MEMS MS22 Optical Switch Module

Operation Manual

Contents

1. Product Overview

This manual is intended for use with the following part numbers:

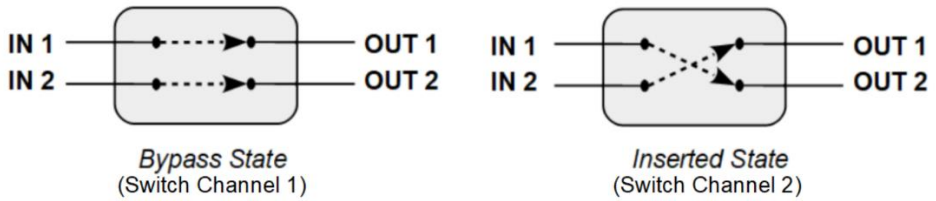
MS-1315TT-22
MS-1315TT-22-PC
MS-1315TT-22-APC
MS-1315RS-22
MS-1315RS-22-PC
MS-1315RS-22-APC

1.1 MEMS 2x2 Optical Switch

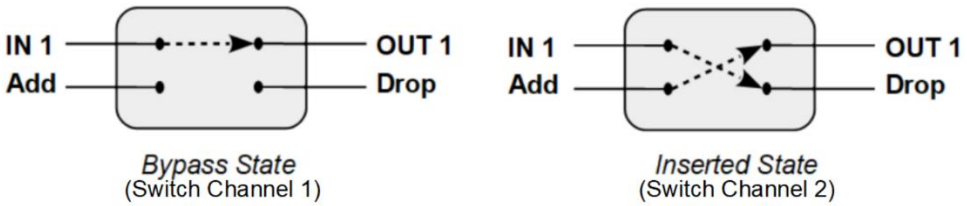
Newport's MEMS 2x2 Optical Switch is based on a micro-mechanical system (MEMS) chip. The MEMS chip consists of an electrically movable mirror on a silicon support. The 2x2 MEMS chip has two axes of rotation. Voltages applied to the MEMS chip cause the mirror to tilt along one or both axes, which changes the coupling of light between two input fibers and two output fibers.

There are three configurations of 2x2 switches:

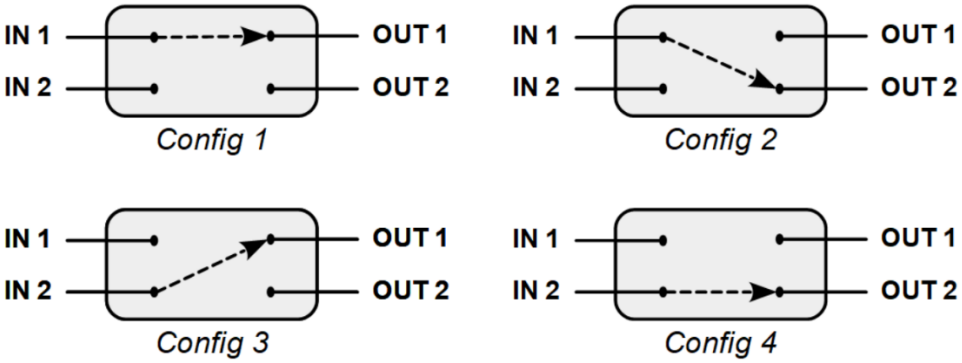
- **MEMS 2x2 Switch** (standard configuration), 2 switch states



- **MEMS 2x2 Add Drop Switch**, 2 switch states



- **MEMS 2x2 Blocking Switch**, 4 switch states


IN 1
IN 2
OUT 1
OUT 2
Config 1
IN 1
IN 2
OUT 1
OUT 2
Config 2
IN 1
IN 2
OUT 1
OUT 2
Config 3
IN 1
IN 2
OUT 1
OUT 2
Config 4

