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Product Specification

MEMS-based Tunable Optical Filters

Optoplex Corporation

Revision 3.0

September 22, 2022

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Revision History

Rev	Date	Revision History	Originated by	Signed by
1.0	5/4/2016	Initial release	Stephanie Hung	Jindong Li
1.1	7/14/2016	<ul style="list-style-type: none"> • Revised Corporate address to 48500 Kato Road • Corrected Operating case temperature range: -5 to 65°; Optical Input Power to 10dBm (section 3) • Revised -1dB, -3dB, and -20dB BW specs, removed Spectral Shape from spec table (Table 4.1) 	Stephanie Hung	James Pang
1.2	11/9/2016	<ul style="list-style-type: none"> • Changed connector type to LC/UPC (Table 5.1) • Removed sections 7.2 Message from Host to Device Format and 7.3 Message from Device to Host Format • Added section 7.2 UART Command Format • Revised value of “Slot ID word” from “16-bit: 1 to 6” to 0 in Tables of now section 7.3 • Removed ‘S for SCS’ from Supplier serial number of section 8 Labeling 	Stephanie Hung	James Pang
1.3	2/13/2017	<ul style="list-style-type: none"> • Revised <i>Slot ID word</i> to “0x0000” in all tables of section 7.3 	Stephanie Hung	James Pang
1.4	5/10/2017	Corrected a typo on code of Command Word_1 (“RD”) (see tables in sections 7.3.4, 7.3.5, and 7.3.6)	Stephanie Hung	James Pang
1.5	7/2/2018	<ul style="list-style-type: none"> • Revised Pin 1 in section 6.2 UART Port from /Reset to Trigger. • Added several commands in section 7.3 UART command set containing: Increase TF target wavelength, Decrease TF Target wavelength, Increase TF target channel, Decrease TF target channel, Start TF wavelength scan 	Yue Chen	Songtao Du
2.0	3/16/2022	Consolidate all models and part numbers into a single document	Gary Wang	Vincent Guo
3.0	9/22/2022	Added S-Band products, two part numbers (#660 and #661)	Gary Wang	Vincent Guo

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1. DESCRIPTION

1.1 Principle of MEMS TOF

This specification defines the requirements for a 2-port O-Band MEMS Tunable Optical Filter (TOF) full function module. The TOF device is based on MEMS tuning mirror and a diffraction grating. The TOF de-multiplexes the input optical signals of a plurality of wavelengths into a selected channel as output by controlling the driving voltage. With special design of the MEMS and the control algorithm, the tuning speed can be as fast a few *milliseconds*. The transfer function of the MEMS/Grating TOF is Gaussian that offers good chromatic dispersion and group-delay performance.

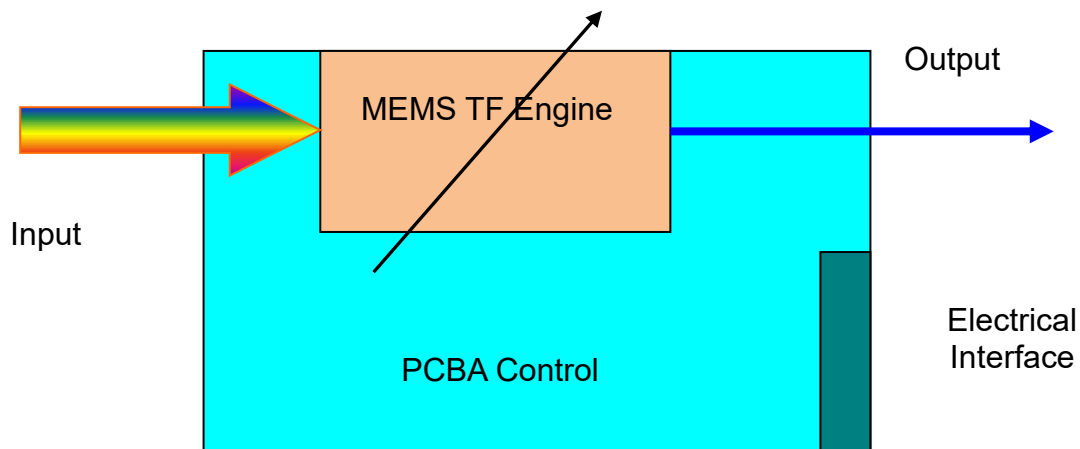


Figure 1.1, Function Block Diagram of MEMS TOF

The MEMS TOF is a compact and high-speed device that is suitable for various wavelength selection applications from wavelength locking to ROADM. Particularly, it is a good candidate for next-generation colorless, directionless and contention-less (CdC) ROADM due to its high-performance and low-cost.

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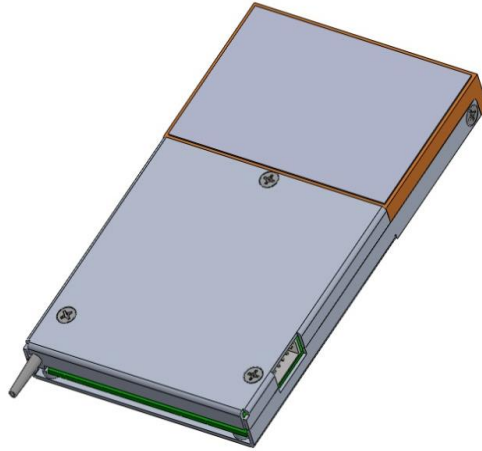


