MEMS Tunable Filter Products

MEMS Technology

Optoplex's MEMS Tunable Optical Filter is based on a patented micro-optic design with MEMS tuning technology. It is an integrated module consisting of a MEMS chip, micro-optics and control electronics and interface. When receiving a stream of optical signals of a plurality of wavelengths from the Input-Port (IN), the 2-port tunable optical filter directs a selected channel to the Output-Port (OUT). Wavelength (frequency) tuning is achieved by changing driving voltage applied to the MEMS chip, via the control electronics and the built-in firmware.

The MEMS tunable filter offers high optical filtering performance: low insertion loss and high adjacent and non-adjacent channel isolation. Moreover, the MEMS tunable filter provides high-speed tuning that is highly demanded in many applications. The standard optical tunable filter product family includes 50- and 100-GHz channel spacing.

Optoplex's MEMS tunable filter is ideal for applications from wavelength locking, optical channel monitoring and optical add/drop in optical communications; optical filtering and wavelength management in fiber sensing and spectroscopic instrumentation.

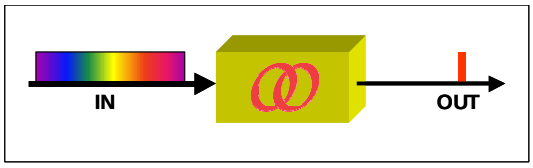

Figure 1, Functional block diagram of a tunable filter

Applications

- Wavelength selection in DWDM systems
- Optical performance monitoring
- Optical spectrum analyzer
- Tunable optical noise filtering
- Noise suppression for optical amplifiers

Key Features and Benefits

- Athermal design
- Fast tuning speed
- Compact size
- Wide tuning range, covering entire C-band or L-band
- Low TDL and WDL
- Low & uniform insertion loss
- High channel isolation
- Low power consumption
- Telcordia GR-1221 qualified

Gaussian Spectral Shape

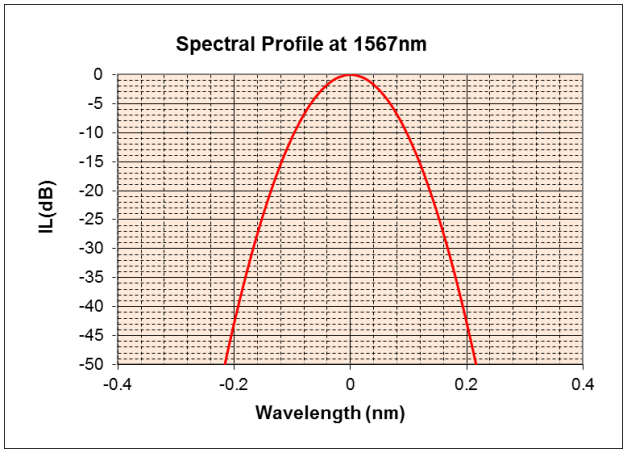

Figure 2a, Gaussian Spectral Shape (center wavelength at 1527nm)

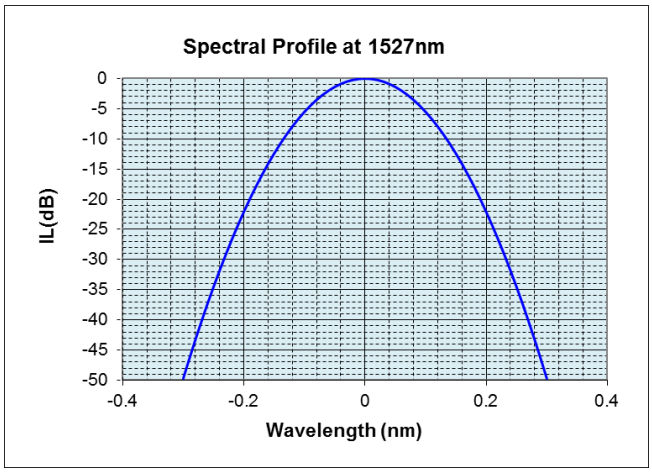

Figure 2b, Gaussian Spectral Shape (center wavelength at 1567nm)

The tunable filter is based on optical grating and MEMS technology and the spectral shape is Gaussian-type. See Figure 2a and Figure 2b.