2. Switch Operation

2.1 Pin Assignments

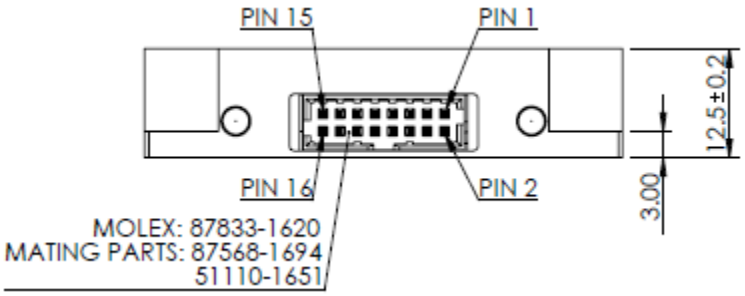
The MEMS Optical Switch Module (Size 2 and Size 3) operates through a 16-pin connector. The pin assignments for RS-232 and TTL control interfaces are listed in tables 1, 2, and 3 respectively. The electrical connector is a Molex 87833-1620 male connector, which mates with the female connector 87568-1694 or 51110-1651.

Warning!

Failure to ensure that the electrical connections are made properly can damage the module. Beware that if the electrical jumper has the same type of connector on both ends, special care must be taken to ensure that the correct end is plugged into the module. If the electrical jumper is reversed, damage will occur to the switch module because this will connect power to pins on the module that will become damaged if a voltage is applied.

Do not apply voltages to any pin labeled 'NC'. Any voltage applied to these pins can cause immediate and catastrophic damage to the switch. Applying a voltage greater than the maximum rating or any voltage to a pin labeled 'NC' will void the switch warranty.

Figure 1. Defined Electrical Pin-out for MEMS Switch Module (Size 2 and Size 3)



(Units in mm)

Molex Pin Assignment:

Please note that Molex's pin assignment for the mating Molex connector, 87568-1694, is reversed compared to device pin assignment.

Warning! Please refer to the warning on page 7.

Table 1. RS-232 Pin Assignment

PIN #	Name	Description	Direction	Specification	Unit
1	NC	No Connection			
2	NC	No Connection			
3	Vcc	Power Supply	IN	+12	VDC
4	Vcc	Power Supply	IN	+12	VDC
5	GND	Signal & Power Ground			
6	GND	Signal & Power Ground			
7	NC	No Connection			
8	NC	No Connection			
9	232TX	RS232 TX	OUT	-15 to +15	VDC
10	232RX	RS232 RX	IN	-15 to +15	VDC
11	NC	No Connection			
12	NC	No Connection			
13	/BUSY	Normally pulled high. While a module is busy, it will be pulled low.	OUT	LVTTL	VDC
14	/ALARM	Normally pulled high. While a module has logged alarms, it will be pulled low.	OUT	LVTTL	VDC
15	NC	No Connection			
16	/RESET	Low level active for hardware reset.	IN	LVTTL	VDC

Warning! Please refer to the warning on page 7

Table 3. TTL Pin Assignment

Pin #	Name	Description	Direction	Specification	Unit
1	D0	Data 0 Input	IN	LVTTL	VDC
2	D5	Data 5 Input	IN	LVTTL	VDC
3	Vcc	Power Supply	IN	+5	VDC
4	Vcc	Power Supply	IN	+5	VDC
5	GND	Signal & Power Ground			
6	GND	Signal & Power Ground			
7	D4	Data 4 Input	IN	LVTTL	VDC
8	D1	Data 1 Input	IN	LVTTL	VDC
9	NC	No Connection			
10	NC	No Connection			
11	D2	Data 2 Input	IN	LVTTL	VDC
12	D3	Data 3 Input	IN	LVTTL	VDC
13	/BUSY	Normally pulled low. While a module is busy, it will be pulled high.	OUT	LVTTL	VDC
14	/ALARM	Normally pulled low. While a module has logged alarms, it will be pulled high.	OUT	LVTTL	VDC
15	/STROBE	Falling edge active to synchronize command execution.	IN	LVTTL	VDC
16	/RESET	Low level active for hardware reset.	IN	LVTTL	VDC

2.2 Power Pins (Pins 3 & 4)

The power pins 3 & 4, named VIN in the pin assignment tables above, are the power supply pins to the MEMS optical switch module. It is recommended that both of these pins should be connected to the supply voltage.

