Double Pass Fiber Acousto Optic Modulator

400 to 1500 nm

(patent pending)

DATASHEET

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The Optical Fiber-Coupled Double-Pass Acousto-Optic Modulator (AOM) Module is a compact, fully integrated solution for laser frequency shifting, optical switching, amplitude modulation, and modulation sideband generation in demanding applications such as quantum computing, laser cooling, atom trapping, ion trapping, precision spectroscopy, and quantum metrology. By routing the +1st-order diffracted beam through the AOM a second time, the module produces a total optical frequency shift equal to twice the applied RF frequency. The double-pass configuration inherently cancels beam angular deviation during RF frequency tuning, allowing wide-range laser frequency scanning while maintaining a fixed output beam direction and excellent fiber-coupling stability. The fiber-coupled architecture eliminates complex free-space alignment, providing robust, maintenance-free operation with stable optical input and output. The module supports arbitrary RF modulation waveforms and is available for customizable operating wavelengths from 400 nm to 1500 nm. To achieve the highest diffraction efficiency and lowest insertion loss, the module employs an optimized large-diameter collimated beam through the AOM crystal.

Features

- High polarization stability
- High coupling efficiency
- Miniaturized design, small size
- Modular design, easy integration
- Strong environmental stability

Applications

- Cold atomic system
- Quantum optics
- Lon trap system
- Quantum precision measurement system
- Quantum computing

Warning: The device needs to be mounted on a heat sink or on a metal frame

Specifications

Parameter	Min	Typical	Max	Unit
Center Wavelength	400		1500	nm
RF Center Frequency	80	100	200	MHz
RF Bandwidth (3dB)	±30		±50	MHz
Modulation Bandwidth	DC		19	MHz
Wavelength Shift	±30		±50	MHz
RF Control Resolution	1			MHz
Carrier RF Power		2.5	3	W
Insertion Loss [1]	2.5	3	3.5	dB
Polarization Dependent Loss		0.2	0.5	dB
Extinction Ratio (On/Off) [2]		50	55	dB
Rise/Fall Time [3]	10		50	ns
Return Loss [4]	45	50	55	dB
Voltage Standing Wave Ratio		1.2:1		
Polarization Extinction (PM)	20	22	25	dB
Average Optical Power [5]		0.5	5	W
Input Impedance		50		Ω
RF Power		2.5	3.5	W
Electrical Interface		SMA		
Ultrasonic Velocity		4200		m/s
Operating Temperature	-10		65	°C
Storage Temperature	-45		85	°C
Weight		26		g

Notes:

[1]. Without connector. Each connector typically adds 0.2-0.3dB, RL increase by 5dB, and ER reduces by 2dB. **1dB is for 80MHz 80ns rise/fall with special order**
PM connector key is aligned to the slow axis as a default.
Insertion Loss refers to output - input at ON state. Other wavelength band the loss may be higher

[2]. For Single Mode only, multimode reduces depend on mode filled ratio
ER refers to output power ratio between ON/OFF states

[3]. (10%-90%). The rise/fall and bandwidth are related to the beam size, small beam has higher insertion loss. In another word, fast response with larger bandwidth will add insertion loss

[4]. 50dB is standard for SM, 45dB for 50/125

[5]. @1550nm. For shorter wavelength the power handling is reduced due to smaller core size. Higher power version is available by expand the beam inside the fiber tip.