Compact Design

The MEMS tunable filter is designed and assembled in a compact module. For instance, the optical engine of a 50GHz tunable filter is about 56x27x9.99m, while a 100GHz one (optical engine) is 35x25x8.5mm. The full function tunable filter module (including control electronics) is about 100x60x12mm.

Figure 3a, Photo of a 100GHz MEMS TF (optical engine with analog control interface, no control electronics included) . The size is 35 x 25 x 8.5mm.

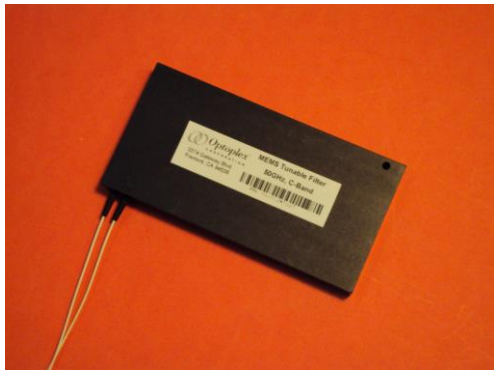

Figure 3a, Photo of a 50GHz MEMS TF full functional module with control electronics included . The size is 104 x52.5 x 12.5mm.

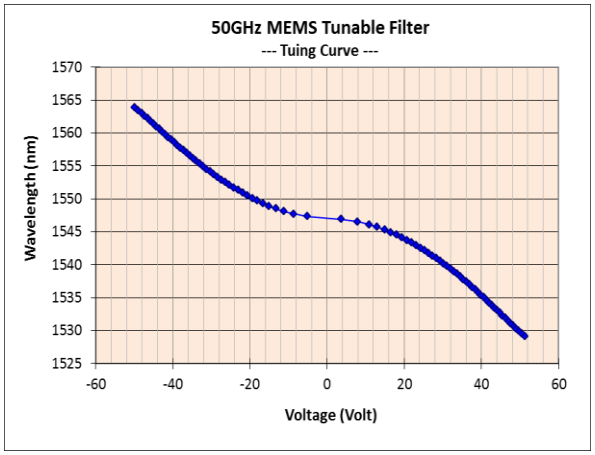

Figure 4a, Wavelength vs Voltage tuning curve of a 50GHz MEMS TF

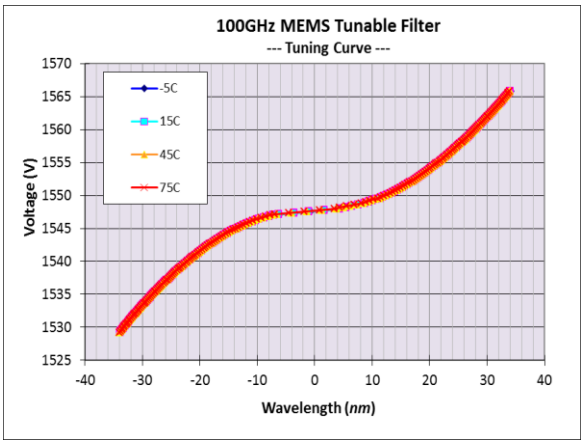

Figure 4b, Wavelength vs Voltage tuning curve of a 100GHz MEMS TF

Easy to Use

The MEMS tunable is controlled with driving voltage. With the optical engine, a analog driving voltage is from -60 to +60VDC. In the tunable filter full function module, a voltage converter is built-in, and the driving voltage is from -5VDC to +5VDC.

In manufacturing, the wavelength vs driving voltage is well calibrated (including the effect of operating temperature). With the calibration data, the user can easily tune the tunable filter to desired wavelength in an optical engine with analog interface. Or in a full function module, the user just needs to simply issue a command to tune the device to required wavelength.

Fast Tuning Speed

The MEMS tunable filters are designed to have fast tuning speed. For a MEMS TF of 50GHz channel spacing operating in C-band, the fastest tuning speed from channel-1 to channel-88 is less than 3 ms.