2.3 Ground Pins (Pins 5 & 6)

The signal & power ground pins 5 & 6, named GND in the pin assignment tables above, are tied together electrically inside the module and share both pins. It is recommended that both pins are connected to ground and not left floating.

Please note that case ground is floating and is not connected to the ground pins. Also, it is not necessary to ground the case.

2.4 Reset Pin (Pin 16)

The reset pin is a LVTTL input. It is an optional pin and it is not required to be used, in order to operate the switch. If it is not desired to use this pin, then this pin can be left floating. If the reset pin is to be used, then this pin should be left in the logic high state for normal switch operation. If the reset pin is set to logic low, then the switch module will be reset.

2.5 Electrical Specifications

Table 4. Electrical Specifications

Parameter		Logic Low	Logic High	Damage Threshold	Unit
Latching Type		Non-latching			
Input	RS232 Interface	<0.5	+5.0	-30 // +30	VDC
	LVTTL Interface[2]	<0.4	2.4 to 3.3	-0.5 // +3.8	VDC
Output	RS232 Interface	-5	+5.0	-15 // +15	VDC
	LVTTL Interface[2]	<0.4	2.9 to 3.3	-0.5 // +4.6[2]	VDC
		Minimum	**Typical**	**Maximum**	
Vcc Power Supply Voltage	RS232	10.8	12.0	13.2	VDC
	TTL type	4.75	5.0	5.25	VDC
Power Consumption	RS232		1.0	1.3	W
	TTL type		0.4	0.7	W

1. Pullup to Vin or Vout on customer equipment.
2. If driving the input or output with 5V TTL logic, install a 220 – 1000 ohm resistor in series to limit input current. The damage threshold is 6 VDC with this drive configuration.