Figure 1.2, Optoplex's MEMS TF optical module

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1.2 Models and Part Numbers

Table 1, Model and Part Numbers of Optoplex's MEMS-based Tunable Optical Filters

Wave-length Bands	Product Description	Wavelength Range (nm)	FWHM (GHz)	MPN	Notes
C-Band	MEMS TF, C-Band, 30GHz BW	1528 ~ 1567	30GHz	TO-1C2FM500	
	MEMS TF, C-Band, 20GHz BW	1528 ~ 1567	20GHz	TO-1C2FM502	
	MEMS TF, C-Band, 1.0nm BW	1528 ~ 1567	1.0nm	TO-5C2FM503	
	MEMS TF, C-Band, 2.0nm BW	1528 ~ 1567	2.0nm	TO-9C2FM504	
	MEMS TF, 1500 ~ 1530nm, 30GHz BW.	1500 ~ 1530	30GHz	TO-1C2FM506	
	Mini MEMS TF, C-Band, 180GHz FWHM	1528 ~ 1567	180GHz	TO-9C2FM509	Small Form Factor, SFF
L-Band	MEMS TF, L-Band, 30GHz BW	1570 ~ 1611	30GHz	TO-1L2FM510	
	MEMS TF, L-Band, 20GHz BW	1570 ~ 1611	20GHz	TO-1L2FM512	
	MEMS TF, L-Band, 1.0nm BW	1570 ~ 1611	1.0nm	TO-5L2FM513	
	MEMS TF, L-Band, 2.0nm BW	1570 ~ 1611	2.0nm	TO-9L2FM514	
	Mini MEMS TF, L-Band, 180GHz FWHM	1570 ~ 1611	180GHz	TO-9L2FM519	Small Form Factor, SFF
C+L Band	MEMS TF, C+L Band, 60GHz BW	1520 ~ 1610	60GHz	TO-2T2FM620	
	MEMS TF, C+L Band, 60GHz BW. With PM Fiber	1520 ~ 1610	60GHz	TO-2T2FM620P	PM Fiber
	MEMS TF, Extended C+L Band, 70GHz BW	1500 ~ 1630	70GHz	TO-2T2FM621	
S-Band	MEMS TF, S-Band, 30GHz BW	1460 ~ 1490	30GHz	TO-1S2FM661	
	MEMS TF, Extended S-Band, 55GHz BW	1450 ~ 1530	55GHz	TO-2S2FM660	
O-Band	MEMS TF, O-Band: 1260 ~ 1360nm, 0.45nm BW	1260 ~ 1360	0.45nm	TO-2Q2FM630	
	MEMS TF, O-Band: 1260 ~ 1300nm, 0.25nm BW	1260 ~ 1300	0.25nm	TO-1Q2FM631	
	MEMS TF, O-Band: 1260 ~ 1300nm, 0.6nm FWHM (for 150GHz DWDM Appl.)	1260 ~ 1300	0.6nm	TO-3Q2FM632	

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	MEMS TF, O-Band: 1290 ~ 1330nm, 0.25nm BW	1290 ~ 1330	0.25nm	TO-1Q2FM633	
Full-Band	MEMS TF, O+E Band: 1260 ~ 1460nm, 2nm BW	1260 ~ 1460	2.0nm	TO-3E2FM640	
	MEMS TF, E+S+C+L Band: 1400 ~ 1700nm, 0.5nm BW	1400 ~ 1700	0.5nm	TO-2E2FM650	
	MEMS TF, Full-Band: 1250 ~ 1650nm, 4nm BW	1250 ~ 1650	4.0nm	TO-9F2FM690	
1030nm	MEMS TF, 1030 +/-30nm, 50GHz BW	1000 ~ 1060	50GHz	TO-2A2FM1030	
1064nm	MEMS TF, 1064 +/-30nm, 50GHz BW	1034 ~ 1094	50GHz	TO-2A2FM1064	
Special	MEMS TF, 750 +/-30nm, 0.5nm BW	720 ~ 780	0.5nm	TO-2B2FM750	
	MEMS TF, 990 +/-30nm, 0.5nm BW	960 ~ 1020	0.5nm	TO-2A2FM990	
	MEMS TF, 1930 +/-30nm, 0.5nm BW	1900 ~ 1960	0.5nm	TO-2U2FM1930C	

Notes:

- 1) For above all models and part numbers, the electrical interface, and the communication protocol (FW) are exactly same
- 2) Except those remarked as SFF and LFF in the Note column, all other models and part numbers share the same mechanical package as described in this document.
- 3) Except for those listed in "Special" category, PM fiber version will be available for all other models and part numbers. Contact Optoplex for details.


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1.3 Key Features and Benefits

- Compact in size
- High speed: $< 20 \text{ ms}$ for tuning
- High durability: 5×10^9 cycles
- High resolution: 0.5 GHz for fixed scanning
- High repeatability: 10 pm
- Low power consumption: $< 2.0 \text{ W}$
- Low TDL: $< 1.5 \text{ dB}$
- Athermal

1.4 Applications

- Wavelength locking in DWDM transmission system
- ROADM
- Optical performance monitoring
- In-band OSNR measurement
- Tunable optical noise filtering
- Noise suppression for optical amplifiers
- Other spectral analyzing systems

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2. ABSOLUTE MAXIMUM RATINGS

Table 2, Absolute Maximum Ratings

Item	Parameter	Symbol	Condition	Min	Max	Unit
1	Storage temperature range	T_{stg}		-40	85	°C
2	Storage humidity	RH_{stg}	Non Condensing	5	95	%
3	Maximum optical power handling	P_{opt_max}	Continuous wave on any input port		23	dBm
4	Fiber bend radius	R		25		mm
5	Fiber tensile load		10 seconds max		5	N
6	Mounting screw torque		2#-56 screws	0.07		N.m
7	Electro static discharge (ESD) threshold voltage	V_{ESD}	HBM		500	V

The MEMS TOF device is hermetically sealed package. Helium gas leak rate is $< 4.0 \times 10^{-9}$ ATM-cc/s.

3. OPERATING CONDITIONS

Table 3, Operating Conditions

Item	Parameter	Symbol	Condition	Min	Typ.	Max	Unit
1	Operating case temperature range	T_{case}		-5		65	°C
2	Relative humidity range	RH	Long Term, non condensing	5		90	%
3	Operating wavelength range	λ		Refer to Table 1			nm
4	Optical input power	P_{op}	Continuous			10	dBm

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4. OPTICAL PERFORMANCE SPECIFICATIONS

4.1 Optical Specifications

The MEMS Tunable Optical Filter (TOF) is able to withstand and continue to function within specifications over the required temperature range, over the specified wavelength range, and for all polarization states of optical signals. All optical specifications are met at all temperature throughout the life of the device, unless it is mentioned explicitly.

The performance of device is not affected by the physical orientation of the device mounting. Table 4-1 shows the general optical performance specifications of the MEMS based tunable optical filter, independent of models and part numbers.

Table 4.1, General MEMS TOF Specifications

Parameters	Symbol	Min	Max	Unit	Notes
Polarization Dependence Loss	<i>PDL</i>		0.5	<i>dB</i>	
Temperature Dependence Loss	<i>TDL</i>		1.0	<i>dB</i>	
Wavelength Tuning Resolution	<i>RES</i>	-10	10	<i>pm</i>	
Absolute Center Wavelength Setting Accuracy	<i>ACC</i>	-4	4	<i>GHz</i>	
Center Wavelength Setting Repeatability		-1	1	<i>GHz</i>	
Tuning Speed			20	<i>ms</i>	
Optical Return Loss (at Input and Output Ports)	<i>RL</i>	40		<i>dB</i>	
Chromatic Dispersion	<i>CD</i>	-20	+20	<i>ps/nm</i>	<i>DG</i>
Polarization Mode Dispersion	<i>PMD</i>		0.5	<i>ps</i>	<i>DG</i>
Filter Durability		2.5*10 ⁹		<i>Cycles</i>	

The bandwidths (1dB BW, 3dB BW – FWHM, and 25dB BW), SMSR (Side-Band Suppression Ratio – also called isolation), and insertion loss (IL) are listed in Table 4.2. They are typical values.