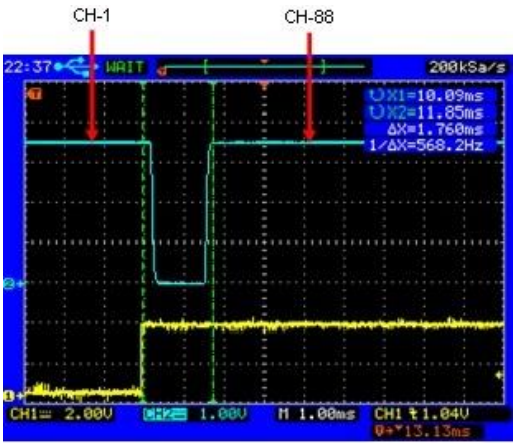

Figure 5a, Tuning from CH-1 to CH-88

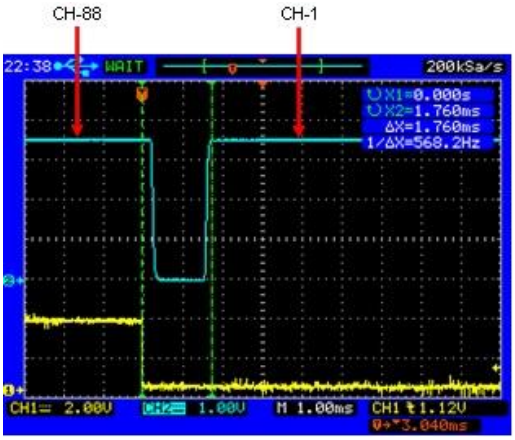

Figure 5b, Tuning from CH-88 to CH-1

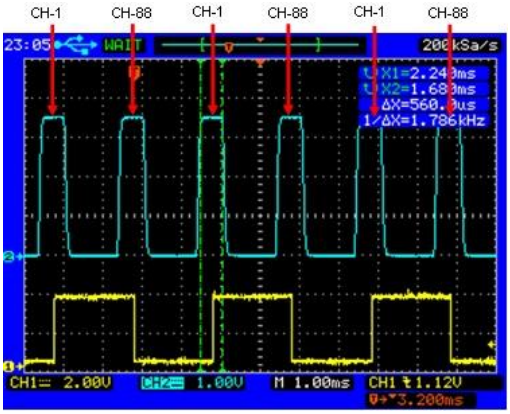

Figure 6, Tuning speed (time) from CH-1 to CH-88 and then to CH-1.

With optimized design and control, the tunable filter's tuning speed is rated as less than 20ms from any channel to any other channel in the C-band for 50GHz channel spacing MEMS TF.

Engineered Spectral Profiles

As standard offers, a 100GHz (channels spacing) MEMS TF has a typical 3dB BW of 60GHz while the standard 50GHz one has a 3dB BW of 30GHz.

For 50GHz, we have a narrower BW version with a 3dB BW, typically, of 20GHz.

The spectral profile can be custom-engineered to meet special requirements. Contact Optoplex for details.

Wavelength Coverage

For 50GHz channel spacing (3dB BW of 30GHz or 20GHz), we offer C-band or L-band wavelength coverage.

For 100GHz, we can cover C, L-, C+L or O-band (1260 ~ 1360nm).

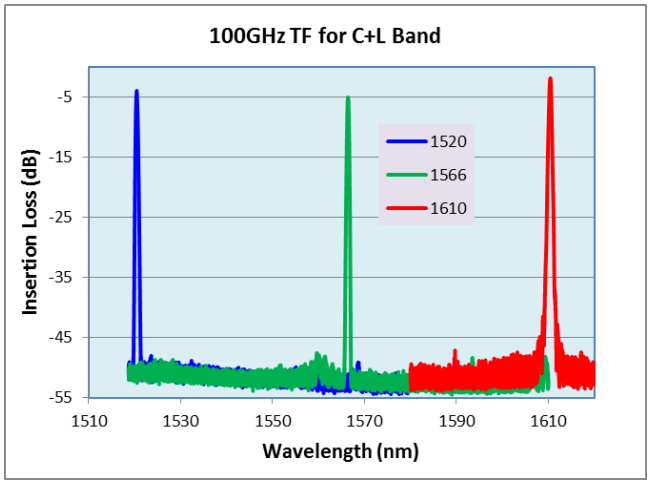

Figure 7, a 100GHz MEMS Tunable Filter with C+L Band Coverage

A full-band version with wavelength coverage from 1250 ~ 1650nm is available with FWHM of 4nm.

