

KEITHLEY

Model 7090 Optical Switch Card

Instruction Manual

A GREATER MEASURE OF CONFIDENCE

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Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

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KEITHLEY

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Model 7090 Optical Switch Card Instruction Manual

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number 7090-901-01)	July 2001
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Revision C (Document Number 7090-901-01)	December 2001

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.


When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Model 7090 1xN Series Optical Switch Card Specifications

General Specifications:

Switching Time ⁽¹⁾		1x4	1x8	1x16
	Reset/Open	250ms	315ms	450ms
	Settle/Close	450ms	500ms	630ms
Maximum Switch Drive Current:		300mA	300mA	300mA
Dimensions	Width	114 mm [4.5 in]		
	Length	272 mm [10.75 in]		
	Height	32 mm [1.25 in]		
Weight		0.66kg		
Temperature	Operating	0 to 40 °C ⁽²⁾		
	Storage	-20 to 65 °C		
Relative Humidity		Up to 35 °C <80% RH Non-Condensing		
EMC		European Union Directive 89/336/EEC EN61326		
Safety		European Union Directive 73/23/EEC EN61010-1		

Referenced Switch Manufacturer Optical Specifications⁷:

	Typ.	Max.	Units
Wavelength Range	780 to 1650		nm
Switch Life	> 10 million cycles (min.)		
Insertion Loss ³	0.6	1.2	dB
Repeatability ⁵	-	+/-0.03	dB
Back Reflection (SM/MM) ⁴	-60 / -20	-55 / -	dB
Polarization Dependent Loss (PDL) ⁶	-	0.05	dB
Crosstalk	-	-80	dB

NOTES:

1. Actuation time measured from system trigger. Reset/Open refers to Channel N to Reset time. Settle/Close refers to Reset to Channel N or Channel N to Channel M time. Reset position is optically blocked.
1. At higher operating temperatures, a typical 0.1 dB and 0.3dB additive insertion loss for each channel should be expected for the strain relief and bulkhead models respectively.
1. Measured at 23 ± 5 °C.
1. Based on standard 1m pigtail length.
1. Sequential repeatability for 100 cycles at constant temperature after warm up. (Difference in Insertion Loss).
1. Measured at 1550 nm.
1. All optical specifications are referenced without connectors and are guaranteed by switch manufacturer only. Connectorization data will be provided for Insertion Loss and Back Reflection for each channel per switch card.

Specifications are subject to change without notice.

Model 7090 Switch Properties

Configuration	Single Channel, 1xN non-blocking switch				
Model Number	# of Channels	Fiber Type	Wavelength (nm)	Connector	FiberLength
7090-4-1	1x4	Single-Mode fiber (SMF-28) 9/125 each ch.	1290-1650	FC/APC	1 meter
7090-4-2BH ⁽⁸⁾	1x4	Single-Mode fiber (SMF-28) 9/125 each ch.	1290-1650	FC/SPC	Bulkhead Connector
7090-8-3	1x8	Single-Mode fiber (SMF-28) 9/125 each ch.	1290-1650	FC/APC	1 meter
7090-8-4	1x8	Multi-Mode fiber (MMF) 62.5/125 each ch.	780-1350	FC/SPC	1 meter
7090-8-5	1x8	Single Mode fiber (SMF-28) 9/125 each ch.	1290-1650	FC/SPC	1 meter
7090-16-6	1x16	Single Mode fiber (SMF-28) 9/125 each ch.	1290-1650	FC/SPC	1 meter
7090-16-7	1x16	Single Mode fiber (SMF-28) 9/125 each ch.	1290-1650	FC/APC	1 meter

NOTE:

1. This model contains a back plate with 5 FC/PC mating sleeve adapters. The fiber length is not applicable compared with the other models that are fiber pigtailed. Additional insertion loss due to the mating sleeve adapter is not accounted for in the referenced switch specification.

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1

General Information

Introduction

This section contains general information about the Model 7090 Optical Switch Card. The information is organized as follows:

- Feature overview
- Warranty information
- Manual addenda
- Safety symbols and terms
- Specifications
- Unpacking and inspection
- Switch properties

If you have any questions after reviewing this information, please contact your local Keithley representative or call one of our Applications Engineers at 1-800-348-3735 (U.S. and Canada only). Worldwide phone numbers are listed at the front of this manual.

Feature overview

The Model 7090 optical switch cards have the following features (depending on model):

- $1 \times N$ multiplexer optical switching
- 780 to 1650nm wavelength
- SMF-28 or MMF fiber type

Warranty information


Warranty information is located at the front of this instruction manual. Should your Model 7090 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the card for repair, be sure to fill out and include the service form at the back of this manual to provide the repair facility with the necessary information.


Manual addenda

Any improvements or changes concerning the switch card or manual will be explained in an addendum included with the manual. Be sure to note these changes and incorporate them into the manual.

Safety symbols and terms

The following symbols and terms may be found on the multiplexer card or used in this manual.

The  symbol indicates that the user should refer to the operating instructions located in the manual.

The  symbol shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the multiplexer card. Such damage may invalidate the warranty.

Specifications

Full Model 7090 specifications are included at the front of this manual.