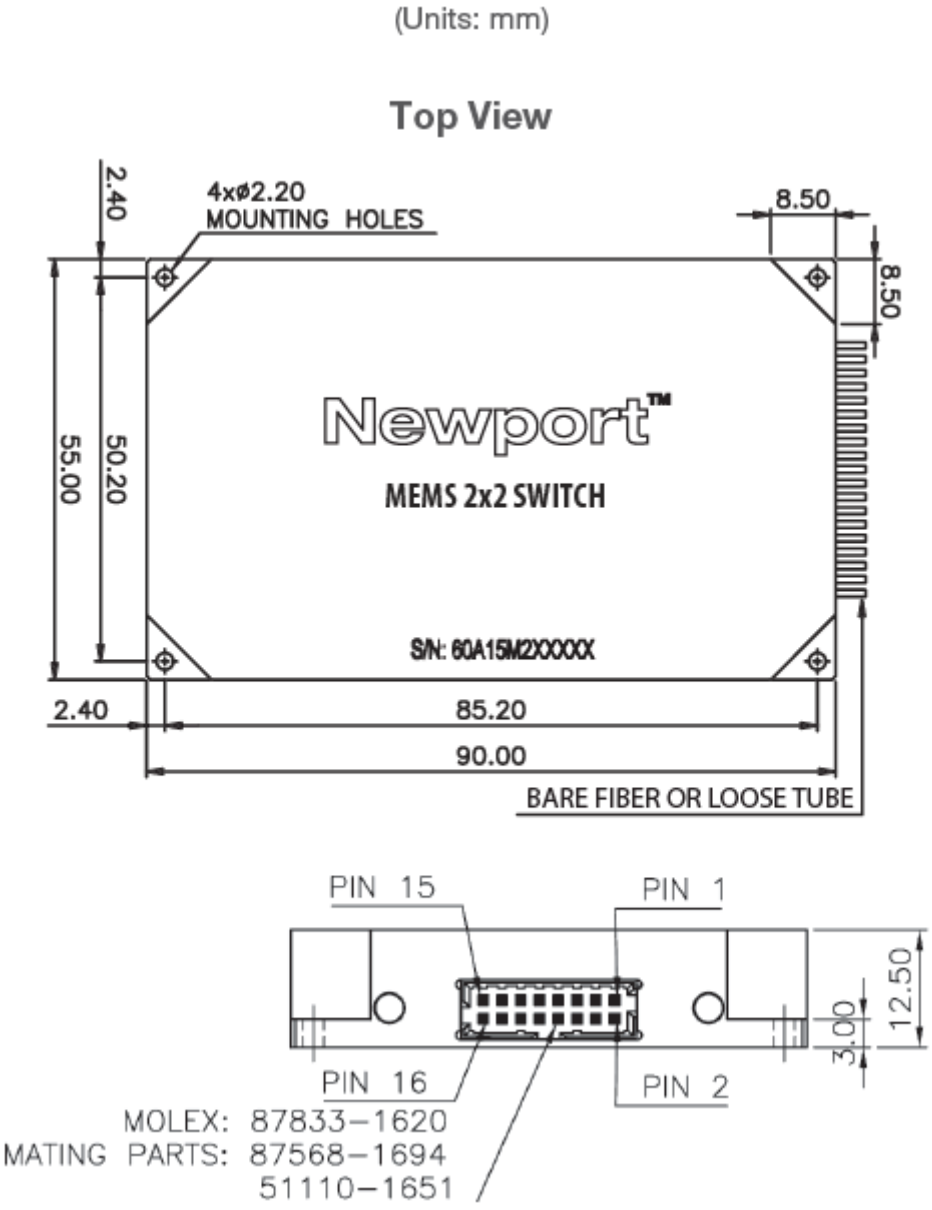
2.6 Environmental Specifications

Table 5. Environmental Specifications

Parameter	Specification	Unit
Operating Temperature	-5 to 70	^{o}C
Storage Temperature	-40 to 85	^{o}C

3. Mechanical Dimensions

Figure 2. Size 2 Mechanical Dimensions

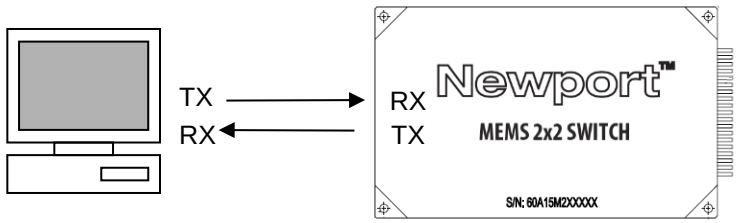


4. RS232 Interface

4.1 RS232 Control Line Connection

To control the switch module with RS232 control, the TX port from the control computer needs to be connected to the RX port on the RS232 module. Similarly, the RX port on the computer needs to be connected to the TX port on the switch module, as shown below in figure 4.

Figure 4. RS232 TX and RX control line connection diagram



Control Computer MEMS Optical Switch

4.2 RS232 Parameters

The RS232 baud rate is 115,200bps with 8 data bits, 1 stop bit and no parity. All RS232 ASCII commands use <CR> as the terminator character. And the RS232 ASCII responses use <LF> and <CR><LF>> as the terminator character. Table 6 lists the conventions used in this manual for RS232 control.

Table 6. Conventions

Convention	Meaning
(…)	Enclosure for a variable. The '(' and ')' characters are not part of the data.
[…|…|…]	Have one or none
{…|…|…}	Must have one
'and'	'and' is a comment
<SP>	Separator that is a space character
<CR>	Carriage return as a terminator
<LF>	Line feed

4.3 RS232 Command Set

Table 7. RS232 Serial Port (ASCII) Command Set

Command	Description
ID?	Queries the switch's identification string
CF?	Queries the input/output channel dimensions of the switch
EO	Sets the echo option
ER?	Queries the system status/error
I1	Sets the state of the optical switch to the output channel N
I1?	Queries the output channel
PK	Sets the optical switch to parking state

ID?

