



Agiltron Photonic Products

11/20/2018

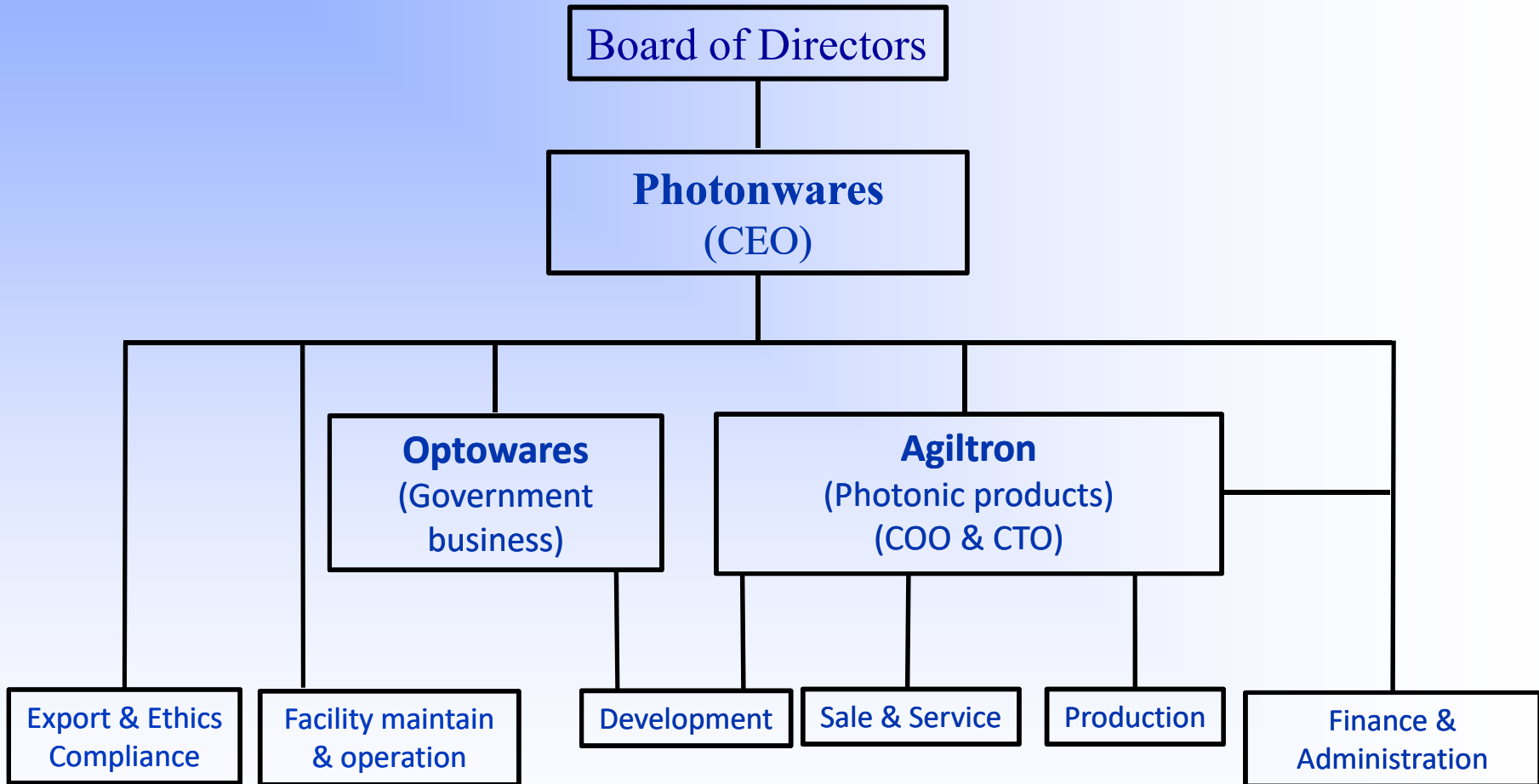
Agiltron, Inc.
15 Presidential Way
Woburn, Massachusetts 01801
www.agiltron.com