Unpacking and inspection

Inspection for damage

The Model 7090 is packaged in a re-sealable, anti-static bag to protect it from damage due to static discharge and from contamination that could degrade its performance. Before removing the card from the bag, observe the precautions on handling discussed below.

Handling precautions

- Always grasp the card by the covers. Do not touch board surfaces or components.
- After removing the card from its anti-static bag, inspect it for any obvious signs of physical damage. Report any such damage to the shipping agent immediately.
- When the card is not installed and connected, keep the card in its anti-static bag, and store it in the original packing carton.
- Care should be taken when handling fiber-optic cables. They can be easily damaged by excessive handling and improper use.

Shipment contents

The following items are included with every Model 7090 order:

- Model 7090 Optical Switch Card
- Model 7090 Instruction Manual
- Additional accessories as ordered

Instruction manual

If an additional Model 7090 Instruction Manual is required, order the manual package, Keithley part number 7090-901-00. The manual package includes an instruction manual and any pertinent addenda.

Repacking for shipment

Should it become necessary to return the Model 7090 for repair, carefully pack the unit in its original packing carton or the equivalent, and perform the following:

- Call the Repair Department at 1-800-552-1115 for a Return Material Authorization (RMA) number.
- Advise as to the warranty status of the card.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.
- Fill out and include the service form located at the back of this manual.

Switch properties

The switch properties for the various Model 7090 card configurations are summarized in the specifications and switch properties guide supplied with each card.

2

Installation and Connections

Introduction

This section contains information about overall card configuration and connections, and it is organized as follows:

- Handling and cleaning precautions
- Card configuration
- Card installation and removal
- Card connections

WARNING It is the responsibility of the customer to operate instruments in a safe manner. Follow all applicable safety regulations for installing, configuring, and using the Model 7090. The Model 7090, as installed, should be approved by the appropriate safety personnel, such as the responsible Laser Safety Officer or equivalent.

Suggested starting points for workplace regulations and standards:
ANSIZ136,1, IEC 825, OSHA 29 CFR 1910.

As a general rule, always be aware of workplace hazards, strive to minimize them, and work safely.

Handling and cleaning precautions

Handling fiber-optic cables

Treat fiber optic cables with care to avoid cable damage and minimize optical loss. 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 may break.

General handling precautions include:

- Avoid bending the optical cable near a cable strain relief boot or switch housing. Bending an optical cable near a strain relief boot or switch housing 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 can create micro-bends or break an optical cable when tightened. Micro-bends can cause a dramatic reduction in optical performance.

- Do not pull on the bare fiber. Doing so can break the fiber inside the component.
- Avoid using soldering irons near optical cable. 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.
- In order to obtain the most stable, repeatable optical performance, immobilize optical cables using wide pieces of tape or some form of mechanical cushion after the optical cables have been connected.

Storing optical connectors

All switch cards are shipped with dust caps in place covering all optical connectors. Optical connectors should remain covered at all times when the card is not in use.

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 clean compressed air. Be careful when using compressed air because improper use may deposit a spray residue.

Card configuration

Card layouts

Figure 2-1 shows the general layout of Model 7090 versions with attached fiber cables. The card includes one common optical fiber cable and a number of channels (depending on model). Figure 2-2 shows the typical layout of bulkhead versions.