Contact Optoplex for details.

Environmental Stability

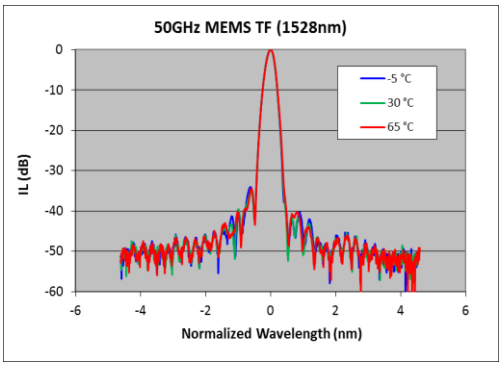

Figure 8a, Optical spectral stability of a 50GHz MEMS TF in -5°C to +65°C. Center wavelength at 1528nm.

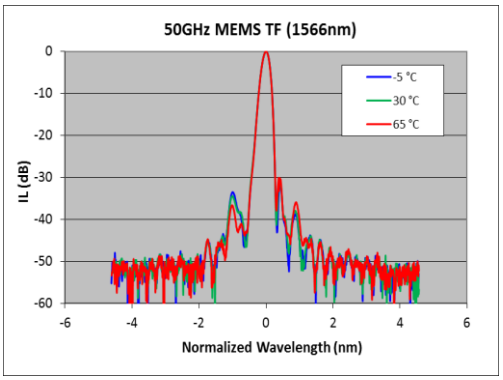

Figure 8b, Optical spectral stability of a 50GHz MEMS TF in -5°C to +65°C. Center wavelength at 1528nm.

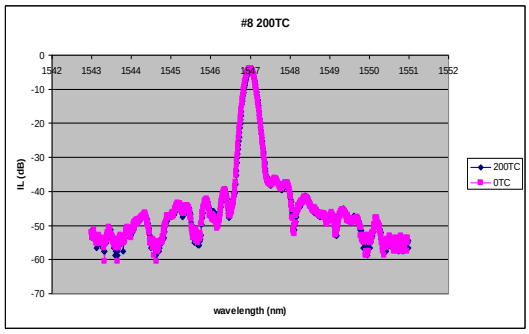

Figure 9, Optical spectral stability of a MEMS TF before and after 200 temperature cycling test.

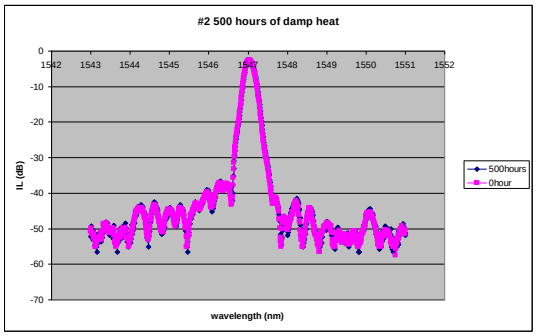

Figure 10, Optical spectral stability of a MEMS TF before and after 500 hour damp-heat test.

Operational vibration #2

Swept sine wave at a level of 2.0 g, 100 Hz to 200 Hz, 8 octaves/minute, 3 axis

Device #	X axis		Y axis		Z axis	
	Δ loss (dB)		Δ loss (dB)		Δ loss (dB)	
	V=0 V	V=35 V	V=0 V	V=35 V	V=0 V	V=35 V
#21	0.11	0.10	0.08	0.09	0.11	0.11
#22	0.12	0.12	0.10	0.11	0.12	0.11

Note: Laser wavelength was set at the peak of the TOF channels.