Agiltron At A Glance

- ❖ Formed in 2001 and located in Woburn, MA
- ❖ A Photonwares company since November 2016
 - Agiltron is the photonic product brand
- ❖ > 50 employees including 10 PhD/MS in engineering team
- ❖ Established repeat customer base including Fortune 500 companies
- ❖ 50,000 sq. ft. R&D, manufacturing, and administrative facilities
- ❖ ISO 9001 certified optical systems manufacturer
- ❖ Established volume production in China since 2006



Organizational Chart



ISO Certification



- ❖ QMS established since 2005
- ❖ ISO9001 certified for the design and manufacture of optical components and systems
- ❖ First certified on Sept. 24 2005
- ❖ Current ISO9001: 2015 certificate good through September 29, 2020



Business Model

- ❖ Photonic products
- ❖ Revenue streams
 - Product sales
- ❖ Product divisions
 - Fiber Optic Components
 - Spectroscopy
 - Mid-Infrared Detectors
- ❖ Premium products made in US
- ❖ Volume and low cost production in exclusive CM
- ❖ Product differentiation through advanced development

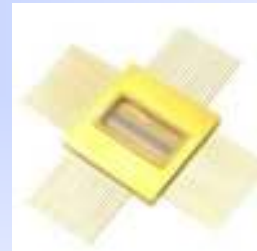
Fabrication Facility in US



- ❖ Fiber optic components assembly
>10 key technicians/operators over 10yrs experience on Agiltron's products



- ❖ PbSe/PbS IR detector

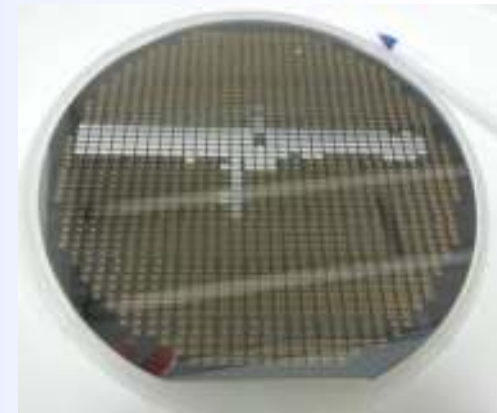


- ❖ Raman System



❖ MEMS Wafer Manufacturing

- All MEMS wafer manufactured in U.S
- Six-inch wafer fabrication with 0.3 micron capability
- High quality control system