Figure 2-1
Card configuration for versions with attached fiber cables

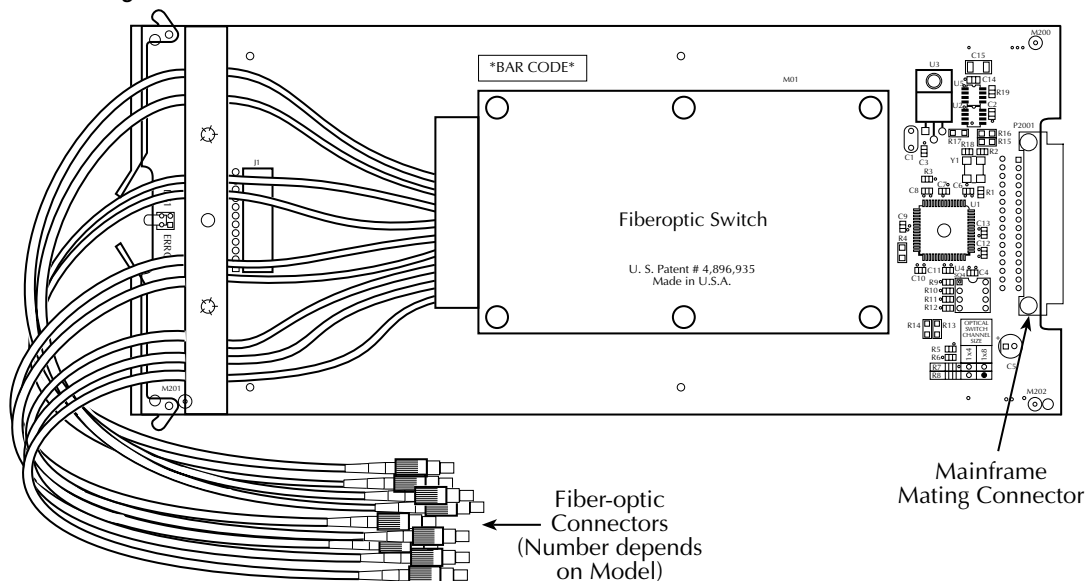
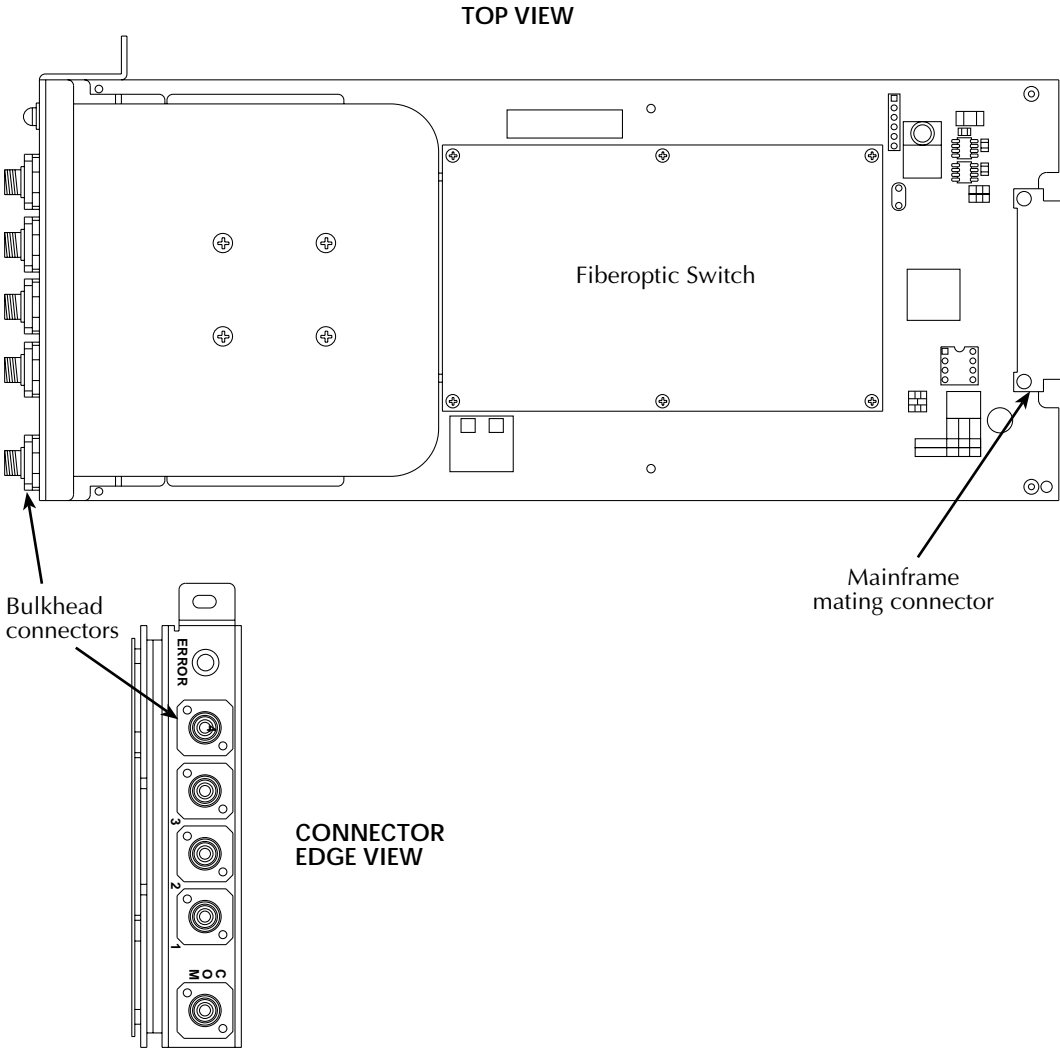
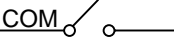



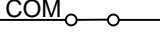

Figure 2-2
Typical card configuration for bulkhead versions



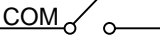

Switching conventions

Electrical industries

Given channel  COM  CHannel N

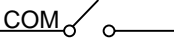

Channel “Close”  COM  CHannel N

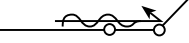

⇒ Channel path electrically connected ⇒ current flow.

Channel “Open”  COM  CHannel N

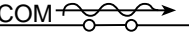

⇒ Channel path not electrically connected ⇒ no current flow.

Optical industries

Given channel  COM  CHannel N

Channel “Close”   CHannel N

⇒ Channel path obstructed ⇒ no light can pass.

Channel “Open”  COM  CHannel N

⇒ Channel path un-obstructed ⇒ light can pass.

NOTE We are applying electrical conventions with optical signals.