In-Situ Vibration and Shock Test of 100 G MEMS TOF

Test criteria: Bellcore 468			Operational vibration #2			
Swept sine wave at a level of 2.0 g, 100 Hz to 200 Hz, 8 octaves/minute, 3 axis						
	X axis		Y axis		Z axis	
	λ shift (nm)		λ shift (nm)		λ shift (nm)	
	V=0 V	V=35 V	V=0 V	V=35 V	V=0 V	V=35 V
Device #21	0.026	0.025	0.025	0.025	0.026	0.027
Device #22	0.025	0.027	0.024	0.025	0.026	0.026
Bellcore 468 Operational Shock						
10 G, 0.3 ms half-sine shock pulse, 3 axes						
	X axis		Y axis		Z axis	
	λ shift (nm)		λ shift (nm)		λ shift (nm)	
	V=0 V	V=35 V	V=0 V	V=35 V	V=0 V	V=35 V
Device #21	0.012	0.011	0.01	0.01	0.013	0.013
Device #22	0.013	0.013	0.011	0.012	0.012	0.013

Table 1, Mechanical shock and vibration test results of a MEMS TF

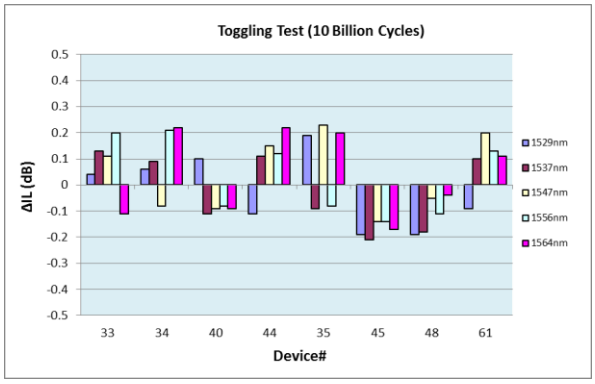

Figure 11, insertion loss change of a MEMS tunable filter at different wavelengths after 10 billion cycle toggling test

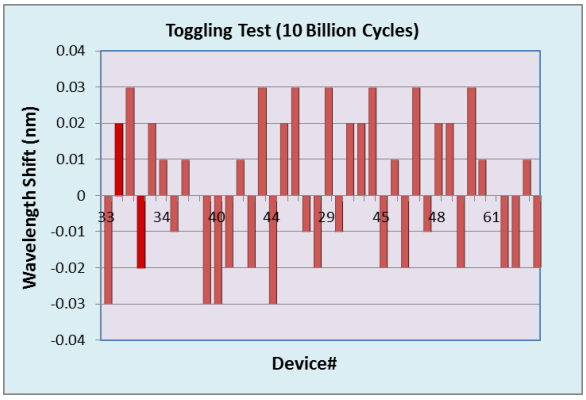

Figure 12, insertion loss change of a MEMS tunable filter at different wavelengths after 10 billion cycle toggling test

Table 2. Performance Specifications of MEMS Tunable Filters

Parameter[1)]	Unit	50 GHz Std.	50 GHz NB[2)]	100 GHz
Wavelength Tuning Range	*nm*	C - band: 1528 ~ 1562; L - band: 1567 ~ 1603		
Wavelength Tuning Resolution	*pm*	~ 10 pm or Calibrated to ITU grids		
Passband Width @ 1.0 dB	*GHz*	> 16	-	> 25
Passband Width @ 3.0 dB	*GHz*	30 (typical)	16.5 to 23.0	60
Passband Width @ 20 dB	*GHz*	<85	< 75	< 185
Peak Insertion Loss (without connector)	*dB*	< 5.0	< 6.0	< 4.0
Polarization Dependent Loss	*dB*	< 0.5	< 0.5	< 0.3
Chromatic Dispersion	*ps/nm*	± 5	± 5	± 5
Wavelength Setting Error	*GHz*	< ±4	< ±4	< ±5
Wavelength Repeatability	*GHz*	1	1	1
Return Loss	*dB*	> 40		
Maximum Input Optical Power	*mW*	500		
Tuning Speed (channel to channel)	*ms*	< 20		
Tuning Voltage	*V*	< 65	< 85	< 38
Operating Temperature	*℃*	-5 to 75		
Storage Temperature	*℃*	- 40 to 85		
Dimension (L × W × H) (Optical Engine)	*mm*	57×26×9.9	85×45×15	35×25×8.5
Dimension (L X W X H) (Full Functional Module)		104 x 52.5 x 12.5		104 x 52.5 x 12.5