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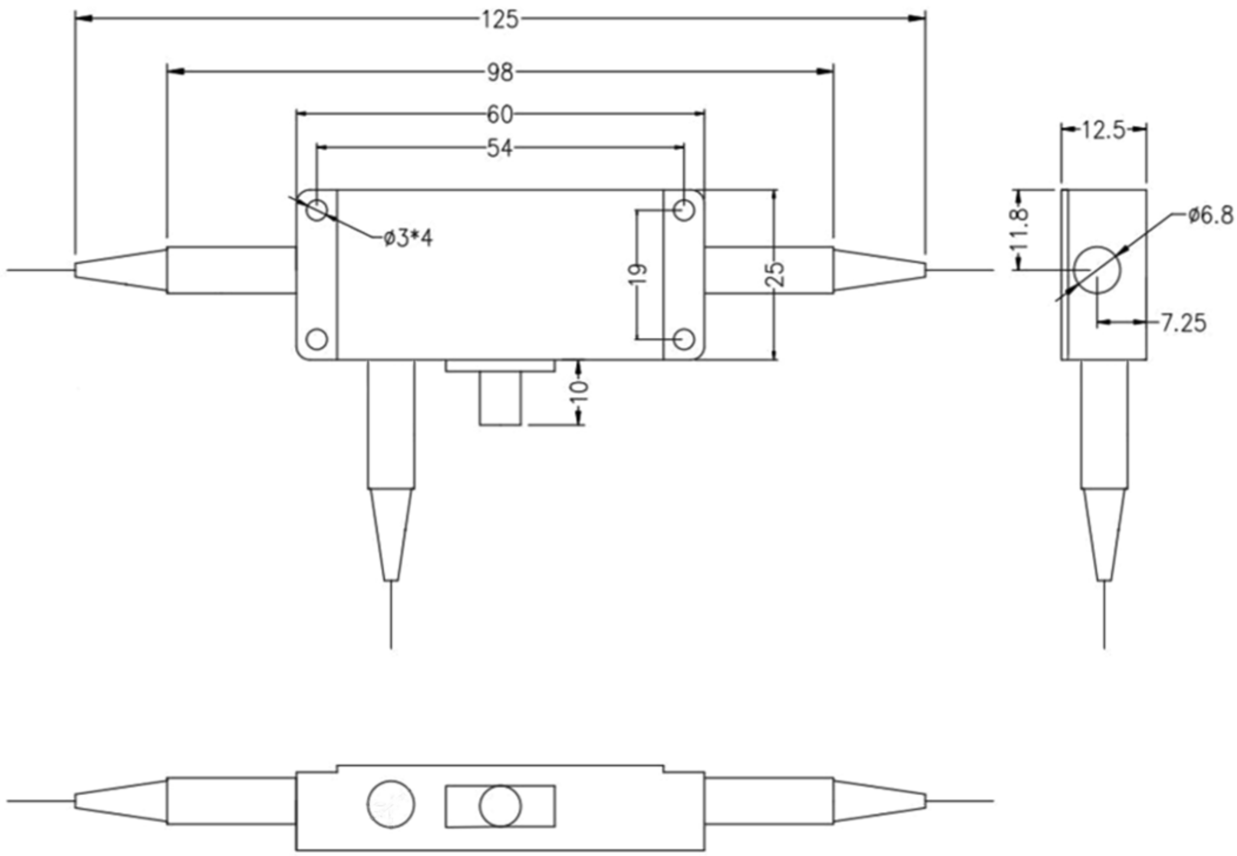
Mechanical Dimensions (mm)



*Product dimensions may change without notice. This is sometimes required for non-standard specifications.

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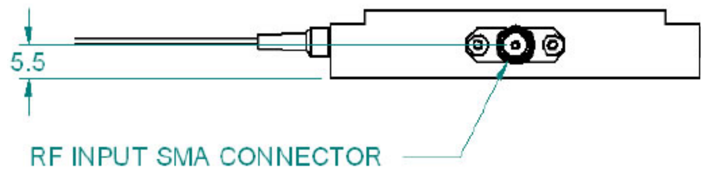
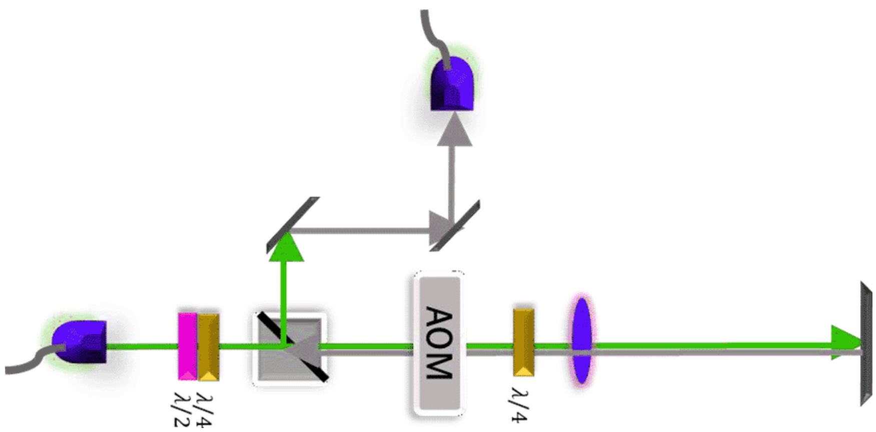
Electrical/Computer Connection



