Fiber-Fiber™ Optical Switch 1x1, Dual 1x1, 1x2

(SM, PM, MM, Broadband, Bidirectional, <0.5ms Fast Switching)

DATASHEET

Return to the Webpage

The FF Series fiber optic switch offers nearly lossless transitions, ultra-broadband capability with minimal wavelength dependence (limited only by fiber characteristics), rapid switching (<1 ms), low temperature sensitivity, high on/off ratio, vibration resistance, and cost-effectiveness. It connects optical channels through direct fiber-to-fiber coupling, utilizing an in-house, wafer-level produced silicon-based micro-mechanical auto-alignment platform. The continuous optical path is filled with index-matching liquid between the two coupling fibers, eliminating the need for lenses or coatings and avoiding surface reflection issues. This robust, temperature- and vibration-insensitive platform supports all fiber types with a 0.125 mm outer diameter, including SM, MM, PM, double cladding, bendable, and both large and small core fibers.

FF switches activate via an electrical relay with a latching mechanism to retain the optical path after power is removed. Bidirectional lightpaths are conveniently controlled with a 4.5V input. A specially formulated, non-fluorescent index-matching liquid fills a gap of <5 µm to ensure optimal performance.

Two types of MEMS chips are available: a slow chip in a T-shaped package designed for PM fiber, and a fast chip in a square package that can also support PM fiber, though with higher fiber alignment costs.

Features

- Ultra Low Loss ~0.2dB
- Ultra Broadband
- Little Wavelength Dependence
- Little Temperature Dependence
- Fast <0.5ms
- Vibration Insensitive

Applications

- Laser Systems
- Reconfigurable Optics
- Instrumentations

Specifications

Parameter	Min	Typical	Max	Unit
Wavelength	350		5500	nm
Insertion Loss [1]	0.01	0.2	0.4	dB
Wavelength Dependent Loss			0.01	dB
Polarization Dependent Loss			0.05	dB
Polarization Extinction Ratio (PM)	18	25	35	dB
Return Loss	50 (SM)			dB
	35 (MM) [3]			dB
Cross Talk	50		75	dB
Optical Rise/Fall Time (PM Fiber) [2]	5		20	ms
Optical Rise/Fall Time (SM Fiber) [2]	0.2	0.4	0.8	ms
Repetition Rate (PM Fiber)			1	Hz
Repetition Rate (SM Fiber)			5	Hz
Repeatability			± 0.02	dB
Durability	10^8			cycles
Operating Optical Power [3]		0.3	0.5	W
Operating Voltage	4.3		4.5	VDC
Operating Current		30	60	mA
Switching Type	Latching / Non-Latching			
Operating Temperature	-40		80	°C
Storage Temperature	-50		90	°C

Notes:

[1]. SM 28 Fiber, Typical loss is 0.3dB. Ultra-low loss 0.1 is special order. Excluding Connectors. For small core fibers the specs are reduced. For IR fluoride fiber loss increase.

[2]. Rise/Fall time is defined as 10/90% optical signal change.

[3].For 1310/1550nm. The optical power handling rapidly reduces as fiber core size/ reduces. At 650nm the max is 2mW. Expanding the fiber core can increase the power handling.