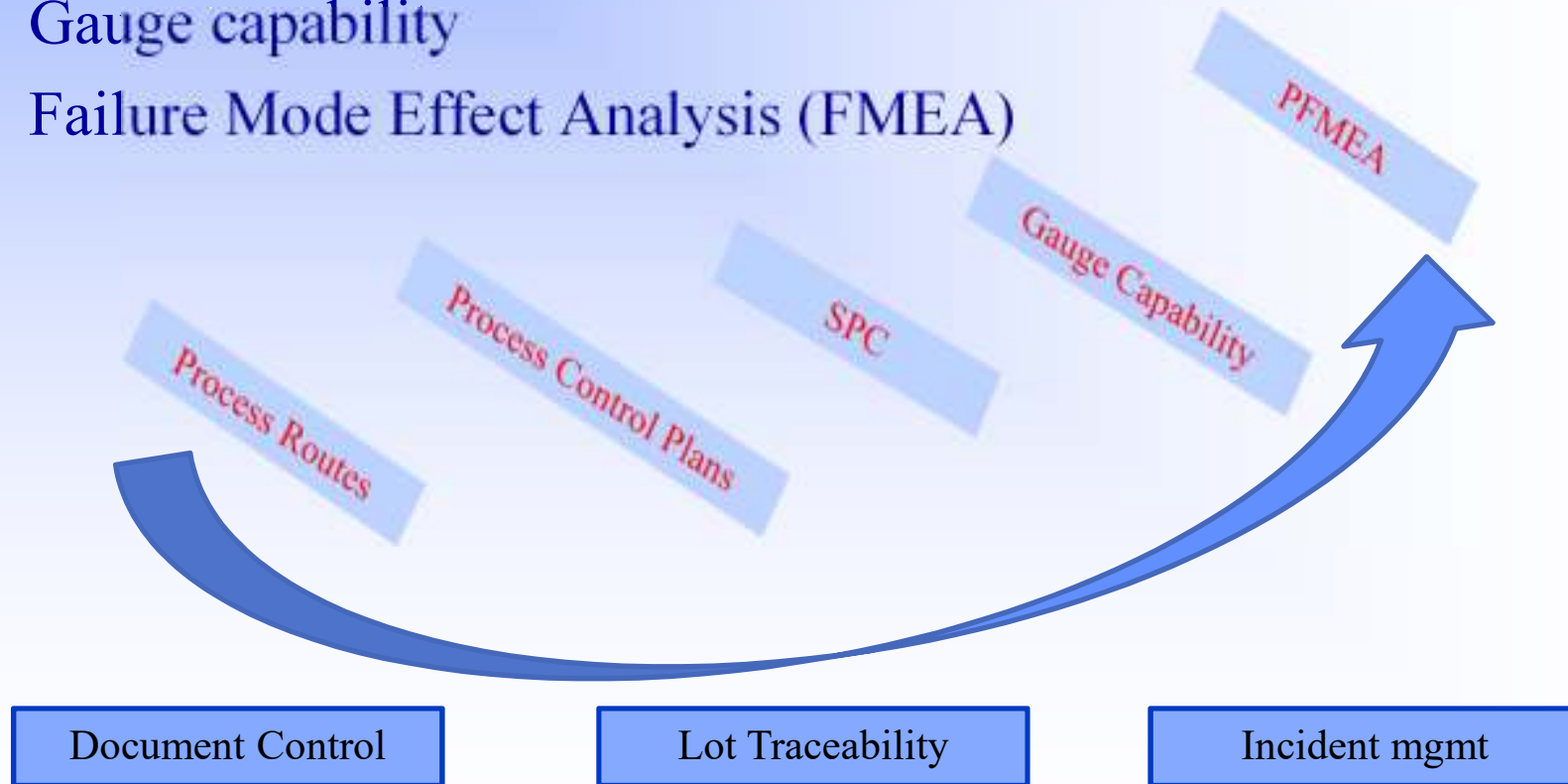
Class 100/1000 Clean Room

- ❖ 2000 sq-foot clean room & 2000 sq-foot service chase area in building
- ❖ DIRE, wet etching and metallization, lithography, etc
- ❖ Stepper and contact mask aligner

Wafer Quality System



- ❖ Product route documents
- ❖ Process control plan
- ❖ Statistical process controls (SPC)
- ❖ Gauge capability
- ❖ Failure Mode Effect Analysis (FMEA)



Product Qualification Capability (environment, life test etc.)



- ❖ Agiltron has in-house capability for Telcordia and Mil-Std performance and environmental tests
 - Thermal shock chamber
 - Shock and vibration station
 - Damp heat
 - Cycling ovens and constant temperature ovens
 - Fiber Integrity: Fiber Pull, Twist, Flex
 - Automatic and manual test stations for optical measurements

Exclusive Contract Manufacture Spectronics - Nanning



- ❖ Founded in 2010 at Nanning, China under Agiltron's guidance and supervision as well as support
- ❖ Full technical support and production training from Agiltron
- ❖ Manufacturing exclusively for Agiltron
- ❖ 11,000 m² manufactory building, 3000 m² assembly clean room
- ❖ Total 41,000 m² buildings including office building, residential apartments and warehouses



Entrance



Production building



Residential apartments

Production Capacity



- ❖ > 100 employees on the production lines
- ❖ > 15 experienced technicians, team leaders in production lines
- ❖ 5 optical, electrical and mechanical engineers
- ❖ ISO9000 Registered in March 2012 first, TUV Certificate, renewed in 2017
- ❖ Products capacity > 200,000pcs/year
- ❖ Delivered ~ 120,000pcs products in 2017



Fiber Optic Products

Fiber Optic Components



➤ Switch Series

- LightBend™ (LB) type : Electro-mechanical relay
- CrystaLatch™ (CL) type: Magneto-optic rotator
- MEMS type: Electro-thermo-mechanical actuation
- NanoSpeed™ (NS) type: Electro-optic effect

➤ VOA Series

- MEMS type: Electro-thermo-mechanical actuation
- NanoSpeed™ (NS) type: Electro-optic effect