Optical signals

“Close” ⇒ Light can pass

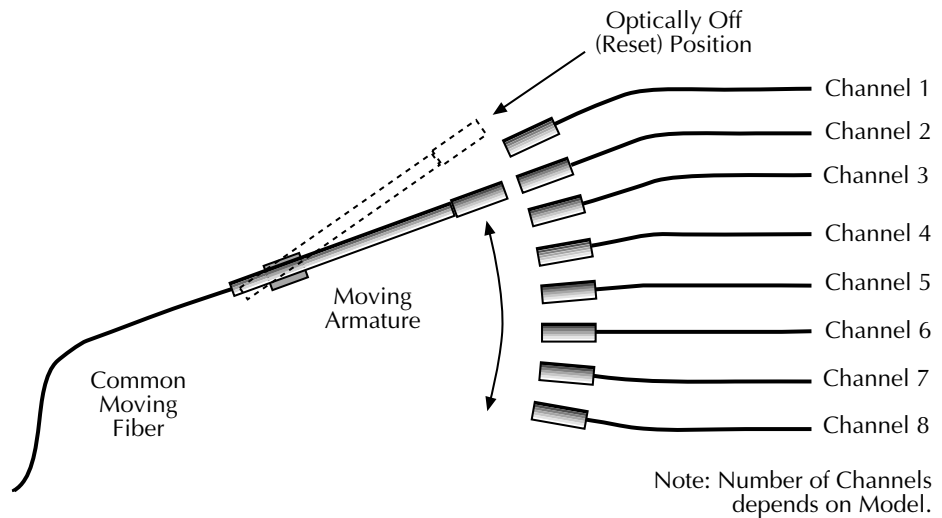
“Open” ⇒ Light cannot pass

⇒ May not be obvious to optical field personnel.

Switching diagram

Figure 2-3 shows a switching diagram of the Model 7090. The card is arranged as one $1 \times N$ optical multiplexer. The unit is basically an opto-mechanical switch that selects individual fiber channels using a high-resolution stepper motor, which moves the common moving fiber into direct alignment with one of the fixed fibers. Optical switching is passive and bi-directional. When the switch is reset, the moving fiber is in the optically off position.

Figure 2-3
Functional diagram



Card installation and removal

This paragraph explains how to install and remove the Model 7090 card assembly from the Model 7001 mainframe. (Model 7002 installation is similar.)

WARNING It is the responsibility of the customer to operate instruments in a safe manner. Follow all applicable safety regulations for installing, configuring, and using the Model 7090. The Model 7090, as installed, should be approved by the appropriate safety personnel, such as the responsible Laser Safety Officer or equivalent.

NOTE To prevent performance degradation caused by contamination, handle the card only by the edges and covers.

Card installation

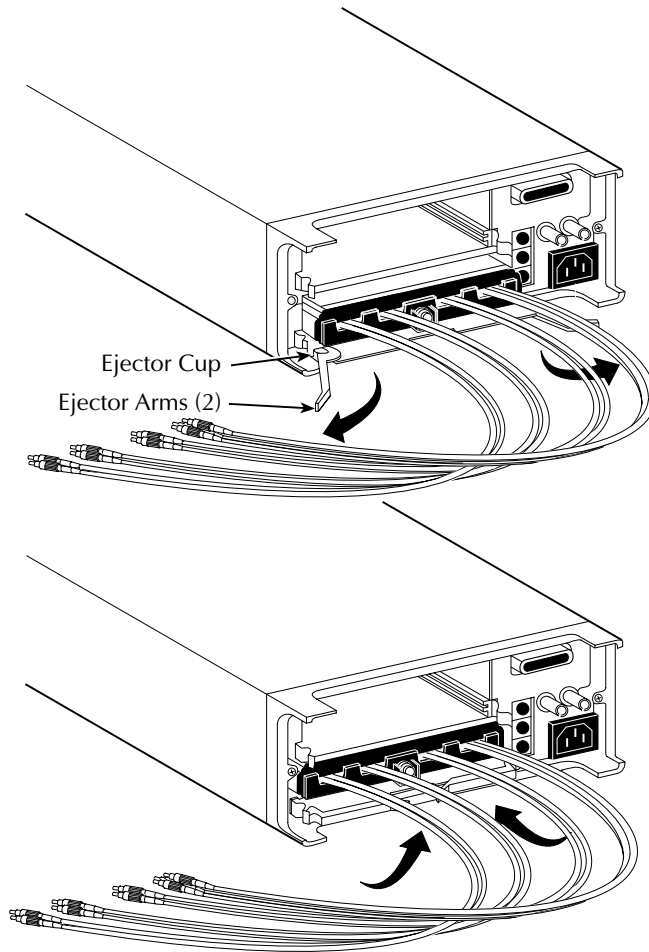
Refer to [Figure 2-4](#) to install the card assembly in the Model 7001 mainframe.

WARNING Turn off the power, and disconnect all line cords before installing the optical switch card.

1. Open the ejector arms at the back edge of the card.
2. Slide the card edges into the guide rails inside the mainframe.
3. Carefully push the card all the way forward until the ejector arms engage the mounting cups.
4. Push in on the card edge and ejector arms until the card is properly seated.
5. Make sure the ejector arms are properly latched.

NOTE Before using Model 7090, it would be a good idea to clean connectors and keep dust caps in place until the unit is ready to interface to an optical system.

Figure 2-4
Card installation



Card removal

Follow the steps below to remove the optical switch card from the mainframe:

WARNING Turn off and disconnect any laser sources and disconnect the line cord before removing the card.