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Table 4.2, Wavelength Bands, Bandwidths, SMSR and Insertion Loss of Different Models (P/Ns)

Wavelength Band	MPN	Wavelength Range (nm)	FWHM (GHz)	1dB BW	20dB BW	IL (dB)	SMSR (dB)	Note
C-Band	TO-1C2FM500	1528 ~ 1567	30GHz	14GHz	80GHz	4.0	30	
	TO-1C2FM502	1528 ~ 1567	20GHz	10GHz	65GHz	4.0	30	
	TO-5C2FM503	1528 ~ 1567	1.0nm	70GHz	380GHz	4.0	35	
	TO-9C2FM504	1528 ~ 1567	2.0nm	0.8nm	7.0nm	4.0	35	
	TO-1C2FM506	1500 ~ 1530	30GHz	14GHz	80GHz	4.0	30	
C-Band, SFF	TO-9C2FM509	1528 ~ 1567	180GHz	100GHz	490GHz	4.0	35	SFF: Small Form Factor
L-Band	TO-1L2FM510	1570 ~ 1611	30GHz	14GHz	80GHz	4.0	30	
	TO-1L2FM512	1570 ~ 1611	20GHz	10GHz	65GHz	4.0	30	
	TO-5L2FM513	1570 ~ 1611	1.0nm	70GHz	380GHz	4.0	35	
	TO-9L2FM514	1570 ~ 1611	2.0nm	0.8nm	7.0nm	4.0	35	
L-Band, SFF	TO-9L2FM519	1570 ~ 1611	180GHz		490GHz	4.0	35	SFF: Small Form Factor
C+L Band	TO-2T2FM620	1520 ~ 1610	60GHz	25GHz	160GHz	4.5	30	
	TO-2T2FM621	1500 ~ 1630	70GHz	40GHz	180GHz	4.5	30	
S-Band	TO-2S2FM660	1450 ~ 1530	55GHz	25GHz	160GHz	4.5	30	
	TO-1S2FM661	1460 ~ 1490	30GHz	14GHz	80GHz	4.0	30	
O-Band	TO-2Q2FM630	1260 ~ 1360	0.45nm	0.22nm	1.40nm	4.5	35	
	TO-2Q2FM630P	1260 ~ 1360	0.45nm	0.22nm	1.40nm	4.5	35	PM Fiber
	TO-2Q2FM630E	1260 ~ 1380	0.45nm	0.22nm	1.40nm	4.5	35	Extended O-Band
	TO-1Q2FM631	1260 ~ 1300	0.25nm	0.14nm	0.85nm	4.0	30	
	TO-3Q2FM632	1260 ~ 1300	0.6nm	0.30nm	2.0nm	4.0	30	

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O+E Band	TO-3E2FM640	1260 ~ 1460	2.0nm	1.0nm	5.0nm	4.5	30	
E+S+C+L Band	TO-2E2FM650	1400 ~ 1700	0.5nm	0.25nm	2.0nm	5.0	30	
Full-Band	TO-9F2FM690	1250 ~ 1650	3.5nm	2.0nm	7.0nm	9	25	
Special	TO-2B2FM750	750 +/- 30	0.5nm	0.2nm	1.5nm	5.0	30	
	TO-1A2FM940	940 +/- 15	0.15nm	0.06nm	0.35nm	5.0	30	
	TO-2A2FM990	990 +/- 30	0.5nm	0.2nm	2.5nm	4.5	30	
	TO-2A2FM1030	1030 +/- 30	50GHz	20GHz	150GHz	4.5	30	
	TO-2U2FM1930	1930 +/- 30	0.5nm	0.2nm	1.5nm	6.0	30	LFF: Large Form Factor

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4.2 Parameter Definitions

- **Insertion Loss at Peak [I_m]** is defined as insertion loss at maximum transmission within the channel passband bandwidth, without connector loss. Measured at output fiber, as shown in Figure 4.1.
- **Insertion Loss Variation** peak to peak insertion loss variation within the tuning range. Measured at output fiber.
- **PDL** is the worst case Polarization Dependant Loss at ITU wavelength. This value must be met for all channels under all operating conditions, such as temperature, aging, and any other condition that may affect the performance of the module. Measured at output fiber.
- **PDW** Maximum center frequency shift relative to target frequency, due to polarization dependence.
- **TDL** Temperature dependence loss is defined as the change of insertion loss (at a fixed polarization and wavelength) over operating temperature range.
- **-3 dB Net Bandwidth [B_{3dB}]** is measured while the filter is adjusted to this particular channel. It is the full spectral width measured at 3-dB below the peak insertion loss (I_m) point. I_m is defined above. This value must be met for all channels under all operating conditions, such as temperature, polarization, aging, and any other condition that may affect the performance of the module. Measured at output fiber.

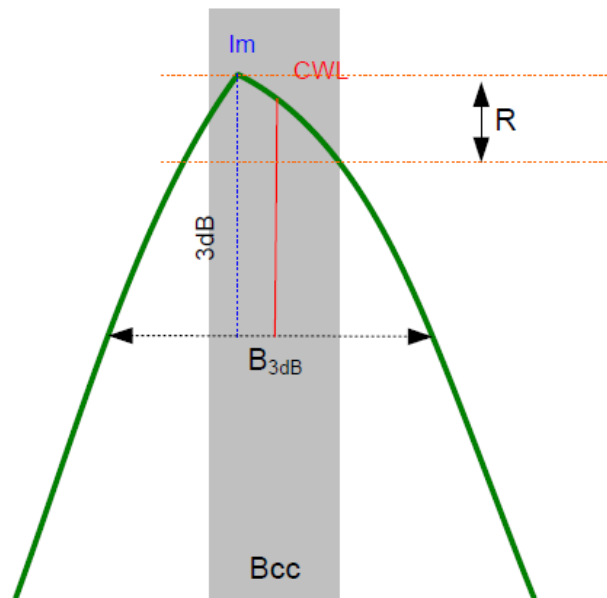


Fig. 4.1, Definitions of bandwidth, insertion loss, and ripple for a through channel