➤ Premium Components

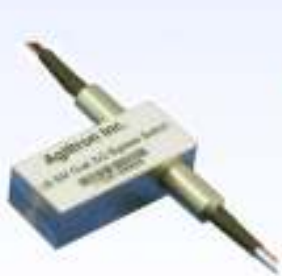
- High power pump combiner
- TGG based OI & OC: VIS ~ NIR band (500nm ~ 1100nm)
- Garnet based OI & OC: S, C and L band (1300 ~ 2000nm)
- Tunable filter
- OCT probe

LightBend™ (LB) Series of Switches

- ❖ Opto-mechanical configurations activated via an electrical control signal
- ❖ Speed ~ 10ms
- ❖ Variety optic configuration, such as 1x1, 1x2, 1x3, 1x4, 1x8, 1x16, 2x2, dual 1x2, dual 2x2 bypass, dual 2x2, quad dual 2x2, 4x4...
- ❖ Latching or non-latching w/ bidirectional
- ❖ Low cost



1x3 or 1x4



Single or Dual



Quad or Octo

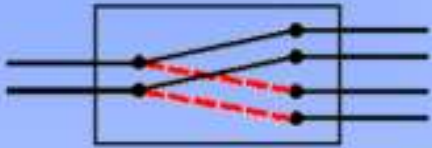


Octo type

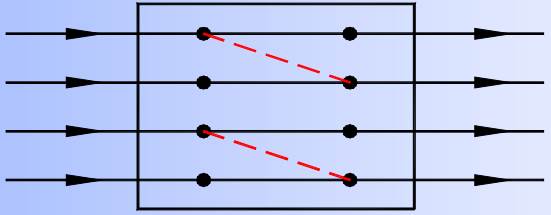


1x8

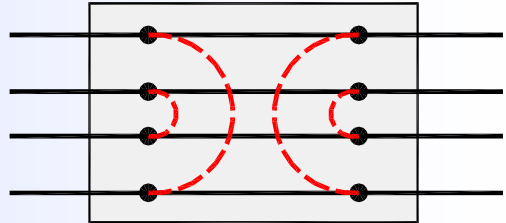
Advanced Switching Configuration (1)



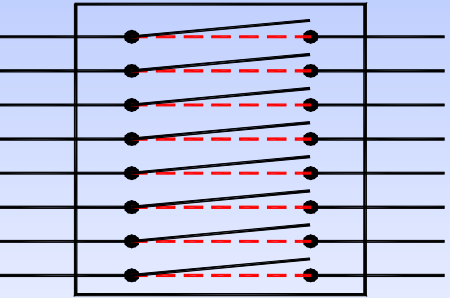
LB Dual 1x2 (SM or MM)



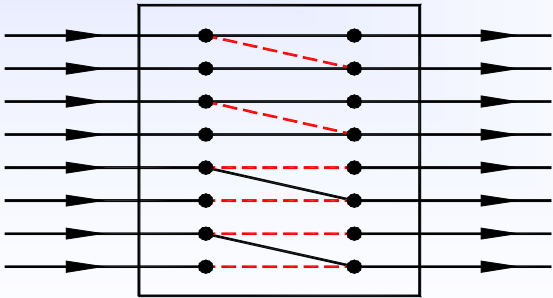
LB Dual 2x2 Bypass (SM or MM)



LB Dual full 2x2 (MM only)

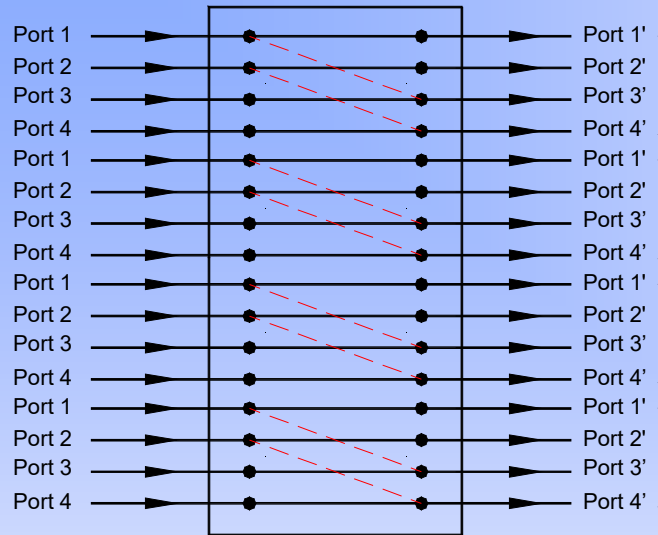


LB Octo 1x1 (SM or MM)