1. Pull out on the ejector arms until the card pulls free from the internal connector.
2. Carefully slide the card out of the switching mainframe.

Card connections

Mating optical connectors

After installing the card, make your optical connections as needed. Observe the following precautions when mating optical connectors:

- Clean both connectors prior to mating. Any small particles trapped during the mating process can permanently damage the connector.
- Insert the appropriate connector ferrule smoothly into the adapter. Do not allow the fiber tip to contact any surface. If the tip accidentally contacts a surface before mating, do not make the connection. 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 doing so 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. 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 connection. Continue to monitor optical power until it stabilizes. (Optical power trending can also be a natural effect of the laser source as it warms up.) If the loss is unacceptable, re-clean the connectors, and start again.

Bulkhead version connectors

The bulkhead versions have the fiber coming from the optical switch module connected to a bulkhead on the rear of the card. This bulkhead contains FC/PC mating sleeves for user connections. The error light is also mounted in the bulkhead. Bulkhead connections to this card can be made in the same manner as described in *Mating optical connectors* above. Also refer to *Handling and cleaning precautions* at the front of this section to avoid damage.

3

Operation

Introduction

WARNING It is the responsibility of the customer to operate instruments in a safe manner. Follow all applicable safety regulations for installing, configuring, and using the Model 7090. The Model 7090, as installed, should be approved by the appropriate safety personnel, such as the responsible Laser Safety Officer or equivalent.

Suggested starting points for workplace regulations and standards:
ANSIZ136,1, IEC 825, OSHA 29 CFR 1910.

As a general rule, always be aware of workplace hazards, strive to minimize them, and work safely.

This section contains information about operating considerations for the Model 7090 Optical Switch Card. The information is organized as follows:

- Optical signal characteristics
- Operation overview
- Card programming
- Error conditions

Optical signal characteristics

Refer to the specifications and switch properties guide supplied with this card for card signal characteristics.

Operation overview

The Model 7090 Optical Switch Card contains a fiber-optic 1×N switch module along with the appropriate electronics to interface to the Model 7001/7002 Switch Systems. The fiber-optic switch contains a number of channels (depending on model), one switched common channel, and one reset position. During normal operation, the switch will optically connect the common channel to one of the available channels, or to the reset position, which is optically blocked. When an optical channel is connected, the switch will

transmit light through the common and connected channel passing wavelengths 780nm to 1650nm with associated losses according to system setup and switch specifications. The actual switch optical characteristics and system losses vary depending on the particular switch parameters ordered and the characteristics of the system in use (refer to the switch properties guide).

Upon system power-up, the optical switch goes through an initialization period of approximately one second. The Model 7001/7002 system will be ready to receive instructions after approximately six seconds at which time the switch will be in reset position. Once a switching command is complete, the optical switch module requires up to 0.5 seconds to execute, model specific. Max in now .63 (depending on model). While the optical switch is busy changing switch channels, the optical channel connections are invalid. The optical switch is a relatively slow device due to the mechanical nature of its switching design.

Card programming

The optical switch can be in reset or have only one optical channel connected at any time. Once the Model 7001/7002 is programmed, and the optical switch is auto-initialized, the switch will be ready to receive switching instructions via the front panel of the Model 7001/7002, or with the appropriate SCPI commands. When closing individual channels, the channel list should be cleared between single channel CLOSE commands to avoid the logical impossibility of closing more than one channel at a given time. In other words, a CLOSE command is executed properly when the intention is to close only one channel, and only one channel should be included in the channel list at a time. The preferred method of switching is to program a scan. Refer to 7001 Operating Manual for programming details.

NOTE *Operation in single channel mode will result in switch reset operations between each channel CLOSE operation.*

Front panel card programming

Selecting the single-channel mode

1. Upon initial power-up of the Model 7001, wait until the menu system becomes active.
2. Press the SCAN CONFIGURATION key.
3. Press the ► key three times to select “CHAN-RESTRICTIONS.”
4. Press ENTER, select “SINGLE-CHAN,” then press ENTER again.
5. Press the ► key once, select “ON,” and press ENTER. (Auto-reset is performed at this time.)
6. Press the EXIT key twice to return to the channel status display.

The message “SELECT CHANNELS” is displayed, and the current state of all channels is shown. At this point, you can enter a single desired channel that is to be opened or closed via the numeric keypad.

Closing a single optical channel

1. Select desired channel to close (1-N). For example, to close channel 3 on a card installed in slot 1, key in 1!3 via the numeric keypad.
2. Press the CLOSE key.

After the appropriate close time elapses, the selected channel will be closed, and a valid optical connection will be maintained.

NOTE *Be sure to close only one channel at a time.*

Opening an optical channel

1. Select the desired channel to open (1-N). For example, to open slot 1, channel 3, key in 1!3 via the numeric keypad.
2. Press the OPEN key.
3. Because of the single-channel nature of the switch module, opening a given channel results in an optically blocked connection, which is identical to the reset position.

Resetting the optical switch

To reset the optical switch at any time, simply press the OPEN ALL key. Recycling power will result in a reset condition as well.