Rev 11/01/24

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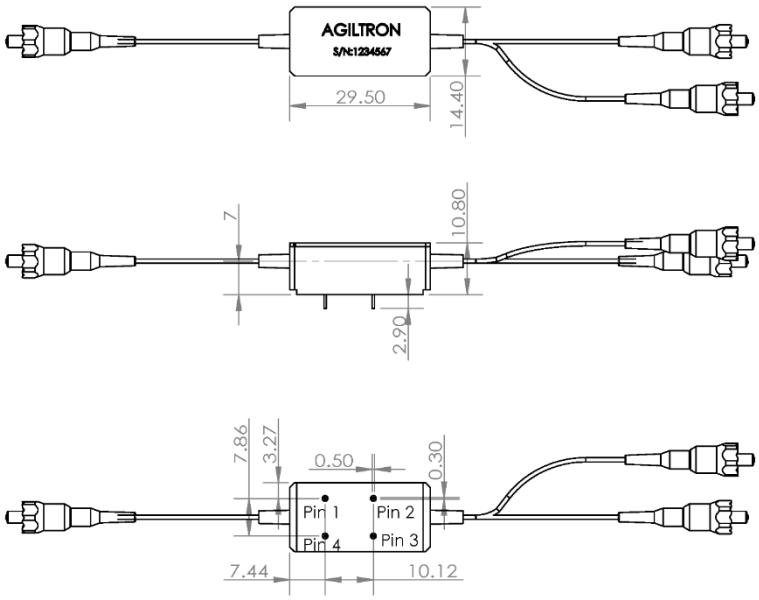
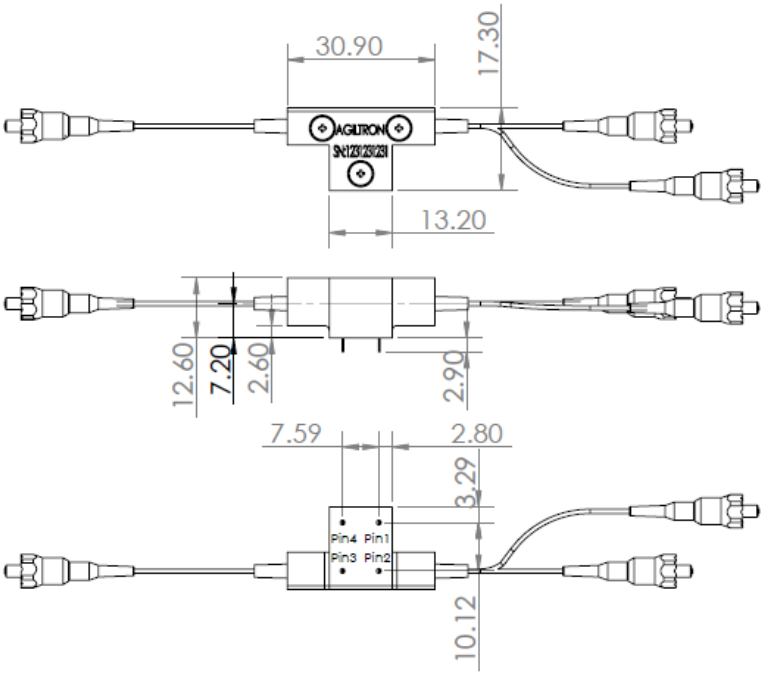
Mechanical Dimensions For PM Fiber (square shape with slow MEMS,) (Unit: mm)



S

Mechanical Dimensions For SM Fiber (T-shape with Fast MEMS,) (Unit: mm)



F

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

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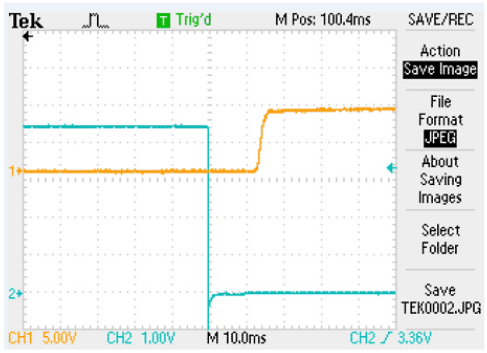
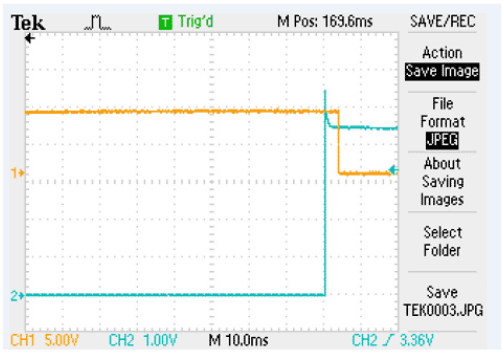
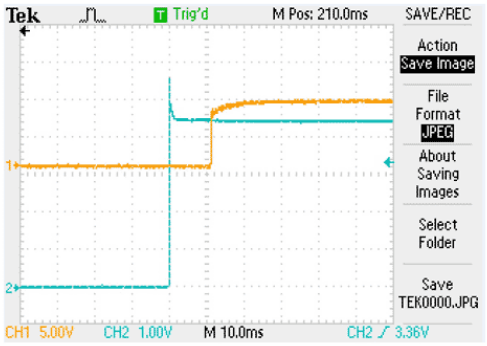
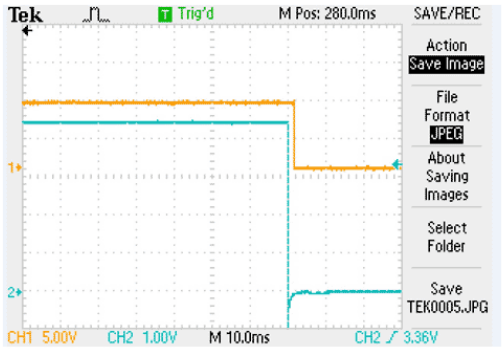
Typical Response Speed (SM, Package S)