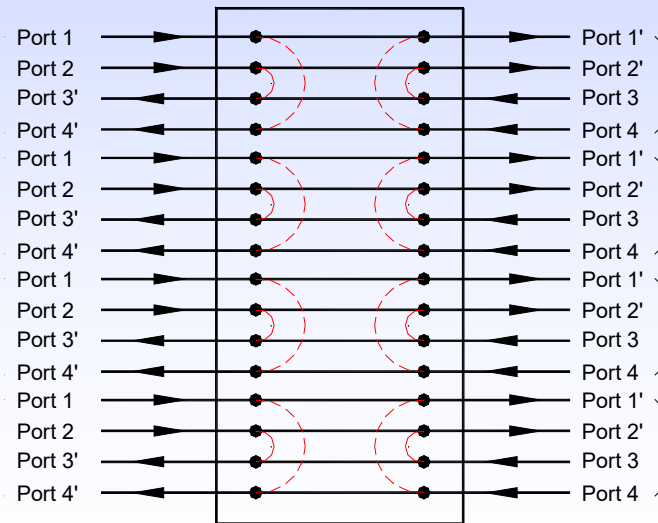


LB Quad 2x2 Bypass (MM only)

Advanced Switching Configuration (2)



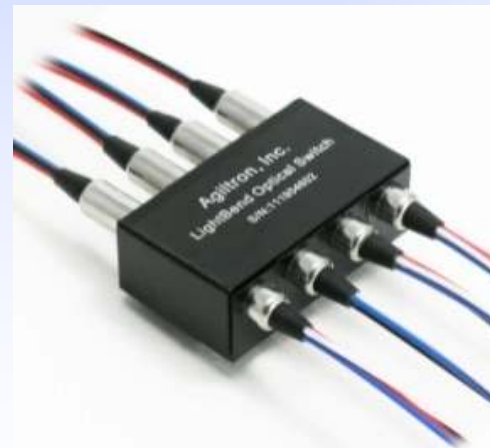
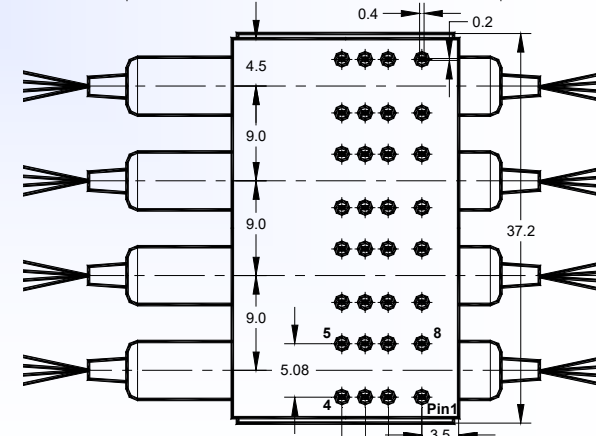
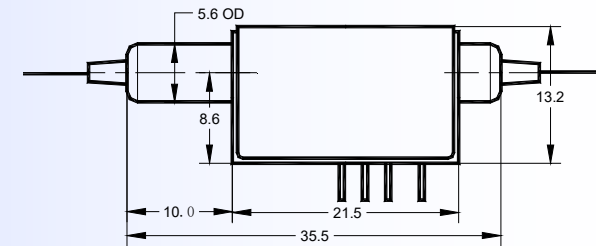
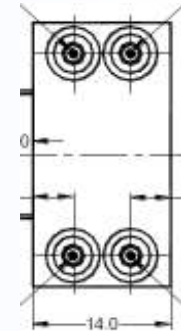
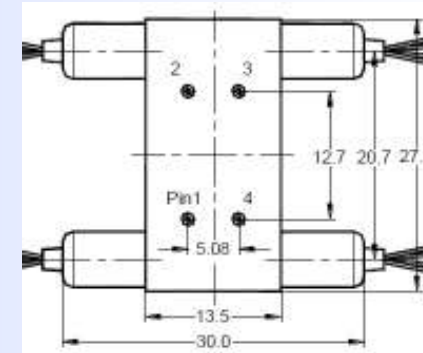
LB Octo 2x2 Bypass (SM & MM)