Notes:

1) Unless Otherwise indicated, all performances are specified in the operating conditions: optical power, wavelength and temperature ranges
2) NB: Narrow-Band 50GHz MEMS Tunable Filter

MEMS Tunable Filter Products

Optical Engines

Optoplex can supply either the optical engines of the MEMS tunable filters with analog control interface.

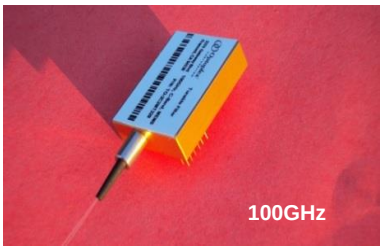

Figure 13, Optical engine of a 100GHz MEMS tunable filter

Figure 14, Optical engine of a std 500GHz MEMS tunable filter

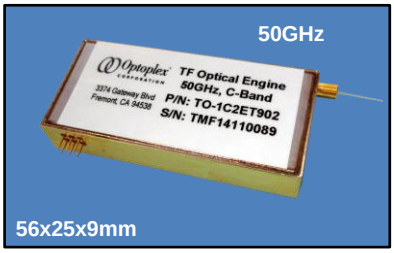

Figure 15, Optical engine of a std 500GHz MEMS tunable filter

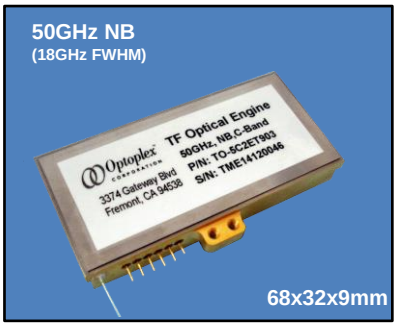

Figure 16, Optical engine of a narrow bandwidth 500GHz MEMS tunable filter

Calibration tables (refer to Figures 4a and 4b) of wavelength vs driving voltage at different temperatures will be provided by Optoplex. With this info, the user can build their own control electronics and algorithm to control the MEMS tunable filters.

Full Function Modules

Full functional MEMS tunable filter module in which driving and control electronics are built-in together with firmware are commercially available.

Figure 17, 100GHz MEMS tunable filter module

Figure 18, 50GHz (std.) MEMS tunable filter module

Figure 18, 50GHz (narrow bandwidth version) MEMS tunable filter module

With the full-function MEMS tunable filter, the user just needs to follow the electrical communication interface definition and control the MEMS tunable filter with FW command from a host.

Optoplex also supplies an evaluation kit (including a software program and a USB cable). With the evaluation kit, the user can run the program in a computer to control the MEMS TF directly.

Ordering Information

Below is the general information for ordering for Optoplex's standard MEMS tunable filters.

Table 3, Ordering info of standard MEMS tunable filters

Channel Spacing	Operating Wavelength Range	Optical TF Engine, P/N	Full Function TF Module, P/N
100GHz	C-Band	OT-2C2NM300	OT-2C2CM500
	L-Band	OT-2L2NM310	OT-2L2CM510
	C+L Band	OT-2T2NM320	OT-2T2CM520
	O-Band	OT-2O2NM330	OT-2O2CM530
50GHz	C-Band	OT-1C2NM400	OT-1C2CM600
	L-Band	OT-1L2NM410	OT-1L2CM610
	C+L Band	OT-1T2NM420	OT-1T2CM620
	O-Band	OT-1O2NM430	OT-1O2CM630

Custom design and manufacturing are available upon request. Contact Optoplex for details.

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