressed in recent years mainly due to inevitable delay restriction of previous technologies. For example, to tune a fiber resonator, only thermal and mechanical effects offer any manipulation. Usually, response speeds are in the ms-orders, which are undetectable by the naked eye. Television program transmission relies on the fact that as long as the human eye is unable to detect the delay image changes, ms-order optical

system response speeds are sufficient. Even current high capacity wavelength division multiplexing communication systems of today operate with ms-order switch and component delays. The ability to increase wide-range wavelength tuning speeds into the μ s-order opens new and greater opportunities and applications not only in the communications field.

Potential Benefits

The potential benefits of adding high performance and high-speed tunable filters to existing or new optical systems include the following:

- Leverage of decreasing cost per wavelength range
- Reduction of signal loss
- Increase monitoring capacity
- Increase of instrument precision
- Reduction of optical or decision delay
- Increase wavelength selectivity
- Increase signal quality

The ability to decrease cost of spectral usage is advantageous especially when multi-wavelength usage have been increasing in all applications involving wavelength selectivity. Signal loss reduction is another advantage resulting from not only insertion loss, but how well the target wavelength can be isolated from other wavelengths. The other major added benefits include increase in tuning capacity, high resolution, and high speed of optical decision.

Basic Applications

The following examples indicate some of the basic applications of high resolution and high-speed tunable filters. For sensor applications, these tunable filters can be utilized to scan and detect received wavelengths from subjects with florescence, scattering, and reflections such as organic substances, strained materials, and inorganic particles. High finesse provides the increased capacity of detection and high speed provides the quickness of the detection process.

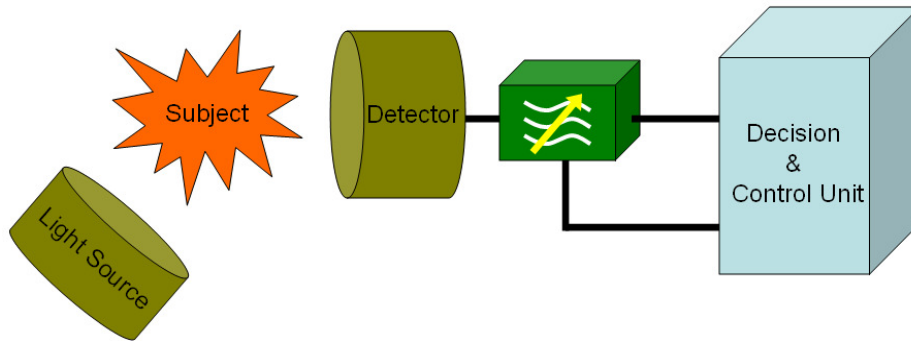


Fig. 1: General optical sensor application with high-speed tunable filter.

In the case of communications, tunable filters are capable of selecting a number of input and output channels for ultra fine resolution optical add/drop multiplexing and wavelength selective switch applications as well as high-performing noise filters to reduce background or inter-channel noise for improved signal to noise ratio performance.

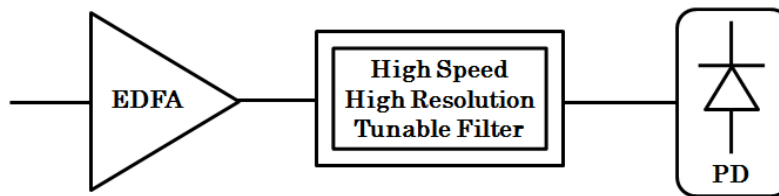


Fig. 2: Noise reduction filter application.

The Lightwaves2020 Solution

The Lightwaves2020 solution for channel wavelength filtering is the high-demand high-speed High Speed Tunable Filter with excellent optical and reliability specifications suitable for a wide area of applications. The High Speed Tunable Filter relies on a Fabry-Perot etalon type resonating cavity that allows for high performing tunable capability with Lightwaves2020's high performance reflector coatings. There are no moving parts in the device and it is shock resistant.