Optical Path



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Ordering Information (Part Number)

	☐	☐	☐	☐	☐☐	☐	☐	☐	☐	☐
Prefix	**Center Frequency**	**Wavelength**	**Insertion [1]**	**Optical Power**	**Fiber Type**	**Fiber Cover**	**Fiber Length**	**Connector [2]**	**PER [3]**	**Package[4]**
AOMD-	80MHz = 8 200Mhz =2	1060 nm = 1 1550 nm = 5 1310 nm = 3 980 nm = 9 850 nm = 8 780 nm = 7 630 nm = 6 530 nm = A 450 nm = 4 Special = 0	2.5dB = 1 1.6dB = 2 1.5dB = 3 15ns R/F = A 25ns R/F = B	Regular = 1 0.5W = 2 1W = 3 5W = 4	***Select fiber below***	0.9mm tube = 3 Special = 0	0.25m = 1 0.5m = 2 1.0 m = 3 Special = 0	None = 1 FC/PC = 2 FC/APC = 3 SC/PC = 4 SC/APC = 5 ST/PC = 6 LC/PC = 7 5WFC/PC = H 10WFC/PC = A	Non = 1 18dB = 2 20dB = 3 25dB = 4 29dB = 5	Component = 1 With Driver = 2

[1]. Without connector, each connector add 0.3dB. For 1310-1550nm. Short wavelength and >1900nm, the loss is higher. The default version is optimized for low loss with rise/fall times under 55ns. Version A is tuned for faster response but with higher loss, while Version B offers moderate rise/fall times with more loss than the default.

[2]. The default connector configuration uses fiber with 0.9mm buffer protection. The connector cannot be installed directly onto bare fiber because the bare fiber is prone to damage during shipping. However, the connector can be assembled on bare fiber if a 3 cm protective loose tube is added for reinforcement. The customer may remove this protective tube after testing. The optical power handling of a standard connector is less than 0.5W for SMF-28 fiber and decreases further for smaller-core fibers.

[3]. Polarization extinction ratio only for PM fiber

[4]. The benchtop integrates the modulator, driver, and power supply. Front Panel: SMA 0-5V electrical control input port for precise modulation. Fiber input and output ports with standard FC/APC connectors. Back Panel: 100-240 VAC power input for global compatibility and a Power switch for easy on/off control.
This all-in-one design simplifies setup and operation

Fiber Type Selection Table:

01	**SMF-28**	34	**PM1550**
02		35	**PM1950**
03		36	**PM1310**
04	**SM450**	37	**PM400**
05	**SM1950**	38	**PM480**
06	**SM600**	39	**PM630**
07	**780HP**	40	**PM850**
08	**SM800**	41	**PM980**
09	**SM980**	42	**PM780**
10	**Hi1060**	43	
11	**SM400**	44	**PM405**
12		45	**PM460**

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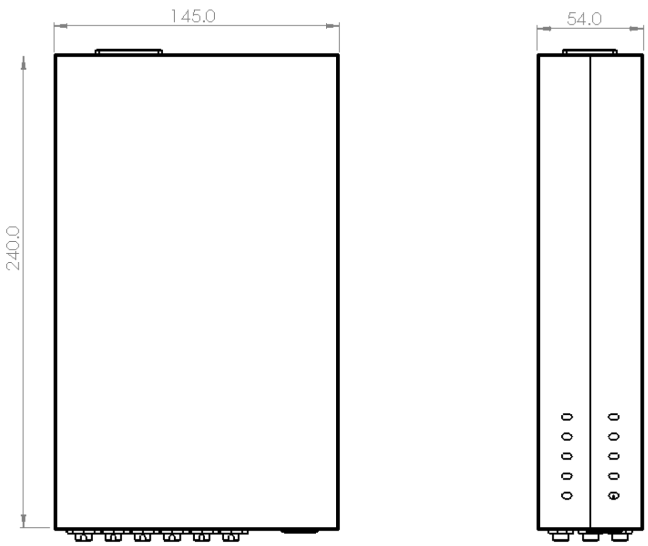
Benchtop Box Mechanical Dimension



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Setup Instructions

- Connect a laser with a wavelength matched to the specified part number to the fiber input.
- Connect the modulator to the accompanying driver using the provided cable.
- Connect a DC power supply to the driver (refer to the AOM driver datasheet for detailed specifications).
- Connect the control signal to the SMA input port.
- The fiber optical output amplitude and repetition rate will vary according to the electrical control signal.