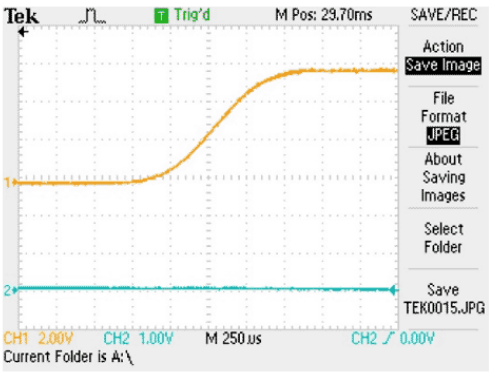
Channel 1 Optical Rise and Fall

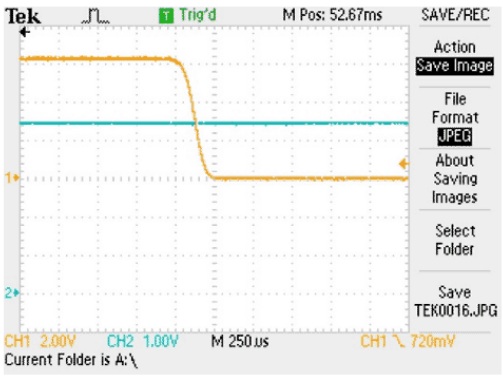




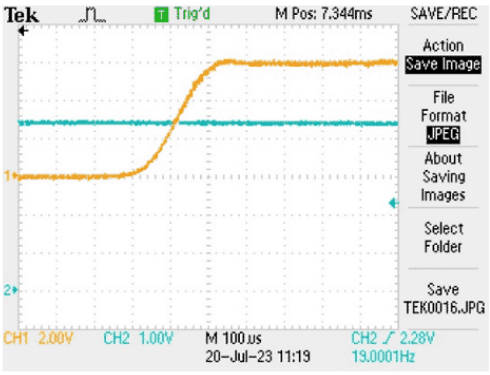
Channel 2 Optical Rise and Fall

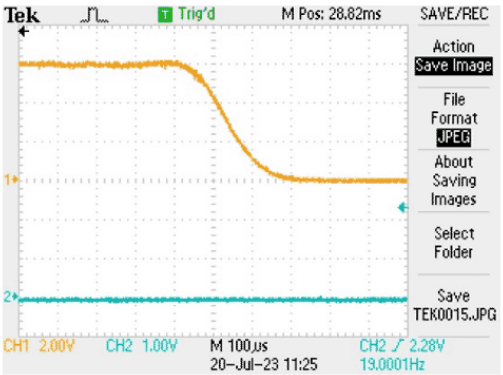
Optical Response Speed (SM Package F)