Description	Queries the switch's identification string.
Parameters	None
Reply	Four string values 1. Device manufacturer name 2. Device model name 3. Device firmware number and version 4. Device serial number
Example	(Send):ID?<CR> (Receive):<LF>MS1x36,FW97198 Rev.C4, 60A0EM2D0001<CR><LF>>

CF?

Description	Queries the input/output channel dimensions of the switch.
Parameters	None
Reply	Two numerical values 1. Maximum input channels 2. Maximum output channels
Example	(Send):CF?<CR> (Receive): <LF>1,32<CR><LF>>

EO

Description	Sets the echo configuration, and returns the current echo flag. 0 indicates that echo is off 1 indicates that echo is on When echo is on, the device will transmit every character that it receives from the RS232 interface. By default, echo is off. The echo setting is volatile. The default value is restored at startup.
Parameters	Echo setting (numeric)
Reply	One numerical value 0 indicates that echo is off 1 indicates that echo is on
Example 1	(Send):EO<SP>1<CR> *Turns echo on.* (Receive): <LF>1<CR><LF>> *Indicates echo is on.*
Example 2	(Send):EO<SP>0<CR> *Turns echo off.* (Receive): <LF>0<CR><LF>> *Indicates echo is off.*

ER?

Description	Queries the system status/error.
Parameters	None
Reply	Error code. Refer to **Table 8** for possible return codes.
Example	(Send):ER?<CR> (Receive): <LF>ERR0001<CR><LF>> *Invalid command.*

I1

Description	Sets the state of the switch to the output channel number ***n***
Parameters	Two numerical values. The first number is the input channel number and the second number is the requested output channel. 1. Input channel number (***1*** for 1xn) 2. Output channel number 0 to ***n*** The commanded output channel should be an integer from 0 to n, where ***n*** is the number of channels in the switch (ex. For a 1x12 switch, ***n*** is 12). Commanding the switch to position 0 will set the switch to the parking position. <u>Note for 2x2 Switches – Standard & Add Drop:</u> Bypass State, set output channel number = 1 (Send):I1<SP>1<CR> Inserted State, set output channel number = 2 (Send):I1<SP>2<CR> <u>Note for 2x2 Switches – Blocking:</u> Config 1, set output channel number = 1 (Send):I1<SP>1<CR> Config 2, set output channel number = 2 (Send):I1<SP>2<CR> Config 3, set output channel number = 3 (Send):I1<SP>3<CR> Config 4, set output channel number = 4 (Send):I1<SP>4<CR>
Reply	None
Syntax	**I1<SP>(output channel number n)<CR>** The output channel number is from 0 to ***n***.
Example 1	(Send):I1<SP>12<CR> *Sets Switch to channel 12*
Example 2*	(Send):I1<SP>0<CR> *Sets Switch to the parking state*

* Command “I1 0” is supported starting from firmware 97198 Rev.C3.

I1?

Description	Queries the state of the switch
Parameters	None
Reply	A numerical value for the output channel number ***n*** will be returned. A return value of 0 indicates that the switch is in the off state since power up or is in the parking state (see Example 2).
Example 1	(Send):I1?<CR> (Receive): <LF>12<CR><LF>>
Example 2	(Send):I1?<CR> (Receive): <LF>0<CR><LF>>

PK

Description	Sets the switch to parking state
Parameters	None
Reply	None
Example	(Send):PK<CR> (Receive):

The return codes for various error conditions are shown below in Table 8.

Table 8. MEMS 2x2 Switch Module Return Codes for RS232 Control

Return Code	Description
+0	Successful
ERR0001	Invalid Command
ERR0002	Value Out of Range
ERR0003	Command Fail

5. TTL Interface

Warning!

All digital lines are LVTTL. The typical LVTTL voltage for the HIGH state is 3.3 V, and the damage threshold is 3.6 V. Do not apply a voltage higher than 3.6 V to any of the data pins or this will damage the internal PCB and repair will not be covered under warranty.

To clarify, the digital lines are defined by the pin assignment in table 3 on page 9, and consist of all data inputs D0 – D5 (pins 1, 2, 7, 8, 11 and 12), the busy pin (pin 13), the alarm pin (pin 14), the strobe pin (pin 15), and the reset pin (pin 16).

