7-bit Solid State Series Variable Fiber Optical Time Delay

(patent pending)

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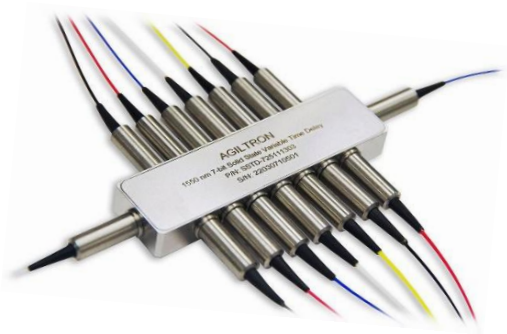

The 7-bit Solid State Series Fiber Optical Time Delay provides a variable time delay over a long range up to the millisecond. This is accomplished by selectively routing optical signals through N fiber segments whose lengths increase successively by a power of 2. Since each switching element allows the signal to either connect or bypass a fiber segment, a delay T may be inserted, which can take any value (in increments of ΔT) up to the maximum value T. This is achieved using a patent-pending non-mechanical configuration and activated via an electrical control signal.

Latching operation preserves the selected optical path after the drive signal has been removed. The solid-state configuration eliminates the need for mechanical movement and organic materials.

The device is designed to meet the most demanding switching requirements of ultra-high reliability and fast response time.

Features

- 4-Bit Resolution or more
- High Speed
- Non-Mechanical
- High Reliability
- Fail-Safe Latching
- Low Insertion Loss
- Low Power Consumption

Applications

- Phase-Array Antennas
- Instrumentation

Specifications

Parameter		Min	Typical	Max	Unit
Wavelength Band		1520	1550	1580	nm
		1280	1310	1340	nm
Insertion Loss [1], [2]		2.5	2.8	3.5	dB
Cross Talk		22	28	35	dB
Polarization Dependent Loss (SM)		0.15	0.25	0.45	dB
Polarization Extinction Ratio (PM)		18	22	30	dB
Return Loss		50	55		dB
Shing Time (rise, fall)			50	200	µs
Repetition Rate				1	kHz
Delay Time Range		n		m	s
Fiber Segment Number		4		7	loop
Polarization Mode Dispersion			0.1	0.2	ps
Switch Type			Latching		
Operating Temperature		-5		+70	°C
Storage Temperature		-40		+85	°C
Optical Power Handling			300	500	mW
Fiber Type	SM		SMF-28, or equivalent		
	PM		PM1310, PM1550, or equivalent		
Fiber Length				1	m

Notes:

[1]. The IL is for 4-bit Delay Line. IL Max value is 4.1 dB for 5-bit Delay Line, and 5.3 dB for 7-bit.

[2]. Excluding Connectors.

Note: The specifications provided are for general applications with a cost-effective approach. If you need to narrow or expand the tolerance, coverage, limit, or qualifications, please [click this link]:

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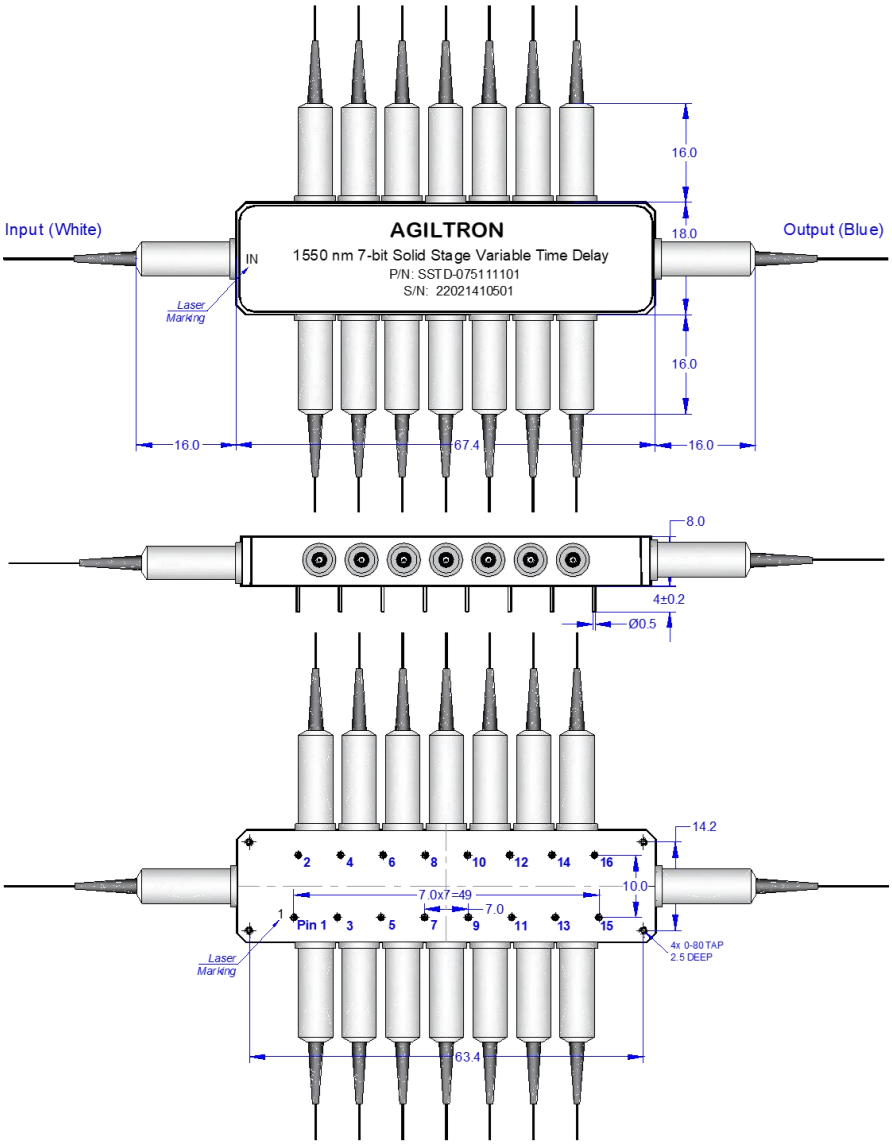
Mechanical Dimensions (mm)



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

Electrical Driving Requirements

Parameter	Minimum	Typical	Maximum	Unit
Driving Voltage	2.25	2.5	2.75 *	V
Resistance (each Pin Group)	15	18	22	Ω
Pulse Duration	0.2	0.3	0.5	ms

*Over this value will damage the device.

[1]. Driving kit with USB or RS232 with Windows™ GUI or TTL interfaces is available.
[2]. Driving table can be provided per request for the customers to design/build their own driving circuit.

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Electrical Driving Requirements (continue)

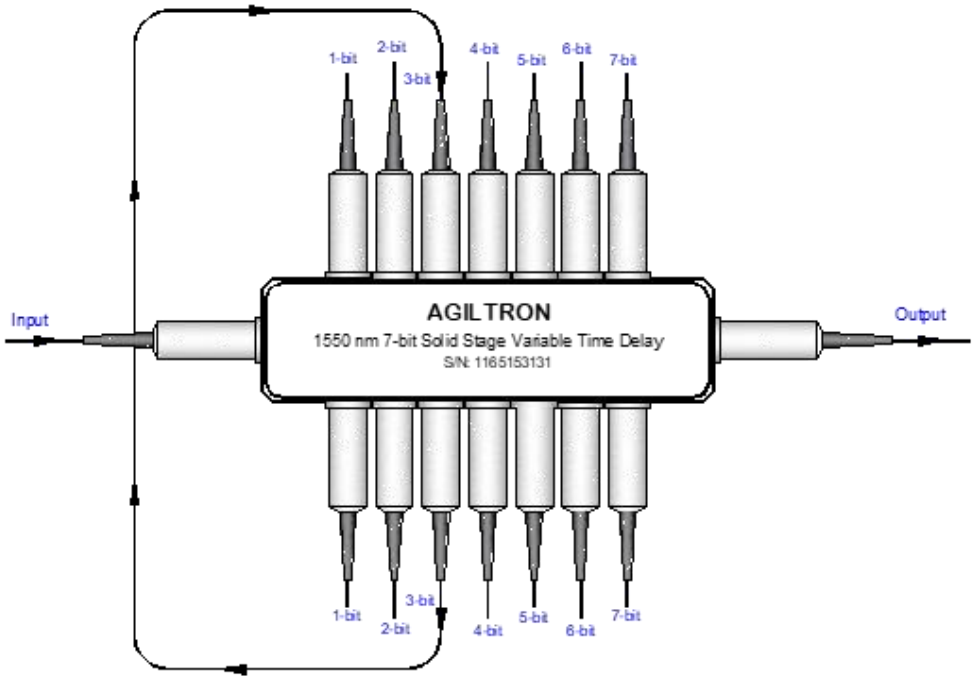
7-bit Time Delay Driving Table:

Switch Position	Pin Group 1		Pin Group 2		Pin Group 3		Pin Group 4		Pin Group 5		Pin Group 6		Pin Group 7		Pin Group 8	
	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Pin 10	Pin 11	Pin 12	Pin 13	Pin 14	Pin 15	Pin 16
Bypass	+	-	-	+	-	+	-	+	-	+	-	+	-	+	+	-
1-bit	-	+	+	-	-	+	-	+	-	+	-	+	-	+	+	-
2-bit	+	-	+	-	+	-	-	+	-	+	-	+	-	+	+	-
3-bit	+	-	-	+	+	-	+	-	-	+	-	+	-	+	+	-
4-bit	+	-	-	+	-	+	+	-	+	-	-	+	-	+	+	-
5-bit	+	-	-	+	-	+	-	+	+	-	+	-	-	+	+	-
6-bit	+	-	-	+	-	+	-	+	-	+	+	-	+	-	+	-
7-bit	+	-	-	+	-	+	-	+	-	+	-	+	+	-	-	+

Note:

Inside the switch core is an electromagnet with a residual magnetic field. The residual magnetic field will be established when an electrical current flows in one direction through the coil for a sufficiently long period. The residual magnetic field latches the switch state even without applying a voltage (the current flow stopped). Flowing a current in the opposite direction for a sufficient time changes the switch stage by establishing a reversal magnetic field. The coil is forgiving to the driver unless one burns it by applying a higher voltage or a current for too long (day). The switch can also be operated at high repetition rates of kHz, where the residual magnetic field may not be fully established.

Optical Path of 3-bit Diagram:



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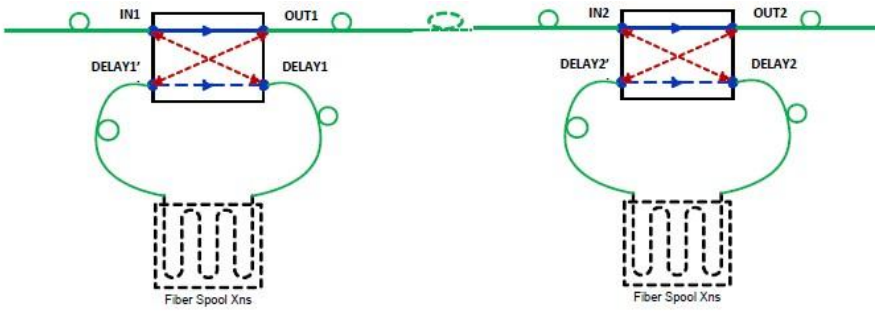
Optical Path Diagram

Switchable fiber loops in series



The variable time delay module selectively routes optical signals through N fiber segments having different lengths. Each fiber segment is defined to have the delay as

$$\Delta T_i = 2^{(i-1)}\delta T,\ i = 1, 2, ..., N$$

Where δT is the increment of time delay. Therefore, the module provides N-bit of digitally variable time delay, having the total time delay as

$$\Delta T_{Total} = (2^N - 1)\delta T$$

N and δT are defined by the customer.

Fiber Length = delay time * index of fiber (index of fiber ~1.456)

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Ordering Information (Part Number)

	☐☐	☐	☐	☐	☐	☐	0	☐
Prefix	**Type**	**Wavelength**	**Configuration**	**Package**	**Fiber Type**	**Fiber Cover**	**Delay Range**	**Connector[2]**
SSTD- [1]	4 Bits = 42 5 Bits = 52 6-bit = 06 7-bit = 07 Special=00	1550nm = 5 1310nm = 3 Special = 0	Standard = 1 Special = 0	Standard = 1 Special = 0	SFM-28 = 1 PM1550 = B PM1310 = D Special = 0	Bare fiber = 1 0.9mm tube = 3 Special = 0	Customized = 0	None = 1 FC/PC = 2 FC/APC = 3 SC/PC = 4 SC/APC = 5 ST/PC = 6 LC/PC = 7 LC/UPC = U Special = 0

[1]. **SSTD**: **S**olid **S**tate **T**ime **D**elay.
[2]. The connector cannot be installed directly onto bare fiber, as it 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 can remove this protective tube after testing. The optical power handling of a standard connector is less than 0.5 W for SM28 fiber and decreases further with smaller core fibers.

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.