Channel 1 Optical Rise and Fall





Channel 2 Optical Rise and Fall

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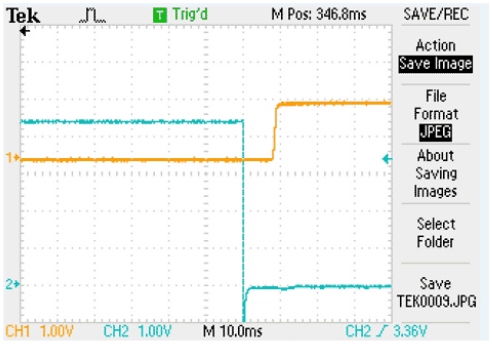
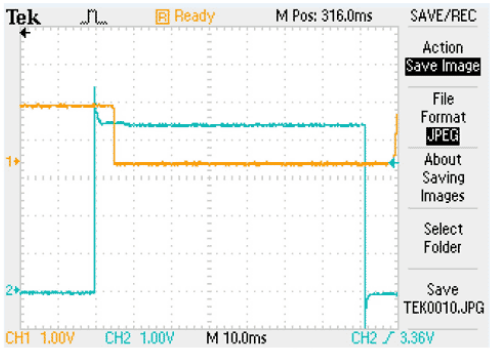
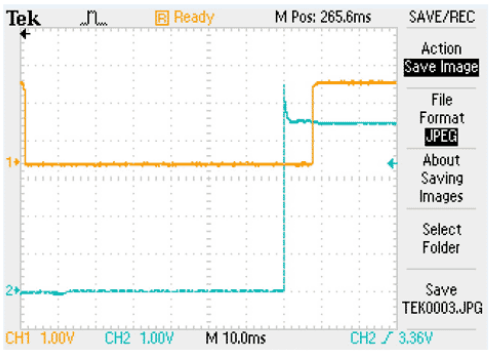
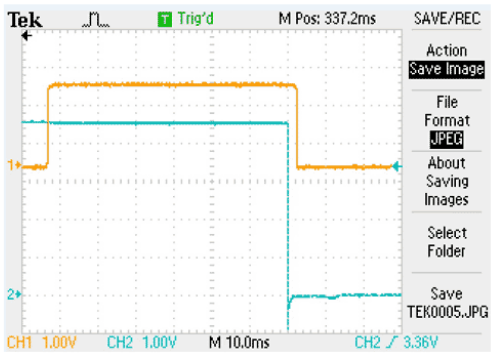
Typical Response Speed (SM Package F)





Channel 1 Optical Rise and Fall





Channel 2 Optical Rise and Fall

Electrical Connector Configurations

Important Note: The device must be driven by the reference circuit. Otherwise, it is not stable. This is because the device contains a permanent magnet inside; thus current must flow in the correct direction to counter the magnet field.

The load is a resistive coil which is activated by applying 4.5V (draw ~ 40mA). The latching switches can also be driven by a pulse mode for energy saving. The switch can withstand 5V which may reduces its durability.

Agiltron offers a computer control kit with TTL and USB interfaces and Windows™ GUI. We also offer RS232 interface as an option.

Latching Type

The activation requires a 4.5V pulse with a duration >15ms

Optical Path	Electric Drive	
	Pin 2	Pin 3
Port 1 → Port 2	4.5V	0V
Port 1 → Port 3	0V	4.5V

Non-Latching Type

Optical Path	Electric Drive	
	Pin 2	Pin 3
Port 1 → Port 2	0V	0V
Port 1 → Port 3	0V	4.5V

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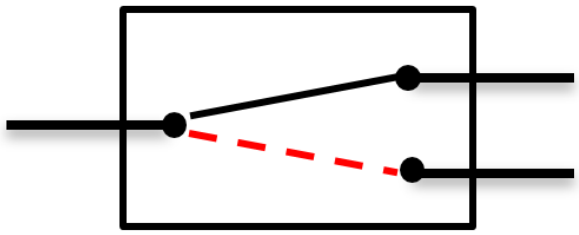
Functional Diagram