LB Octo Full 2x2 (MM only)



Octo 2x2 Bypass (MM only)



Octo 2x2 Bypass & Full

CrystaLatch™ (CL) Series of Switches

- ❖ Magneto-optic rotator activated via an electric pulse
- ❖ $\sim 10\mu\text{s}$ switching speed
- ❖ Long life $\sim 10^{11}$ cycles
- ❖ Intrinsically latching
- ❖ Optical configuration 1x1, 1x2, 1x3, 1x4, 1x8, 1x10, 1x16, 2x2, and 4x4
- ❖ Bi-direction available



1x1, 1x2 or 2x2 switch



1x3 or 1x4 switch



Bidirectional 1x4 switch

Premium of CL 1x4, 1x5, 1x6, 1x8 and 1x10 Switches

- ❖ Highly reliable version
- ❖ Full Telcordia Qualification Test
- ❖ Design verified through product/delivery > 8 years.
- ❖ C-band and/or L-band
- ❖ Unidirectional and/or bidirectional



1 x 4



Reflective port of 1x5 & 1x6



1 x 8

NanoSpeed™ (NS) of Switches/VOA

- ❖ Electro-optic rotator
- ❖ ~80ns switching time
- ❖ Long life ~ 10^{11} cycles
- ❖ Optical configuration 1x1, 1x2, 2x2, and 1x4
- ❖ VOA and Variable beam splitter (V-BS) 1 x 2 & 1x4 (PM)
- ❖ Bi-directional



1x1 switch/VOA



1x2, 2x2 switch

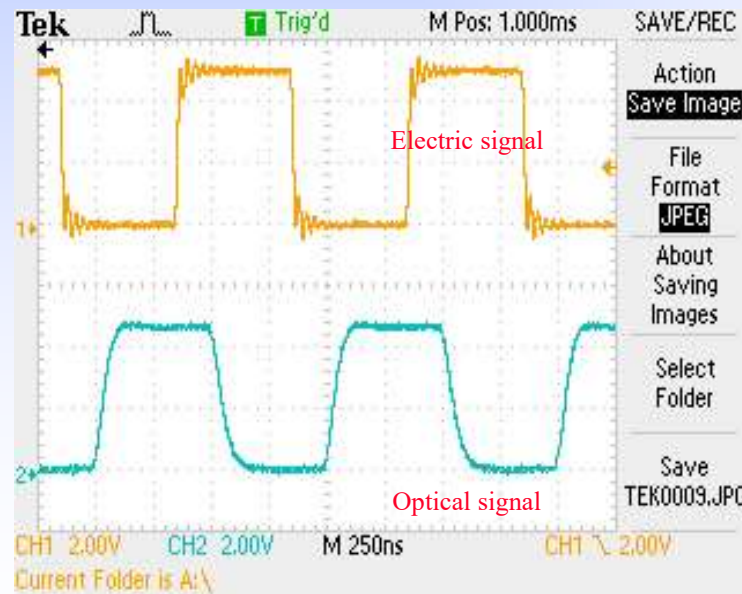


1x4 (PM) V-BS

Premium NanoSpeed™ (NP) of Switches/VOA



- ❖ Higher power handling
 - 5W @ 1550nm
- ❖ Higher repeat rate
 - 1MHz available for NPSW, 5MHz under development
 - 500kHz available for NPOA, 1MHz under development

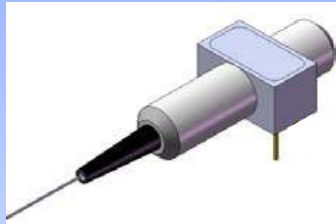


*et*MEMS™ Features

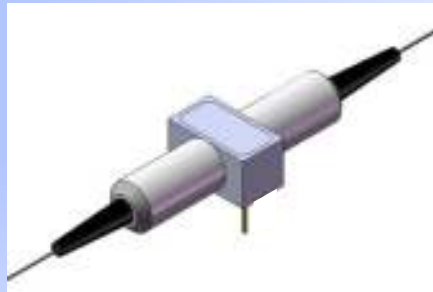
- ❖ Electro-thermo-mechanical actuation (patented)
- ❖ Large in-plane displacement
- ❖ Pure single crystal silicon - never wear out/fatigue
- ❖ Long life: $> 10^9$ cycles
- ❖ No need for hermetic packaging
- ❖ No need for temperature compensation/control
- ❖ Intrinsic resistance to ESD
- ❖ Advanced designs
 - Analog motion for non-latching switch and VOA
 - Bi-stable structure for latching switch
- ❖ Telcordia qualification in fiber optic devices