5.1 Data Inputs D0 – D5 (Pins 1, 2, 7, 8, 11 and 12)

The data inputs D0 – D5 are LVTTL inputs and are used for channel selection. The channel number is defined in the logic table presented in section 6.5 below.

Please note that any unused data inputs must be tied to ground, and not left floating. A floating state on an unused data input could be mistaken as a high state and set the switch to an incorrect switch state. To assure accurate control of the switch, connect all unused data inputs to ground. For example, a 1x4 switch would utilize data inputs D0 and D1, but would not use D2 through D5. In this case, D2 through D5 should be connected to ground.

5.2 Busy (Pin 13)

The busy pin is a LVTTL output that indicates whether the switch is busy or not. A high state indicates that the switch is busy conducting a switch, and commands should not be sent at this time. Please note that use of the busy pin is optional and is not needed in order to operate the switch. It can be helpful however to monitor and assure that the switch is not busy prior to sending a new switch command. If the busy pin is not going to be used, this pin can be left unconnected.

5.3 Alarm (Pin 14)

The alarm pin is a LVTTL output that indicates whether there is an error with the switch. A high state indicates that there is an internal processing or commanding error. Please note that the alarm pin is optional, and does not need to be used in order to operate the switch. It can be helpful to monitor though, to assure that no errors occur. If the alarm pin is not going to be used, then this pin can be left unconnected.

5.4 Strobe (Pin 15)

The strobe pin is a LVTTL input and acts like a ‘Go’ pin. This pin should be set to a high state when the switch module is not changing state. When a switch is desired, the strobe pin should be pulsed low. Upon the falling edge of the strobe pin, the switch module will read the data inputs D0-D5 and then change to the new switch state.

5.5 Parallel Digital I/O Logic Table

Active Channel	D5	D4	D3	D2	D1	D0
CH 01	0	0	0	0	0	0
CH 02	0	0	0	0	0	1
CH 03	0	0	0	0	1	0
CH 04	0	0	0	0	1	1
CH 05	0	0	0	1	0	0
CH 06	0	0	0	1	0	1
CH 07	0	0	0	1	1	0
CH 08	0	0	0	1	1	1
CH 09	0	0	1	0	0	0
CH 10	0	0	1	0	0	1
CH 11	0	0	1	0	1	0
CH 12	0	0	1	0	1	1
CH 13	0	0	1	1	0	0
CH 14	0	0	1	1	0	1
CH 15	0	0	1	1	1	0
CH 16	0	0	1	1	1	1
CH 17	0	1	0	0	0	0
CH 18	0	1	0	0	0	1
CH 19	0	1	0	0	1	0
CH 20	0	1	0	0	1	1
CH 21	0	1	0	1	0	0
CH 22	0	1	0	1	0	1
CH 23	0	1	0	1	1	0
CH 24	0	1	0	1	1	1
CH 25	0	1	1	0	0	0
CH 26	0	1	1	0	0	1
CH 27	0	1	1	0	1	0
CH 28	0	1	1	0	1	1
CH 29	0	1	1	1	0	0
CH 30	0	1	1	1	0	1
CH 31	0	1	1	1	1	0
CH 32	0	1	1	1	1	1
CH 33	1	0	0	0	0	0
CH 34	1	0	0	0	0	1
CH 35	1	0	0	0	1	0
CH 36	1	0	0	0	1	1
CH 37	1	0	0	1	0	0
CH 38	1	0	0	1	0	1
CH 39	1	0	0	1	1	0
CH 40	1	0	0	1	1	1
CH 41	1	0	1	0	0	0
CH 42	1	0	1	0	0	1
CH 43	1	0	1	0	1	0
CH 44	1	0	1	0	1	1
CH 45	1	0	1	1	0	0
CH 46	1	0	1	1	0	1
CH 47	1	0	1	0	1	0
CH 48	1	0	1	0	1	1
CH 49	1	0	1	1	0	0
CH 50	1	0	1	1	0	1
CH 51	1	0	1	1	1	0
CH 52	1	0	1	1	1	1
CH 53	1	1	0	0	0	0
CH 54	1	1	0	0	0	1
CH 55	1	1	0	0	1	0
CH 56	1	1	0	0	1	1

5.6 TTL Control Procedure

The procedure to change the switch state via TTL control is as follows. Please note that all timing requirements in section 6.7 must be followed in order to assure a proper switch occurs:

1) Set the Strobe pin to high, and leave it high until a switch is desired.