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- **Tuning Resolution [RES]**: Minimum tuning step. The filter is preferred to be tuned continuously, meaning any wavelength (or frequency) can be programmed, within the defined accuracy. Channelized tuning could also be accepted. For channelized tuning, the filter can be programmed to tune between ITU channels, within the specified accuracy.
- **Center Frequency Repeatability**: Repeatability of a channel center frequency (defined using 3-dB bandwidth) during repeated tuning of the full tuning range. Measured at output fiber.
- **Tuning Speed**: is the time needed by the tunable filter to tune from one channel to another. Defined from the receiving command to locking at the target wavelength (channel). It is dependent on the originating and destination channels.
- **Optical Return Loss [RL]** is the ratio between the input power and the reflected power over all polarization states at each port, $RL = -10 \times \log_{10}(P_r/P_{in})$. Return loss includes the connectors (if any).
- **Chromatic Dispersion [CD]**: Derivative of the Group Delay versus wavelength within the passband bandwidth.
- **Polarization Mode Dispersion [PMD]**: Maximum Differential Group Delay within the passband bandwidth.
- **Center Wavelength Absolute Accuracy [ACC]**: Including PDL. Defined as $\pm \text{Max}(|\Delta\lambda_i|)$ over all the channels and operating temperature range, where $\Delta\lambda_i$ is the wavelength measurement error against a calibrated wavelength meter for channel i .
- **Wavelength Temperature Dependence**: is the rate of a channel central wavelength versus temperature.
- **Durability**: Number of cycles the tunable filter can operate before it reaches its end of life.

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5. MECHANICAL SPECIFICATIONS

5.1 Standard Package

5.1.1 Mechanical Properties

Table 5.1, Device Size (Standard Package)

#	Parameters	Symbol	Min	Max	Unit	Notes
1	Module Dimension		112 x 68 x 12.5		mm	
2	Fiber Length		900	1100	mm	
3	Fiber Type		SMF-28+ or equivalent			
4	Fiber Jacket Type		0.9um tight buffer			
5	Connector Type		LC/UPC			Other connector type available.

5.1.2 Mechanical Drawings

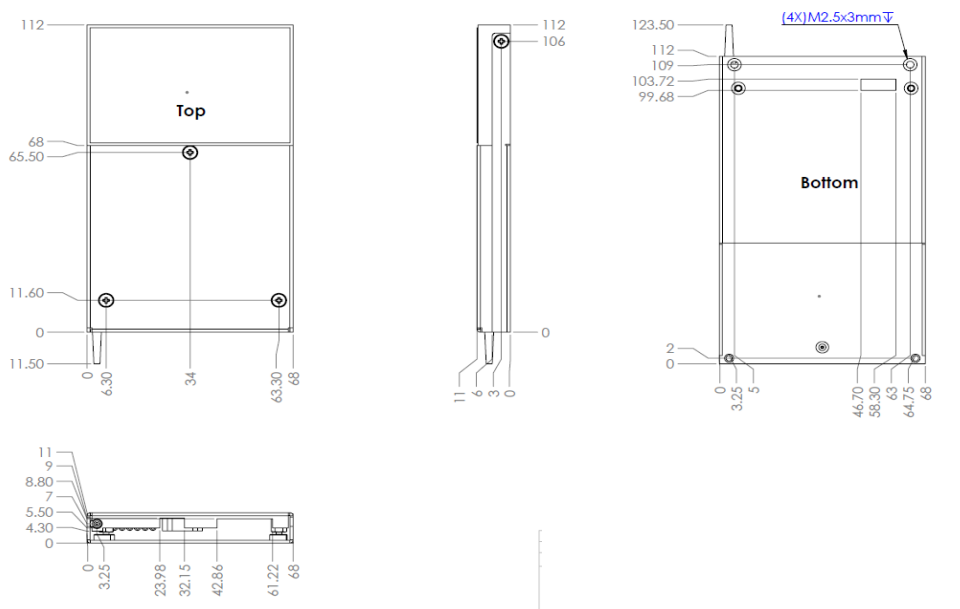


Figure 5.1, Mechanical Drawing of the MEMS TOF Package (Standard)

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5.2 Small Form Factor (SFF) Package

5.2.1 Mechanical Properties

Table 5.2, Device Size (SFF Package)

#	Parameters	Symbol	Min	Max	Unit	Notes
1	Module Dimension		40 x 30 x 10.5		<i>mm</i>	
2	Fiber Length		900	1100	<i>mm</i>	
3	Fiber Type		9/125 μm single-mode fiber			
4	Fiber Jacket Type		900 μm tight buffer jacket fibers			
5	Connector Type		LC/UPC			Other types of connector available

5.2.2 Mechanical Drawings

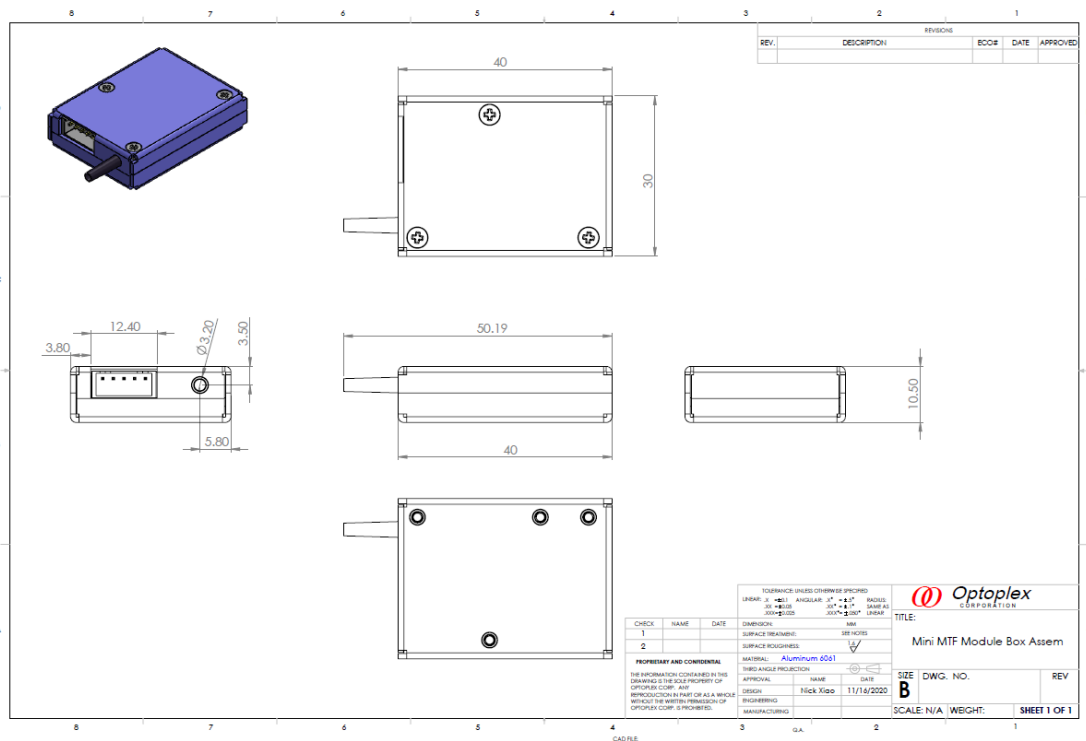


Figure 5.2, Mechanical Drawing of the MEMS TOF Package (SFF)