Variety of MEMS Switches

1) MEMS mini switches



Reflective 1x1, 1x2



2x2, 2x2 bypass, dual 2x2

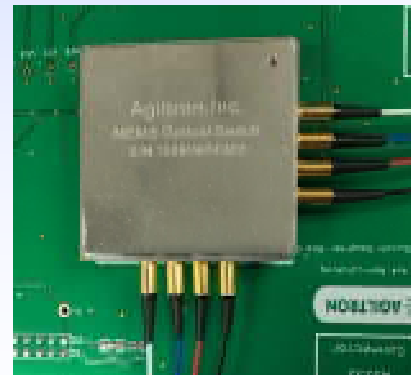


Octo Dual-full 2x2

2) Variety configuration: 1x4, 1x8, 1x16 and 4x4



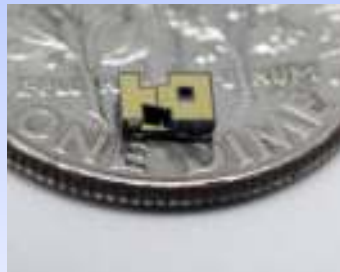
1x4 switch



4x4 switch

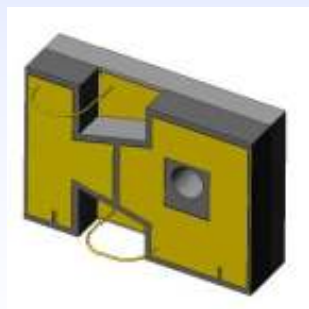
Free Space VOA

- ❖ Aperture size: $\phi 230\mu\text{m}$, $\phi 320\mu\text{m}$, $\phi 400\mu\text{m}$, $\phi 500\mu\text{m}$, $\phi 700\mu\text{m}$,
- ❖ Speed: $\sim 2\text{ms}$
- ❖ Long life: $> 10^9$ cycles
- ❖ Small size: $\sim 3.4\text{mm} \times 2.3\text{mm} \times 0.9\text{mm}$ typical

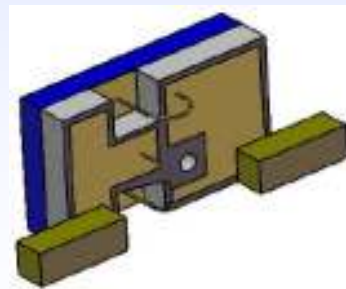


Device aperture

Assembled unit



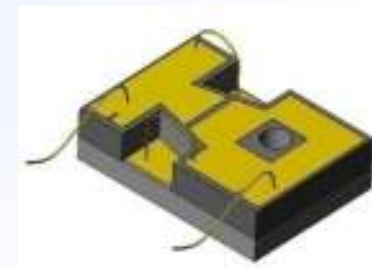
Wire bonded



Mounting shorts



L-pins



Flying wires

MEMS Based VOA

- ❖ High performance (low IL, PDL, TDL, etc)
- ❖ Compact package
- ❖ Intrinsic resistance to ESD
- ❖ No hermetic packaging
- ❖ Simple driver ~ direct voltage driving
- ❖ Telcordia test qualified