Application Notes

Fiber Core Alignment
Note that the minimum attenuation for these devices depends on excellent core-to-core alignment when the connectors are mated. This is crucial for shorter wavelengths with smaller fiber core diameters that can increase the loss of many decibels above the specification if they are not perfectly aligned. Different vendors' connectors may not mate well with each other, especially for angled APC.

Fiber Cleanliness
Fibers with smaller core diameters (<5 μm) must be kept extremely clean, contamination at fiber-fiber interfaces, combined with the high optical power density, can lead to significant optical damage. This type of damage usually requires re-polishing or replacement of the connector.

Maximum Optical Input Power
Due to their small fiber core diameters for short wavelength and high photon energies, the damage thresholds for device is substantially reduced than the common 1550nm fiber. To avoid damage to the exposed fiber end faces and internal components, the optical input power should never exceed 20 mW for wavelengths shorter 650nm. We produce a special version to increase the how handling by expanding the core side at the fiber ends.

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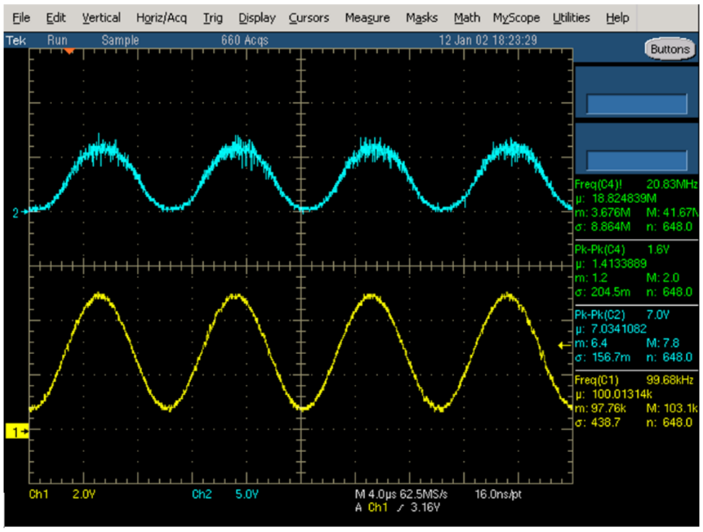
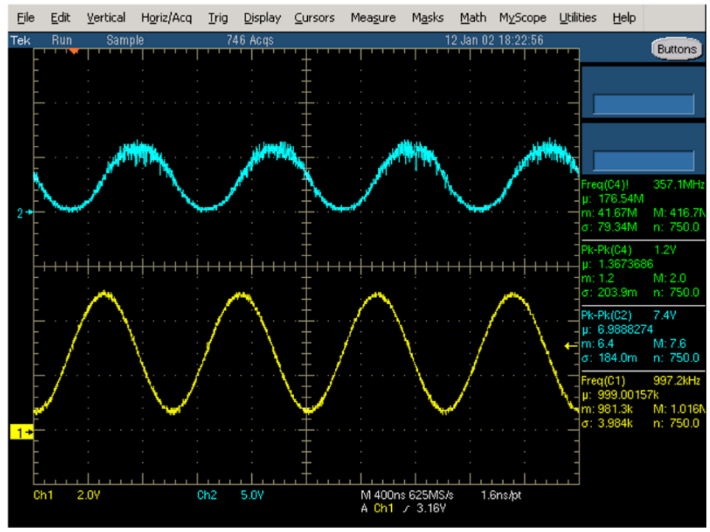
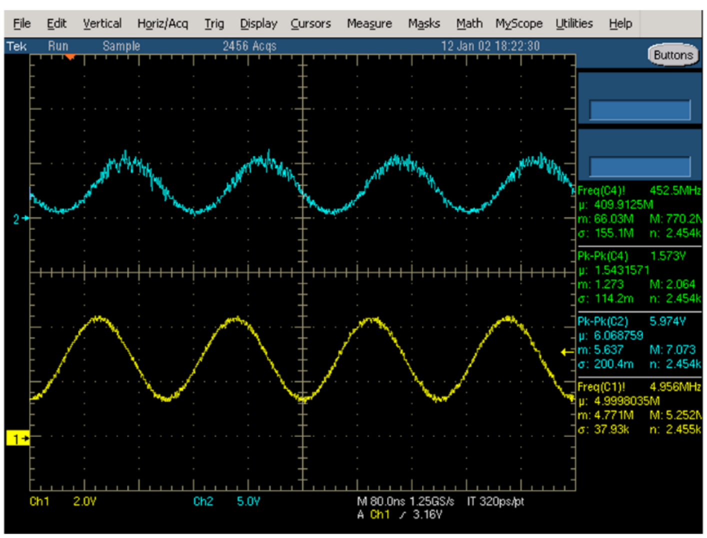
Modulation Response (Top Optical/Bottom Electrical)