5.3 Large Form Factor (LFF) Package

5.3.1 Mechanical Properties

Table 5.3, Device Size (LFF)

#	Parameters	Symbol	Min	Max	Unit	Notes
1	Module Dimension		120 x 90 x 26.5		mm	
2	Fiber Length		900	1100	mm	
3	Fiber Type		Corning SM1950			
4	Fiber Jacket Type		900 μm loose tube jacket fibers			
5	Connector Type		FC/UPC			

5.3.2 Mechanical Drawings

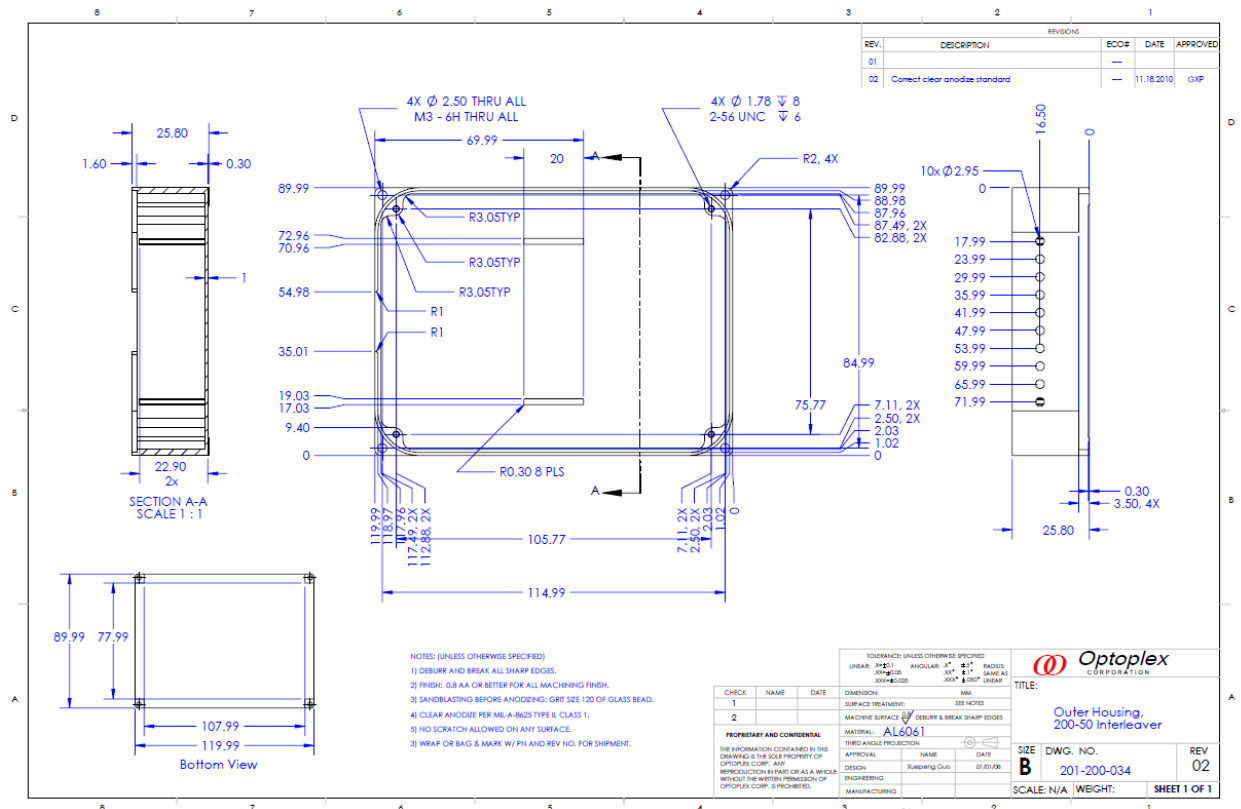


Figure 5.3, Mechanical Drawing of the MEMS TOF Package (LFF)

6. ELECTRICAL SPECIFICATIONS

6.1 Electrical Configuration

The PC sends UART commands to the OSA, and receives data from it. The data are formatted according to the two UART interface protocols as detailed in Section 7.

6.2 Power Supply

TF will accept 5V DC Power supply. Table 6-1 lists their specifications.

Table 6.1, Electrical requirements

Voltage Supply	+5.0 VDC
Typical Current	0.4 A
Maximum Current	0.8 A
Tolerance	± 10%

Notes

- (1). Power supply is 5V and 3.3V compatible. When 3.3V is used, maximum current is 1.0A.
- (2). Worst case maximum of module start, over operating temperature range.

6.3 Electrical Connectors and Pin Assignment for UART Port

UART connectors are:

Pin header on TOF: HRS DF3-5P-2DS (01)

Crimping socket for cable: HRS DF3-5S-2C

5-pin UART pin header on demo board:

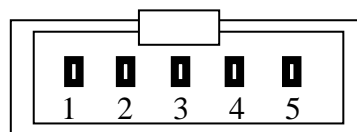


Figure 6.1: UART Connector Pin Assignment

Table 6.2: Connector Pin Assignment

Pin Number	Pin Definition
1	Trigger
2	+5V VCC
3	Device Rx (LVTTTL)
4	Device Tx (LVTTTL)
5	Ground

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7. UART COMMUNICATION PROTOCOL

7.1 Requirements

Communication Signal Level: **LVTTL**

Table 7-1: Logic Voltage Level

Symbol	Parameter	Condition	Minimum	Maximum
V(IH)	High-level input voltage		1.7 V	4.1 V
V(IL)	Low-level input voltage		-0.5 V	0.7 V
V(OH)	High-level output voltage	I(OH) = -4 to -24mA	2.4 V	
V(OL)	Low-level output voltage	I(OL) = 4 to 24mA		0.45 V

(RS232 Line Driver Level PCB is Optional)

RS232 Port Setting:

Baud Rate: 115200
Data Bits: 8
Parity: None
Stop Bits: 1
Flow Control: None

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7.2 UART Command Format

Only one type command frame format is defined for in both “request” and “response” commands. Both host (control computer) and module can send “request” to the other. Each command frame consists of 8 fields as shown in Table 7.2. Each “word” is an unsigned 16-bit number. The “Reserved word” can be any number, if it is not related to the receiver.