Ordering Information

	☐☐	☐	☐	☐☐	☐	☐	☐
Prefix	**Type**	**Package**	**Test Wavelength [4]**	**Fiber Type**	**Fiber Cover**	**Fiber Length**	**Connector**
FFSW-	1x1 (Transparent) [1] = 11 1x1 (Opaque) = 1D 1x1 (Ultralow Loss) = U1 1x2 Standard = 12 1x2 (Ultralow Loss) = U2 High Power 1x2 [2] = H2	Fast Latching[3] = 6 Fast Non-Latching = 7 PM Slow Latching = 2 PM Slow Non-Latching= 3	488 nm = 4 360 nm = A 430 nm = B 532 nm = 5 630 nm = 6 780 nm = 7 850 nm = 8 980 nm = 9 1060 nm = 1 1310 nm = 3 1550 nm = C 2000 nm = 2 2.3-4.1 µm = F 3.2-5.5 µm = G	Pick from below table to match the wavelength range	Bare fiber = 1 900um tube = 3 Special = 0	0.25m = 1 0.5m = 2 1.0m = 3 Special = 0	None = 1 FC/PC = 2 FC/APC = 3 SC/PC = 4 SC/APC = 5 ST/PC = 6 LC/PC = 7 Duplex LC/PC = 8 MTP = 9 LC/APC = A LC/UPC = U Special = 0

[1] Transparent: Light passes through without activation. Opaque: Light is blocked in the non-activated state.

[2] The beam size expands approximately 5x within the fiber tip.

[3] Fast latching is available for PM fiber at twice the cost of slow latching.

[4] This ultra-broadband device is limited by the intrinsic transmission of the fiber and is tested at a single selected wavelength. Testing at multiple wavelengths is available under the “special = 0” option at an additional cost, though it may be unnecessary, as fiber transmission data can be referenced directly from the fiber specifications.

Fiber Type Selection Table:

01	**SMF-28**	34	**PM1550**	71	**MM 50/125µm**
02	**SMF-28e**	35	**PM1950**	72	**MM 62.5µm**
03	**Corning XB**	36	**PM1310**	73	**105/125µm**
04	**SM450**	37	**PM400**	74	**FG105LCA**
05	**SM1950**	38	**PM480**	75	**FG50LGA**
06	**SM600**	39	**PM630**	76	**STP 50/125**
07	**Hi780**	40	**PM850**	77	**IRZS23**
08	**SM800**	41	**PM980**	78	**IRZS32**
09	**SM980**	42	**PM780**		
10	**Hi1060**	43			
11	**SM400**	44	**PM405**		
12		45	**PM460**		
13		46			