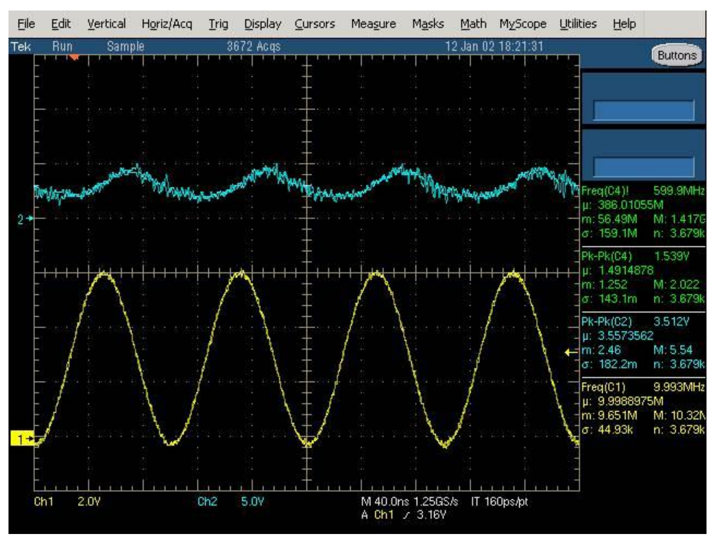
1 kHz



1 MHz



5 MHz



10 MHz

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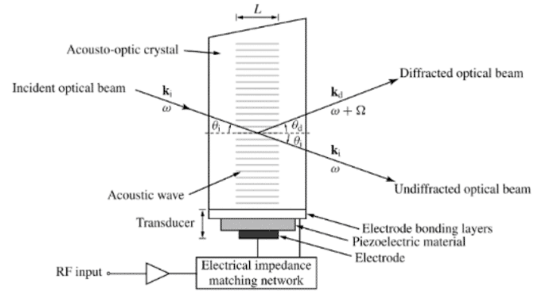
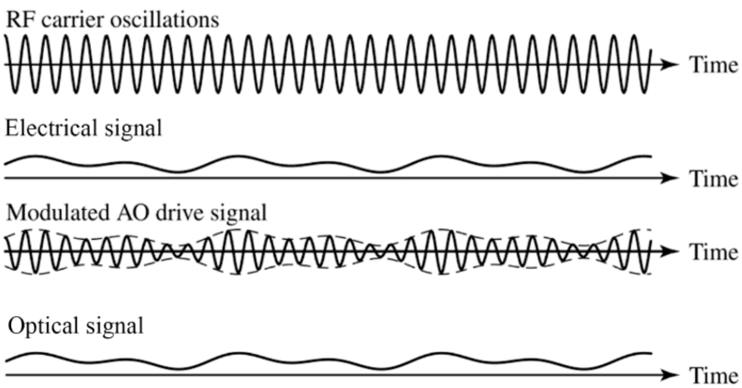
Acoustic Frequency

The operation of an acousto-optic modulator is based on the Bragg diffraction generated by an acoustic wave (traveling refractive grating) inside a crystal, as shown below. The **Acoustic Frequency** is fixed for each device. A RF voltage of the acoustic frequency is applied to the piezoelectric actuator attached to the crystal generating the acoustic wave. The higher the frequency, the higher the cost to make and higher the power consumption.



Modulation Bandwidth

An optical intensity modulator can be achieved by a driving circuity in which the acoustic intensity inside the crystal varies with an input modulation signal. A typical acoustic driver output is shown below: a RF Input electrical signal modulates the intensity profile of the carrier oscillations (acoustic frequency), resulting in a modulated driving signal, which leads to an output optical intensity similar to the RF input. The acoustic frequency intrinsically determines the rise/fall of the optical modulation. The Modulation Bandwidth is proportional to the acoustic frequency. The optical response can be optimized to certain extend via the driving circuit such as digital or analog.