Manually scanning channels

Program ARM, SCAN, and CHANNEL layers appropriately.

1. Press the SCAN LIST key.
2. Enter all desired channels in the scan list, for example: 1!1, 1!2, 1!4, 1!7.
3. Repeatedly press the STEP key to cycle through the scan list, closing one channel at a time starting at the beginning of the list.

Scanning is the preferred method of switching the Model 7090.

NOTE Refer to 7001 Manual to configure ARM layer, SCAN layer, CHANNEL layer and their respective spacings.

Automatically scanning channels

Program ARM and SCAN layers appropriately.

1. Press the SCAN LIST key.
2. Enter all desired channels in the scan list, for example: 1!1, 1!2, 1!4.
3. Press the SCAN button.
4. Select “CHAN-CONTROL,” then press the ENTER key.
5. Select “CHANNEL-SPACING,” then press ENTER.
6. For timed auto-switching, select “TIMER,” then press ENTER.
7. Enter the appropriate time in seconds between switch closures (for example, 0001.000) using the keypad.
8. Press ENTER to complete timer programming.
9. Press the EXIT key three times to return to the scan list display.
10. Press STEP once to arm and execute the auto scan.
11. Press OPEN ALL to stop scanning the scan list.

Remote card programming

Selecting the single-channel mode

Use the following SCPI command to enable the single-channel mode:

```
:CONF:SCH ON
```

Closing a single optical channel

Send the following SCPI command to close the desired channel:

```
:CLOS <channel>
```

For example, the following command will close channel 2 of a Model 7090 installed in slot 1:

```
:CLOS (@ 1!2)
```

Again, be sure not to close more than one channel at a time.

Opening an optical channel

Use the following command to open the closed channel:

```
:OPEN <channel>
```

For example, the command below will open previously closed slot 1, channel 2:

```
:OPEN (@ 1!2)
```

Resetting the optical switch

Send the :OPEN ALL command to reset the optical switch.

Scanning channels

There are a number of commands associated with scanning (see the Model 7001 or 7002 Instruction Manual). However, you can perform a simple scan using only the following five commands:

```
*RST
:CONF:SCH ON
:TRIG:SEQ:COUN:AUT ON
:ROUT:SCAN <list>
:INIT
```

The *RST command selects the default scan configuration, while the second command enables the single-channel mode. The third command automatically sets the channel count to the number of channels in the scan list. The :ROUT:SCAN command programs the scan list, and the :INIT command takes the mainframe out of the idle state and performs the scan.

For example, send the following commands to scan through four channels of a card installed in slot 1:

```
*RST
:CONF:SCH ON
:TRIG:SEQ:COUN:AUT ON
:ROUT:SCAN (@ 1!1:1!4)
:INIT
```

Multiple 7090 cards

Multiple 7090 cards can be programmed in the usual way. Single channel mode option must be off if multiple cards are to have channel closures at the same time.

Error conditions

Refer to the Model 7001 or Model 7002 User Manual for details of Model 7001/7002 front panel reported errors.

For some errors contingent on user actions, the Model 7090 provides one red LED located at the back of the card to indicate certain error conditions, which are summarized in [Table 3-1](#).

Table 3-1
Error conditions

LED Status	Cause	Resolution
On continuously	The switch module has an internal hardware malfunction.	7090 must be returned to the factory to be serviced.
Blinks at ~ 2Hz rate	<p>User error. The 7090 received a close operation to close more than one channel. Under these circumstances, it is not clear which single channel should have been closed. For laser safety reasons, the 7090 resets to avoid a potential open beam condition.</p> <p>NOTE 7001/2 front panel will still show conflicting channels as closed.</p>	<p>Most likely, the 7001/2 system was not programmed for single channel mode when it should have been. Or, there is an error in the scan list or channel list. Refer to 7001 Manual for card programming details. This error clears after the next valid command is given such as an OPEN ALL for reset.</p>

4

Service Information

Introduction

This section contains service information for the Model 7090. The information is organized as follows:

- Handling and cleaning precautions
- Performance verification
- Principles of operation

WARNING The information in this section is intended only for qualified service personnel. Some of the procedures may expose you to hazardous conditions that could result in personal injury or death. Do not perform these procedures unless you are qualified to do so.

Handling and cleaning precautions

Handling fiber-optic cables

Treat cables with care to avoid cable damage and minimize optical loss. 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 may break.

General handling precautions include:

- Avoid bending the optical cable near a cable strain relief boot or switch housing. Bending an optical cable near a strain relief boot or switch housing 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 can create micro-bends or break an optical cable when tightened. Micro-bends can cause a dramatic reduction in optical performance.
- Do not pull on the bare fiber. Doing so can break the fiber inside the component.
- Avoid using soldering irons near optical cable. 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.
- In order to obtain the most stable, repeatable optical performance, immobilize optical cables using wide pieces of tape or some form of mechanical cushion after the optical cables have been connected.

Storing optical connectors

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

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 because improper use may deposit a spray residue. Connectors should always be properly cleaned before each use.

Performance verification

The following paragraphs discuss performance verification procedures for the Model 7090. The procedures involve recommended equipment, test setup, and the procedure for measuring insertion loss.