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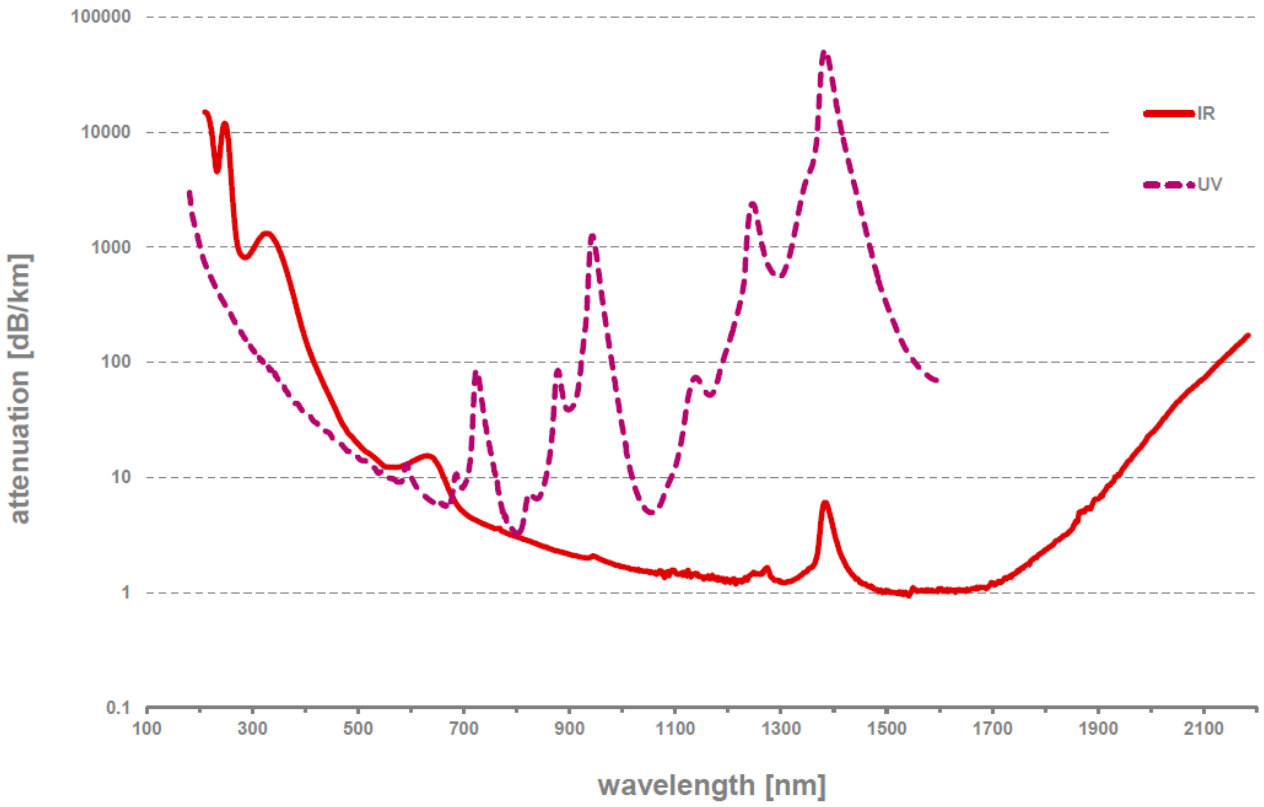
Typical Fiber Transmissions



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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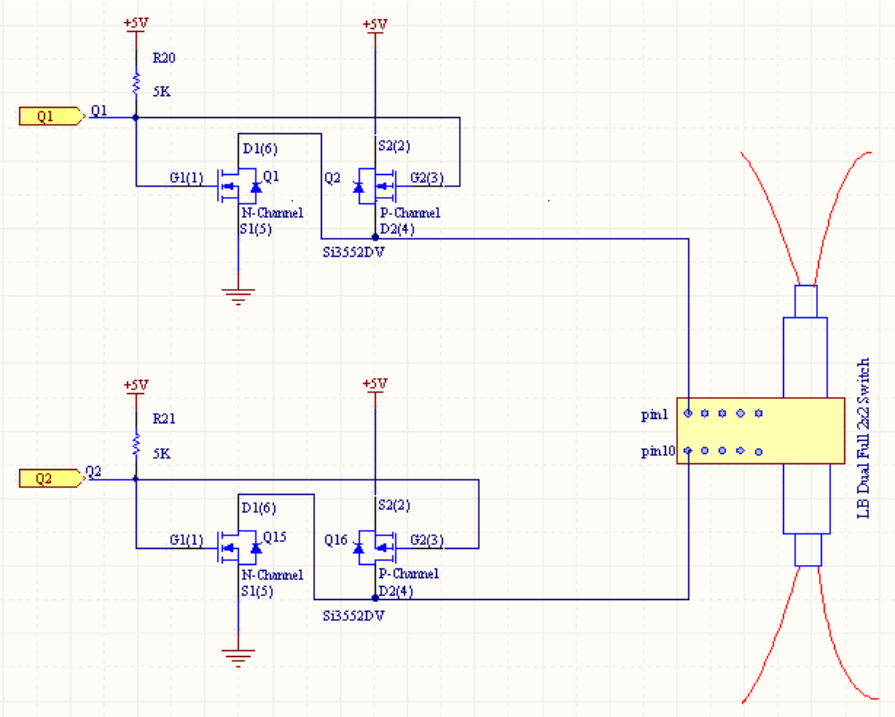
Driver Reference Design



Optical Power Handling vs Wavelength For Single-Mode Fibers