2) Set the Data Input pins to the requested switch state.
3) Before commanding a switch, check the busy and alarm pins, if desired.
4) When a switch is desired, pulse the strobe pin low. On the falling edge of the strobe, the MEMS switch will move to the newly requested switch state.

5.7 Parallel Digital I/O Timing Diagram

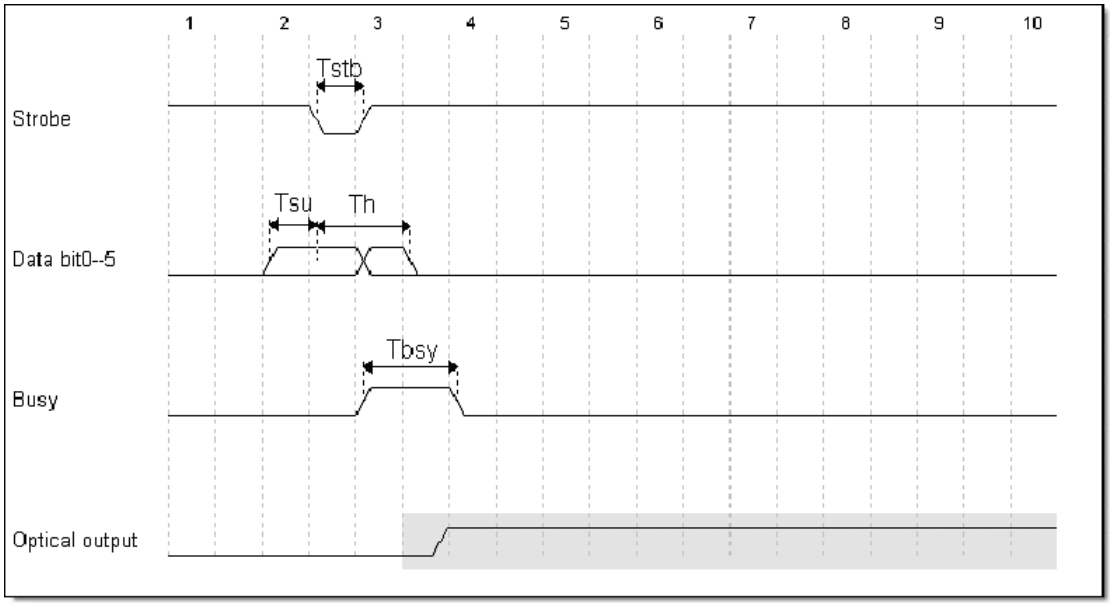


Figure 7. Timing Diagram

Notes:
1. T_{su} is the minimum required data set-up time, relative to the falling edge of Strobe. The channel address <D5:D0> must remain stable preceding the falling edge of Strobe.
2. T_h is the minimum required data hold time, relative to the falling edge of Strobe. The channel address <D5:D0> must remain stable preceding the falling edge of Strobe.
3. T_{stb} is the minimum required pulse width of Strobe

Parameter	Description	Min	Max	Units
T_{su}	Setup time. The channel address (<D5:D0>) must remain stable preceding the falling edge of Strobe.	100	-	µs
T_h	Hold time. The channel address (<D5:D0>) must remain stable following the falling edge of Strobe.	100	-	µs
T_{stb}	Strobe pulse width	1	-	ms
T_{bsy}	Switching time. During this period there may be invalid optical transmission on all channel.	-	30	ms

6. Handling Fiberoptic Components and Cables

Fiber optic components require special handling. Follow these guidelines when handling the cables and connectors.