- 1) Field 1 is a head byte with hex value 0xAA. It is used to indicate the beginning of each command frame.
- 2) Field 2 and Field 3 are two command words. Using 32-bit double word for command to cover different type of plugged-in modules.
- 3) Field 4 is a word to count the number of words in field 5 to field 7 in each command frame.
- 4) Field 5 is a word for error message. It can be 0x00 in the request command, if there is no “error”. Add this “0” word here to make same “command frame format” for both “request” and “response” commands. Normally, the host sends a “request command” to a module, and the module (receiver) responses to the host. A module can also send a “request command” with “non-zero error word” to report “Error Message” to host, even without host’s request. Since there are multiple modules are plugged-in, some modules may be plugged-in and power-on without communication with host for a long period. The module may detect its internal failure condition and need to report to host. In this case, a module can send a “request” to host.
- 5) Field 6 is a word for “Slot ID” from 1 to 6. It is used for user computer to read module data from a selected “Slot location” through mainframe computer. Then, the mainframe computer should use this “Slot ID” number to indicate the data source when it response to the request of user computer. This word can be ignored in the commands between mainframe and plugged-in modules. However, it is better for a module to put the received “Slot ID” number back in its response.
- 6) Field 7 is for “data words”. The number of words is “Length word - 2”. The “Length word” is defined in field 4.
- 7) Field 8 is a word for “Checksum”. It is an unsigned 16-bit number of the summation of all bytes from the first byte of the “Field 2” to the last byte of the “Field 7”. It does not include “Head byte” and “Checksum word”.
- 8) Each “Word” in the field is a 16-bit number in big-endian (high byte first) format.

Table 7.2: Command frame consists of 8 fields

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8
Head byte: (0xAA)	Command word 1	Comman d word 2	Length word	Error word	Slot ID word	Data words	Checksum word

7.3 UART Command Sets

7.3.1 Host set filter target wavelength (pm) command

Table 7.3.1A: Set filter target wavelength command

Parameter	Set target wavelength (pm)
<i>Head byte</i>	0xAA
<i>Command Word 1 (“ST”)</i>	0x5354
<i>Command Word 2 (“WL”)</i>	0x574C
<i>Length word</i>	0x0004
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	0x0000
<i>Data words</i>	<i>Word_1: High 16-bit set WL (pm)</i> <i>Word_2: Low 16-bit set WL (pm)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

Table 7.3.1B: Module responses to set target wavelength

Parameter	Response to Set target wavelength
<i>Head byte</i>	0xAA
<i>Command Word 1 (“ST”)</i>	0x5354
<i>Command Word 2 (“WL”)</i>	0x574C
<i>Length word</i>	0x0004
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	0x0000
<i>Data words</i>	<i>Word_1: High 16-bit at WL (pm)</i> <i>Word_2: Low 16-bit at WL (pm)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

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7.3.2 Host set filter target frequency (GHz) command

Table 7.3.2A: Set filter target frequency command

Parameter	Set target frequency (GHz)
<i>Head byte</i>	0xAA
<i>Command Word 1 (“ST”)</i>	0x5354
<i>Command Word 2 (“FR”)</i>	0x4652
<i>Length word</i>	0x0004
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	0x0000
<i>Data words</i>	<i>Word_1: High 16-bit set Freq. (GHz)</i> <i>Word_2: Low 16-bit set Freq. (GHz)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

Table 7.3.2B: Module responses to set target frequency

Parameter	Response to Set target wavelength
<i>Head byte</i>	0xAA
<i>Command Word 1 (“ST”)</i>	0x5354
<i>Command Word 2 (“FR”)</i>	0x4652
<i>Length word</i>	0x0004
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	0x0000
<i>Data words</i>	<i>Word_1: High 16-bit at Freq. (GHz)</i> <i>Word_2: Low 16-bit at Freq. (GHz)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

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7.3.3 Host set filter target ITU channel command

Table 7.3.3A: Set filter target ITU channel command

Parameter	Set target ITU channel
<i>Head byte</i>	0xAA
<i>Command Word 1 ("ST")</i>	0x5354
<i>Command Word 2 ("CH")</i>	0x4348
<i>Length word</i>	0x0003
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	0x0000
<i>Data word</i>	Pre-defined ITU channel number 0x0000 = First ITU channel
<i>Checksum word</i>	Unsigned 16-bit integer

Table 7.3.3B: Module responses to set ITU channel

Parameter	Response to Set target ITU channel
<i>Head byte</i>	0xAA
<i>Command Word 1 ("ST")</i>	0x5354
<i>Command Word 2 ("CH")</i>	0x4348
<i>Length word</i>	0x0003
<i>Error word</i>	16-bit Error Code
<i>Slot ID word</i>	0x0000
<i>Data word</i>	Position at ITU channel number
<i>Checksum word</i>	Unsigned 16-bit integer

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7.3.4 Host read filter position of wavelength (pm) command

Table 7.3.4A Read filter position of wavelength command

Parameter	Read position of wavelength (pm)
<i>Head byte</i>	0xAA
<i>Command Word 1 (“RD”)</i>	0x5244
<i>Command Word 2 (“WL”)</i>	0x574C
<i>Length word</i>	0x0002
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	0x0000
<i>Checksum word</i>	Unsigned 16-bit integer

Table 7.3.4B: Module responses to read filter position of wavelength

Parameter	Response to read position of WL
<i>Head byte</i>	0xAA
<i>Command Word 1 (“RD”)</i>	0x5244
<i>Command Word 2 (“WL”)</i>	0x574C
<i>Length word</i>	0x0004
<i>Error word</i>	16-bit Error Code
<i>Slot ID word</i>	0x0000
<i>Data words</i>	Word_1: High 16-bit at WL (pm) Word_2: Low 16-bit at WL (pm)
<i>Checksum word</i>	Unsigned 16-bit integer

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7.3.5 Host read filter position of frequency (GHz) command

Table 7.3.5A: Read filter position of frequency command

Parameter	Read position of frequency (GHz)
<i>Head byte</i>	0xAA
<i>Command Word 1 ("RD")</i>	0x5244
<i>Command Word 2 ("FR")</i>	0x4652
<i>Length word</i>	0x0002
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	0x0000
<i>Checksum word</i>	Unsigned 16-bit integer