Environmental conditions

All verification measurements should be made at an ambient temperature between 18° and 28°C, and at a relative humidity of less than 70%. Refer to Model 7090 specifications for environmental operating ranges.

Insertion loss tests (an example)

Two specifications are given for insertion loss. The first specification is a maximum and typical insertion loss reflecting the quality of switch modules manufactured without connectors. The second specification is an actual insertion loss measurement provided with each switch module that was measured with the specific connectors in the measurement. To verify module quality, fiber connections and connector connections, insertion loss measurements should be compared to the second insertion loss specification and might fall within range of the first insertion loss specification. Insertion loss measurements should be done with the same wavelength(s) as those provided with the Model 7090. The following is an example only, and in many cases, the required equipment will vary.

Insertion loss setup

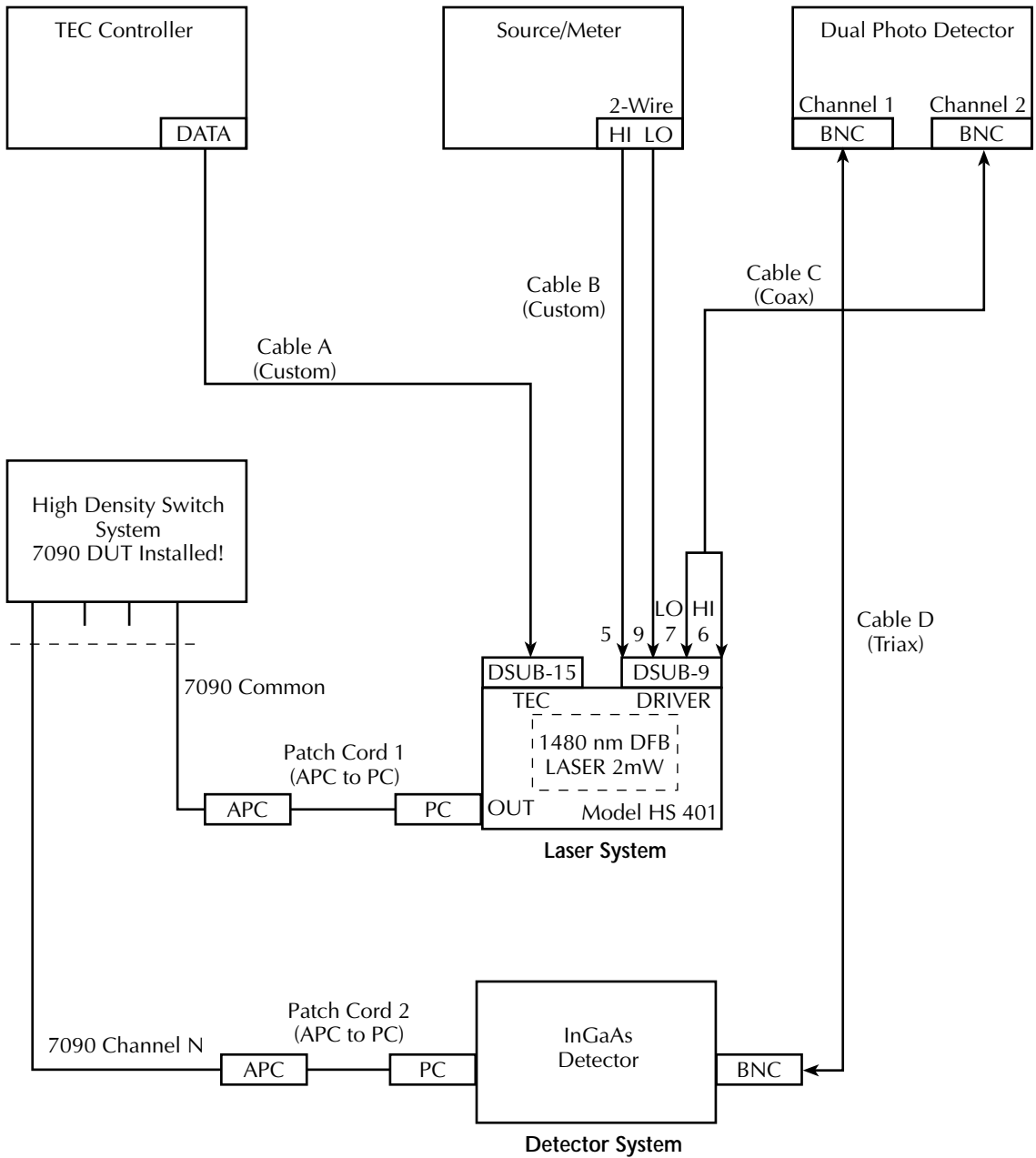
The system shown in [Figure 4-1](#) is sufficient to measure and calculate insertion loss on a given channel of the Model 7090. Two optical patch cords are required to interface the source and detection equipment. Since these connectors may vary, other patch cords may be required. The example system contains APC connectors. Patch Cord 1 is part of the laser source system, and Patch Cord 2 is part of the detector system. Connectors should be properly cleaned prior to any optical measurements.