Optical Wavelength Shift

Due to an energy exchange, all acoustic optical devices apply a frequency shift to the diffracted output beams. These optical wavelength shifts are very small and proportional to the acoustic frequency. Depending on the selected Bragg angle, these devices will either up-shift or down-shift the laser light by the frequency of the applied RF signal.

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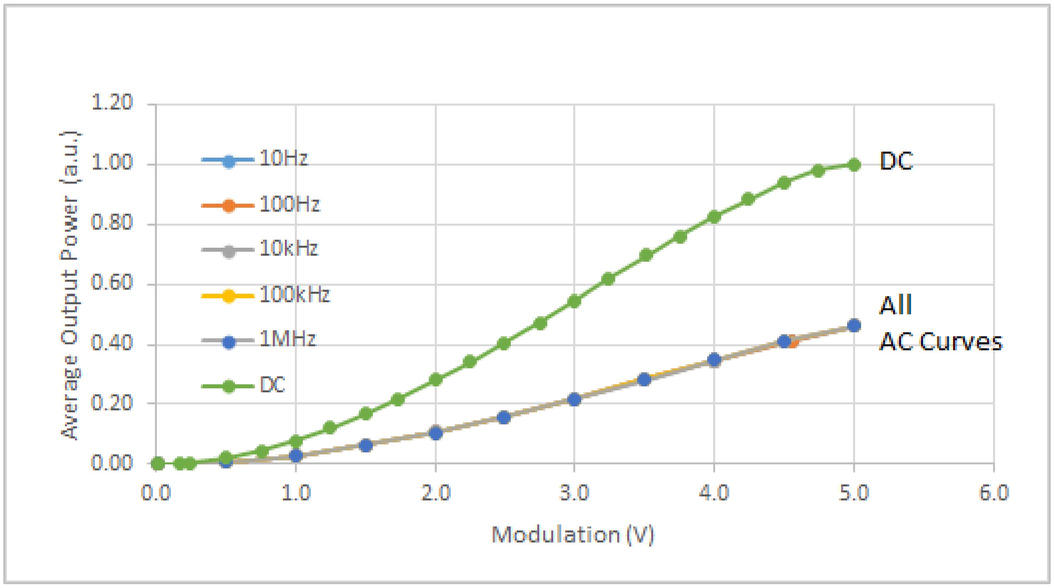
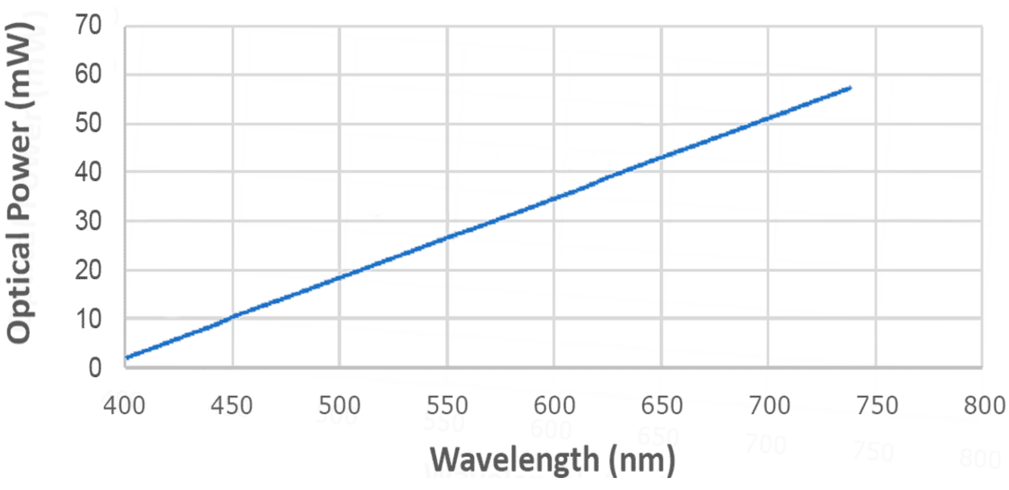
Typical Attenuation vs Control Signal for 200MHz AOM



Optical Power Handling vs Wavelength for Standard SM Fibers



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Typical Stability (@ -20dBm with DC and 1kHz AC control. Fluctuation < 0.1dB)