6.1 Handling Fiber Optic Cables

To avoid cable damage and to minimize optical loss, follow these guidelines when handling fiber optic cables.

- Handle the fiber pigtail outputs carefully.
- The minimum bend radius for most optical cables is 35mm. Never bend an optical cable more sharply than this specification. Optical performance will degrade, and the cable might break.
- Avoid bending the optical cable near a cable strain relief boot. Bending an optical cable near a strain relief boot is one of the easiest ways to permanently damage the optical fiber.
- Avoid bending the optical cable over a sharp edge.
- Avoid using cable tie wraps to hold optical cable. Tie wraps when tightened can create micro-bends or break an optical cable. Microbends can cause a dramatic reduction in optical performance.
- Do not pull on the bare fiber as this can break the fiber inside the component.
- Avoid using soldering irons near optical cables. Accidental damage can easily occur when a soldering iron is used near an optical cable. In addition, solder splatter can contaminate and permanently damage optical fiber connectors.
- To assure the most stable, repeatable optical performance after the optical cables have been connected, immobilize the cables using wide pieces of tape or another form of mechanical cushion.

6.2 Storing Optical Connectors

All switches that include optical connectors are shipped with dust caps covering those optical connectors. Optical connectors should remain covered at all times when the instrument is not in use.

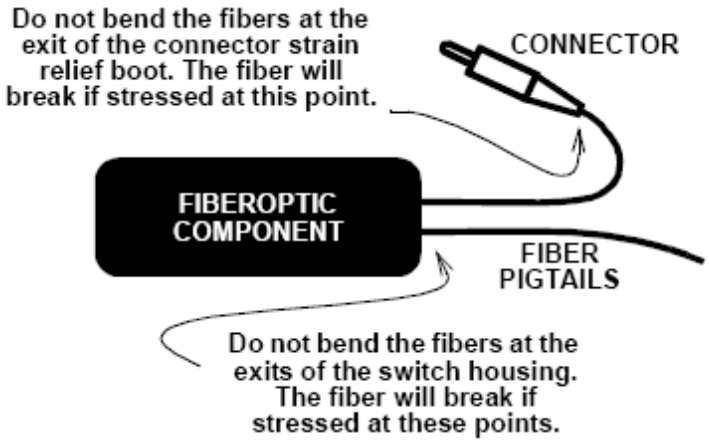


Figure 8. Fiber optic component, connectors, and fiber pigtails

6.3 Cleaning Optical Connectors

Clean any exposed connector using a cleaning kit supplied by the connector manufacturer or high-grade isopropyl alcohol and a cotton swab. To clean with alcohol and a swab, dab the tip of a cotton swab in alcohol and then shake off any excess alcohol. The tip should be moist, not dripping wet. Stroke the swab tip gently across the surface of the connector and around the connector ferrule. Either allow the connector a minute to dry, or blow-dry the connector using compressed air. Be careful when using compressed air: improper use may deposit a spray residue on the connector.

6.4 Mating Optical Connectors

Follow these instructions when mating optical connectors.

- Clean both connectors prior to mating. Any small particles trapped during the mating process can permanently damage the connector.
- Smoothly insert the appropriate connector ferrule into the adapter. Do not allow the fiber tip to contact any surface. If the tip accidentally contacts a surface before mating, stop. Re-clean the connector and try again.
- Tighten the connector until it is finger tight or to the torque specified by the connector manufacturer. Do not over-tighten the connector as this can lead to optical loss and connector damage.
- Check the optical insertion loss. If the loss is unacceptable, remove the connector, re-clean both ends of the mate, and reconnect them. You may have to repeat this process several times before a low-loss connection is made.
    - After you make the connection, monitor the stability of the optical throughput for a few minutes. Optical power trending (slowly increasing or decreasing) is caused by the slow evaporation of alcohol trapped in the connector. Continue to monitor optical power until it stabilizes. If the loss is unacceptable, re-clean the connectors and start again.