Table 7.3.5B: Module responses to read filter position of frequency

Parameter	Response to read position of Freq.
<i>Head byte</i>	0xAA
<i>Command Word 1 ("RD")</i>	0x5244
<i>Command Word 2 ("FR")</i>	0x4652
<i>Length word</i>	0x0004
<i>Error word</i>	16-bit Error Code
<i>Slot ID word</i>	0x0000
<i>Data words</i>	Word_1: High 16-bit at Freq. (GHz) Word_2: Low 16-bit at Freq. (GHz)
<i>Checksum word</i>	Unsigned 16-bit integer

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7.3.6 Host read filter position of ITU channel command

Table 7.3.6A: Read filter position of ITU channel command

Parameter	Read position of ITU channel
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“RD”)</i>	<i>0x5244</i>
<i>Command Word 2 (“CH”)</i>	<i>0x4348</i>
<i>Length word</i>	<i>0x0002</i>
<i>(Reserved word)</i>	<i>0x0000</i>
<i>Slot ID word</i>	<i>0x0000</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

Table 7.3.6B: Module responses to read filter position of frequency

Parameter	Response to read position of Freq.
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“RD”)</i>	<i>0x5244</i>
<i>Command Word 2 (“CH”)</i>	<i>0x4348</i>
<i>Length word</i>	<i>0x0003</i>
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	<i>0x0000</i>
<i>Data word</i>	<i>Position at ITU channel number</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

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7.3.7 Host reads filter module internal temperature

Table 7.3.7A: Read filter module temperature

Parameter	Read filter module temperature
<i>Head byte</i>	0xAA
<i>Command Word 1 (“RD”)</i>	0x5244
<i>Command Word 2 (“TP”)</i>	0x5450
<i>Length word</i>	0x0003
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	0x0000
<i>Data word</i>	<i>Temperature sensor ID (default = 0) (Support multiple Temp. sensors PCBA)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

Table 7.3.7B: Module responses to filter module temperature

Parameter	Response to module temperature
<i>Head byte</i>	0xAA
<i>Command Word 1 (“RD”)</i>	0x5244
<i>Command Word 2 (“TP”)</i>	0x5450
<i>Length word</i>	0x0004
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	0x0000
<i>Data words</i>	<i>Word_1 = Sensor ID Word_2 = Temperature (Unit=degree C/10)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

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7.3.8 Host reads MEMS tunable filter module and firmware version information

Table 7.3.8A: Read module SN and FW version command

Parameter	Read module SN
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“SN”)</i>	<i>0x534E</i>
<i>Command Word 2 (“FV”)</i>	<i>0x4656</i>
<i>Length word</i>	<i>0x0002</i>
<i>(Reserved word)</i>	<i>0x0000</i>
<i>Slot ID word</i>	<i>0x0000</i>
<i>Checksum word</i>	<i>0x01E8</i>

Table 7.3.8B: Module responses to Read SN and FW version

Parameter	Response to Read module SN
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“SN”)</i>	<i>0x534E</i>
<i>Command Word 2 (“FV”)</i>	<i>0x4656</i>
<i>Length word</i>	<i>16-bit unsigned integer</i>
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	<i>0x0000</i>
<i>Data words</i>	<i>10 words for SN (pad SPACE 0x20 for short SN) 10 words for PN (pad SPACE for short PN) 4 words for firmware version 5 words for manufacture date (MM/DD/YYYY) in ASCII format (example : 01/19/2015)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

7.3.9 Host sends “TF Start Wavelength Scan” Command

Table 7.3.9A: Start TF Wavelength Scan Command

Parameter	Read module SN
<i>Head byte</i>	0xAA
<i>Command Word_1 (“SC”)</i>	0x5343
<i>Command Word_2 (“WL”)</i>	0x574C
<i>Length word</i>	0x0006
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	16-bit: 1 to 6
<i>Data words</i>	Word_1 = 0x0001 Word_2 = Reserved Word_3 = Start pre-defined channel number Word_4 = pre-defined channel number
<i>Checksum word</i>	Unsigned 16-bit integer

Table 7.3.9B: Module responses to TF wavelength scan

Parameter	Response to Read module SN
<i>Head byte</i>	0xAA
<i>Command Word_1 (“SC”)</i>	0x5343
<i>Command Word_2 (“WL”)</i>	0x574C
<i>Length word</i>	0x0006
<i>Error word</i>	16-bit Error Code
<i>Slot ID word</i>	16-bit: 1 to 6
<i>Data words</i>	Word_1 = 0x0001 Word_2 = Reserved Word_3 = Start pre-defined channel number Word_4 = End pre-defined channel number
<i>Checksum word</i>	Unsigned 16-bit integer

7.3.10 Host increases TF target wavelength command

Table 7.3.10A: Increase TF target wavelength command

Parameter	Set target ITU channel
<i>Head byte</i>	0xAA
<i>Command Word 1 (“WL”)</i>	0x574C
<i>Command Word 2 (“UP”)</i>	0x5550
<i>Length word</i>	0x0003
<i>(Reserved word)</i>	0x0000
<i>Slot ID word</i>	16-bit: 1 to 6
<i>Data word</i>	WL increment (pm) word
<i>Checksum word</i>	Unsigned 16-bit integer

Table 7.3.10B: Module responses to Increase WL command

Parameter	Response to Increase WL Command
<i>Head byte</i>	0xAA
<i>Command Word 1 (“WL”)</i>	0x574C
<i>Command Word 2 (“UP”)</i>	0x5550
<i>Length word</i>	0x0004
<i>Error word</i>	16-bit Error Code
<i>Slot ID word</i>	16-bit: 1 to 6
<i>Data word</i>	TF Position after WL increment: Word_1: High 16-bit at WL (pm) Word_2: Low 16-bit at WL (pm)
<i>Checksum word</i>	Unsigned 16-bit integer

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7.3.11 Host decreases TF target wavelength command

Table 7.3.11A: Decrease TF target wavelength command

Parameter	Decrease target Wavelength
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“WL”)</i>	<i>0x574C</i>
<i>Command Word 2 (“DN”)</i>	<i>0x444E</i>
<i>Length word</i>	<i>0x0003</i>
<i>(Reserved word)</i>	<i>0x0000</i>
<i>Slot ID word</i>	<i>16-bit: 1 to 6</i>
<i>Data word</i>	<i>WL decrement (pm) word</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

Table 7.3.11B: Module responses to Decrease WL command

Parameter	Response to Decrease wavelength command
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“WL”)</i>	<i>0x574C</i>
<i>Command Word 2 (“DN”)</i>	<i>0x444E</i>
<i>Length word</i>	<i>0x0004</i>
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	<i>16-bit: 1 to 6</i>
<i>Data word</i>	<i>TF Position after WL decrement: Word_1: High 16-bit at WL (pm) Word_2: Low 16-bit at WL (pm)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