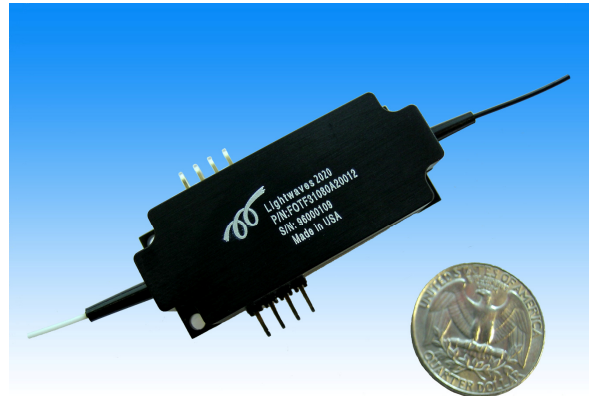


Fig. 3: Lightwaves2020 High Speed Tunable Filter Module.

High Speed Tunable Filter Applications

The High Speed Tunable Filter can be applied to a wide range of applications with some listed below.

- High resolution optical spectrum analysis (OSA)
- Optical performance monitoring (OPM) and optical channel monitoring (OCM)
- Tunable channel add / drop for WDM
- Tunable optical noise filtering
- Tunable laser and instrument
- Optical IR spectroscopy
- Sensor application and optical /electronic warfare
- Biomedical imaging and testing
- Medical diagnosis
- Environmental protection, food safety, anti-drug and anti-terrorism applications

High Speed Tunable Filter Features

The main optical characteristics of the tunable filter are listed below. With higher finesse, the amount of isolation of the filtered channel increases and along with narrow linewidth, channel density or filtering sensitivity also increases. The side lobe suppression ratio is high, which will guarantee noise of the filter be kept to a minimum. Since the High Speed Tunable Filter is capable of realizing wide free spectral range (FSR) spectral characteristics, tuning range is also wide.



Features	Values
Linewidth	≤ 0.01nm
Side lobe Suppression Ratio	≥ 20dB
Tuning Range	≤ 200nm
Scan Speed	≥ 5kHz
Insertion Loss	≤ 1.5dB
Finesse	≤ 6000

With the High Speed Tunable Filter’s technology, insertion loss can be decreased to minimum levels while scanning speed can be higher than 5 kHz, which is suitable for high-speed tuning applications. Moreover, the High Speed Tunable Filter is very compact and offers excellent short-term (1 hour) and long-term (24 hours) stability.

The Benefits

The High Speed Tunable Filter incorporates a front-runner technology that has patents pending in the United States and China. This truly unique technology enables benefits that outclasses the competition and are accelerating the market demand of high performance tunable filters. A comparison of the High Speed Tunable Filter with Lightwaves2020’s linear optical filters and the competition is represented in the following table. In any optical system where wavelength selectivity is sensitive, background and added noise levels are strong factors of

performance. This performance can be strongly improved since the High Speed Tunable Filter outperforms the competition in terms of finesse and side lobe suppression ratio. Based on the High Speed Tunable Filter’s technology, the very low optical insertion loss is unmatched and is beneficial to optical systems where every decibel of optical power counts. In addition, polarization dependent losses and dispersion losses are negligible due to the High Speed Tunable Filter’s unique technology. With the High Speed Tunable Filter unique technology, scanning and tuning speeds can be increased to μs-orders and will benefit all applications where ms-order response speeds are simply too slow.

Features	Competition	High Speed Tunable Filter
Linewidth	≤ 0.01nm	≤ 0.01nm
Side lobe Suppression Ratio	≥ 15dB	≥ 20dB
Tuning Range	≤ 200nm	≤ 200nm
Insertion Loss	≤ 2.5dB	≤ 1.5dB
Scan Speed	≤ 2.5kHz	≥ 5kHz
Finesse	≤ 4000	≤ 6000

Final Remarks

Lightwaves2020’s High Speed Tunable Filter is the premier high-speed tunable filter that offers high tuning sensitivity, high tuning capabilities, lowest loss, and the high-speed performance that are unrivaled. The High Speed Tunable Filter offers unmatched benefits applicable to many applications with the objective of reducing costs and increasing the efficiency of existing and new optical systems.

Lightwaves2020 is an ISO 9001:2008 certified quality managed company with strict corporate policies of striving for zero product-return, on-time product-delivery, and on-going product improvements based on customer feedback. Lightwaves2020 holds more than 140 patents and growing and has been in the optical component industry for more than 10 years.

We strongly encourage your inquiries regarding the Lightwaves2020’s leading High Speed Tunable Filter product or discussions toward potential solutions for your applications. Lightwaves2020’s sales representative can be reached at phone number (408) 503-8888 or online through the Lightwaves2020 website at <http://www.lightwaves2020.com>.