Calculating insertion loss

The laser light source is to be injected into the common channel of the Model 7090 card. When channel N is closed, the detection system is used to measure the optical power output of the DUT. This test is a relative test, and patch cord losses need not be specifically known. Two parameters are required to calculate insertion loss. The first is the optical power of the laser system going into the common channel of the Model 7090 (P_{IN}), and the second is the optical power of the detector system coming from the connected channel N of the Model 7090 (P_{OUT}). The difference in these parameters due to the insertion of passive optics between them is, by definition, insertion loss:

$$\text{Insertion Loss (dB)} = -10\text{LOG}_{10}(P_{OUT}/P_{IN})$$

Figure 4-1
Optical insertion loss test connection block diagram



Insertion loss procedure

1. Allow the connected system to run and warm up for 20 minutes with the laser power on.
2. Turn off the laser power.
3. With the laser power off, connect the laser output directly to the detector input (PC to PC) connection. The channel 1 reading of the Dual Photo Detector is the noise and dark current. Press the Photo Detector's REL button to zero out this level.
4. With the laser power off, reconnect Patch Cord 1 to laser output and Patch Cord 2 to Detector input. With no laser output, connect the APC output of Patch Cord 1 to the APC input of Patch Cord 2.
5. Turn on the laser power, and record the channel 1 reading of the Dual Photo Detector as P_{IN} . This value may be an average of readings, but be sure the reading is stable.
6. Turn off the laser power.
7. With the laser power off, reconnect the Model 7090 common channel to the APC output of Patch Cord 1.
8. Reconnect Model 7090 channel N to the APC input of Patch Cord 2.
9. Using the Model 7001 front panel keys, close Model 7090 channel N.
10. Turn on the laser, and record the channel 1 reading of the Photo Detector as P_{OUT} . This value may be an average of readings, but make sure the reading is stable.
11. Open Model 7090 channel N.
12. Turn off laser power, and compute insertion loss for this channel as outlined in *Calculating insertion loss* above.
13. Repeat the procedure for the remaining Model 7090 channels.

Insertion loss notes

The second channel of the Dual Photo Detector is used to measure back facet photodiode current for the laser diode module. This measurement is one way to verify that the laser is operational, but it is not required to compute insertion loss and can be useful when debugging a troublesome system. The back detector is intended to be used as feedback for applications that this example may not require.

The current measurements from the Dual Photo Detector used in the insertion loss calculation differ from the optical power by a factor that should remain constant and is cancelled out in the system.

Some important points to note while running this test system:

- Repeatability and uncertainty of measurements can be affected by connectors and connection points.
- For specification verification, the insertion loss calculation should be done at several wavelengths, if possible.
- Fixed positions of fiber and connectors is preferable.

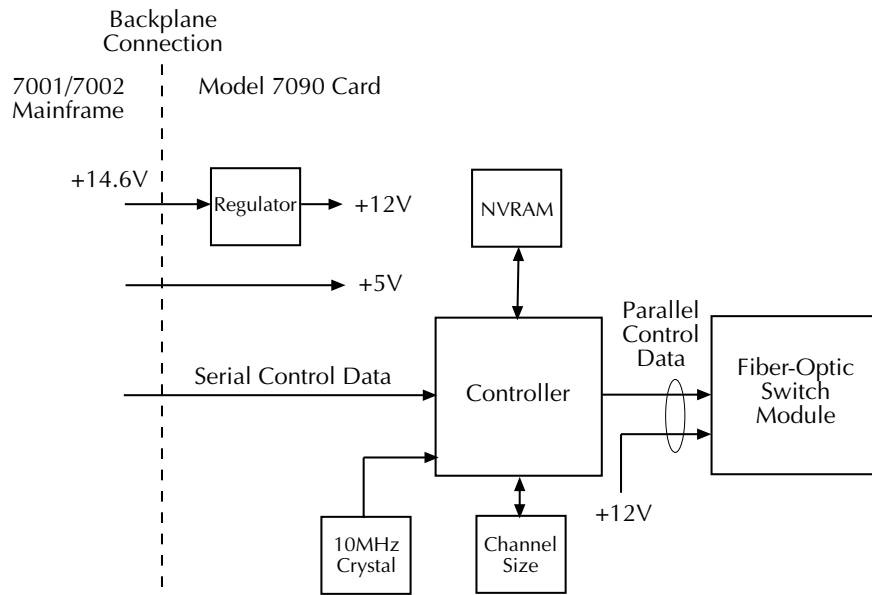
- Minimizing connectors and connect, re-connect points improves repeatability.
- A cooled laser module has a more stable wavelength and output power.
- Excess fiber should be neatly coiled and taped down out of the way.
- Be sure to keep the laser turned off when it is not necessary for it to be on.
- An increase in insertion loss is to be expected when operating in high temperature environments.

Principles of operation

Block diagram

Figure 4-2 shows a block diagram of the Model 7090.

Figure 4-2
Block diagram



Power supplies

Circuits located on the Model 7090 card are powered by two DC supplies: +5V and +12V. +5V is supplied directly from the mainframe, while the +12V supply is regulated from +14.6V mainframe power.

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