7.3.12 Host increases TF target Channel command

Table 7.3.12A: Increase TF target channel command

Parameter	Increase target ITU channel command
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“CH”)</i>	<i>0x4348</i>
<i>Command Word 2 (“UP”)</i>	<i>0x5550</i>
<i>Length word</i>	<i>0x0003</i>
<i>(Reserved word)</i>	<i>0x0000</i>
<i>Slot ID word</i>	<i>16-bit: 1 to 6</i>
<i>Data word</i>	<i>Channel increment word</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

Table 7.3.12B: Module responses to Increase channel command

Parameter	Response to Increase channel Command
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“CH”)</i>	<i>0x4348</i>
<i>Command Word 2 (“UP”)</i>	<i>0x5550</i>
<i>Length word</i>	<i>0x0003</i>
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	<i>16-bit: 1 to 6</i>
<i>Data word</i>	<i>TF Position after channel increment: Current TF channel number (1 = first channel)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

7.3.13 Host decreases TF target channel command

Table 7.3.13A: Decrease TF target channel command

Parameter	Decrease target ITU channel
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“CH”)</i>	<i>0x4348</i>
<i>Command Word 2 (“DN”)</i>	<i>0x444E</i>
<i>Length word</i>	<i>0x0003</i>
<i>(Reserved word)</i>	<i>0x0000</i>
<i>Slot ID word</i>	<i>16-bit: 1 to 6</i>
<i>Data word</i>	<i>Channel decrement word</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

Table 7.3.13B: Module responses to Decrease WL command

Parameter	Response to Increase WL Command
<i>Head byte</i>	<i>0xAA</i>
<i>Command Word 1 (“CH”)</i>	<i>0x4348</i>
<i>Command Word 2 (“DN”)</i>	<i>0x444E</i>
<i>Length word</i>	<i>0x0003</i>
<i>Error word</i>	<i>16-bit Error Code</i>
<i>Slot ID word</i>	<i>16-bit: 1 to 6</i>
<i>Data word</i>	<i>TF Position after channel decrement: Current TF channel number (1 = first channel)</i>
<i>Checksum word</i>	<i>Unsigned 16-bit integer</i>

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8. LABELING

Each MEMS TOF device should have a label including the following information

- A. Supplier name: Optoplex Corporation
- B. Device name: MEMS Tunable Filter, O-Band, Full Function, SM Fiber
- C. Supplier part number: **TO-2Q2FM630**
- D. Supplier serial number: CCCMTyynnnn

For the Supplier serial number: CCCMTyynnnn, CCC-Customer Code, M- MEMS, T-manufacture site (F for Fremont, W for Wuhan), yy- year, nnnn- sequential number.

- E. Production date: mm/dd/yyyy

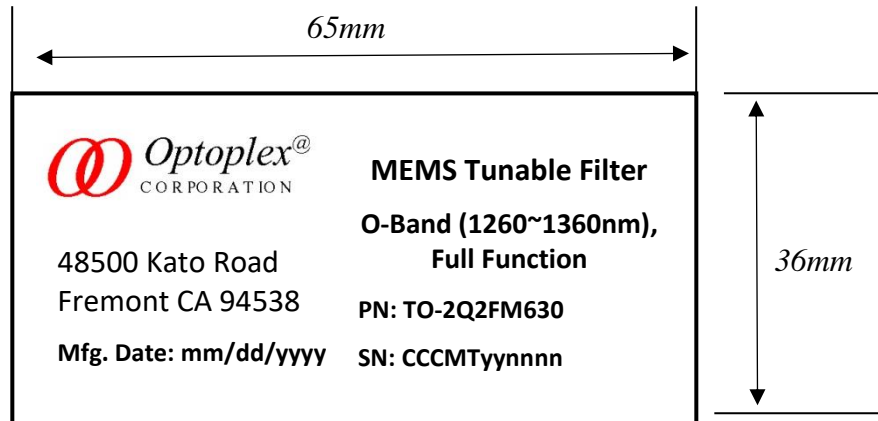


Figure 8.1, Example of Product Label (for illustration only)


(The above label for O-band MEMS TOF is for illustration only. The actual contents of the Label depend on the actual part number and its description).

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9. ORDERING INFORMATION

9.1 Models and Part Numbers

	Wavelength Range (nm)	FWHM (GHz)	MPN	Note
C-Band	1528 ~ 1567	30GHz	TO-1C2FM500	
	1528 ~ 1567	20GHz	TO-1C2FM502	
	1528 ~ 1567	1.0nm	TO-5C2FM503	
	1528 ~ 1567	2.0nm	TO-9C2FM504	
	1500 ~ 1530	30GHz	TO-1C2FM506	
C-Band, SFF	1528 ~ 1567	180GHz	TO-9C2FM509	SFF: Small Form Factor
L-Band	1570 ~ 1611	30GHz	TO-1L2FM510	
	1570 ~ 1611	20GHz	TO-1L2FM512	
	1570 ~ 1611	1.0nm	TO-5L2FM513	
	1570 ~ 1611	2.0nm	TO-9L2FM514	
L-Band, SFF	1570 ~ 1611	180GHz	TO-9L2FM519	SFF: Small Form Factor
C+L Band	1520 ~ 1610	60GHz	TO-2T2FM620	
	1500 ~ 1630	70GHz	TO-2T2FM621	
S-Band	1460 ~ 1490	30GHz	TO-1S2TM661	
	1450 ~ 1530	55GHz	TO-2S2TM660	
O-Band	1260 ~ 1360	0.45nm	TO-2Q2FM630	
	1260 ~ 1380	0.50nm	TO-2Q2FM630E	Extended O-Band
	1260 ~ 1300	0.25nm	TO-1Q2FM631	

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	1260 ~ 1300	0.60nm	TO-3Q2FM632	
O+E Band	1260 ~ 1460	2.0nm	TO -3E2FM640	
E+S+C+L Band	1400 ~ 1700	0.5nm	TO-2E2FM650	
Special	750 +/- 30	0.5nm	TO-2B2FM750	LFF: Large Form Factor
	940 +/- 15	0.15nm	TO-1A2FM940	
	990 +/- 30	0.5nm	TO-2A2FM990	
	1030 +/- 30	50GHz	TO-2A2FM1030	
	1930 +/- 30	0.5nm	TO-2U2FM1930	

9.2 Evaluation Kit (applicable to all models), [Optional](#) at additional cost

Evaluation Kit for MEMS TOF, including an UART/USB cable and a Software Program for Window-PC

MPN: [CP-MTS8C005](#)

9.3 User Manual of the Evaluation Kit:

Free-download from Optoplex website for existing customers.

10. CONTACT INFORMATION

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