Reflective VOA



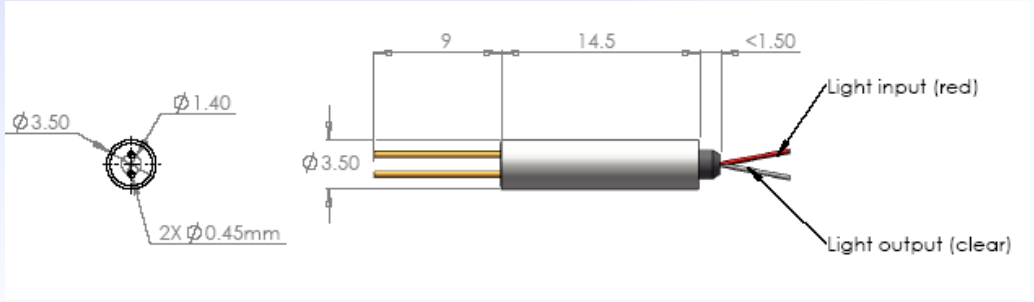
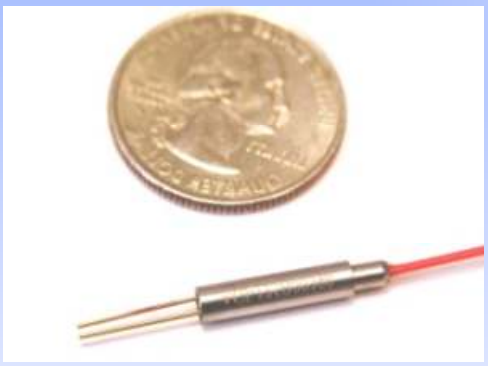
Reflective VOA w/ tap



Straight VOA

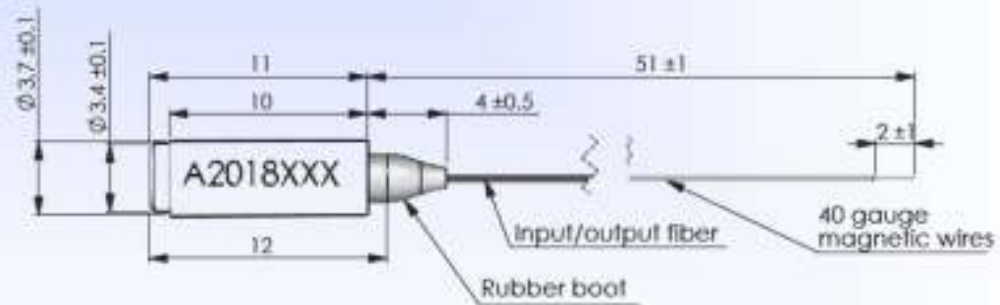
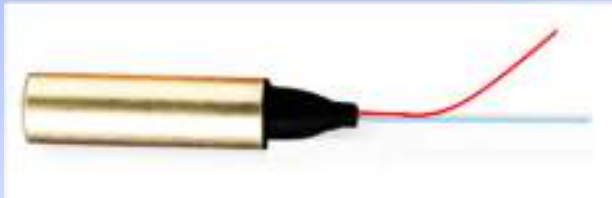
Mini VOA

- ❖ High performance
- ❖ Compact



Ultra-Mini VOA

- ❖ High performance
- ❖ Extreme small package



Fiber Optic Module



Non-blocking fast speed 4x4 switch module



Non-blocking 4x4 LBSW



Non-blocking /multi-casting 10x16 switch module



19-bit Photonic Time Delay Line

Other Fiber Optic Components

❖ (N+1) x 1 Fiber Pump Combiner (N<7)

The LLCB series of (N+1)x1 fiber combiner is designed for high power fiber laser application. They combine N pump lasers and one signal channel into a laser fiber. The LLCB cover a wide range of fiber types.



LLCB	Min	Typical	Max	Unit
Signal Central Wavelength	1064		2000	nm
Pump Central Wavelength	800		1000	nm
Pump Port Number (N)	2		7	number
Pump Coupling Efficiency	DCF	90	97	%
	105/125	90		
	Large Core Fiber	90	97	
Signal Insertion Loss	0.7	0.5	0.3	dB
Maximum Power/Port		25	50	W
Optical Isolation	15	25	30	dB
Operating Temperature	-5		70	°C
Storage Temperature	-40		85	°C

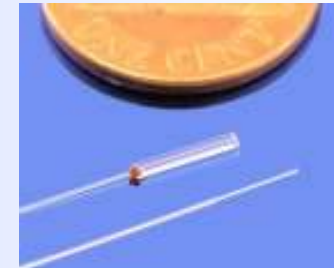
Other Fiber Optic Components

❖ Tunable filter



❖ OCT Probe

- Beam size: 20 ~100 μ m
- Customizable



❖ In-Line Power Monitor



End