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3D MEMS

Move the light, not the fiber

S320 Optical Circuit Switch (OCS)
Hardware User Guide

Confidential and Proprietary Information

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Table of Contents

List of Figures

List of Tables

PREFACE

The *S320 Optical Circuit Switch (OCS) Hardware User Guide* provides detailed information about the physical form and functionality of the CALIENT S320 fiber-optic switch.

AUDIENCE

This guide is written for both network operations center personnel and field service personnel who use and maintain the S320 OCS.

1 INTRODUCTION

This user guide provides detailed information about the hardware components comprising the CALIENT S320 Optical Circuit Switch (OCS).

Topics covered herein include safety precautions for installing, using and maintaining the switch; an overview of OCS functionality and physical architecture, including precise descriptions of the LEDs and physical interfaces located on the front and rear of the OCS chassis; and step-by-step procedures for unpacking and installing a new S320 OCS.

This document also provides system specifications for regulatory, reliability, space, optical and environmental requirements, as well as CALIENT part numbers for ordering additional systems or hardware components that may eventually need replacement (e.g., fan filter).

2 SAFETY OVERVIEW

This section of the document reviews specific safety precautions to observe when installing, operating or working around the S320 OCS.

To ensure the safety of personnel, the following actions should be implemented prior to installing the S320 OCS:

- It is recommended that a pre-installation site survey be performed; review the completed site survey for accurate site information.
- Become familiar with the safety precautions, notes and warnings contained in this guide.
- Observe all weight cautions related to handling equipment. Make sure that adequate personnel and resources are available to safely lift and transport the S320 OCS during installation.
- Locate power sources and prepare to observe all safety precautions pertaining to connecting and applying electrical power.
- Make sure to implement all electrostatic discharge (ESD) prevention measures when handling the S320 OCS.
- Inspect the installation site for sources of laser light and take all applicable precautions when near such sources.
- Exercise all applicable precautions when moving and handling hazardous materials such as alcohol and compressed gas.
- Make sure to implement the prescribed precautions for handling and cleaning optical fiber.

2.1 Laser Safety

It is especially important to observe the proper precautions when working with or around lasers. The following subsections describe the potential risks associated with laser technology and the recommended procedures for using it safely.

2.1.1 General Precautions

The S320 OCS switches coherent (laser) light between input and output optical-fiber terminations. The range of the light wavelengths passed through the equipment is outside the visible spectrum. Because the unaided human eye cannot detect its presence, this light can pose a serious health hazard.

If the hazard is not mitigated through the use of proper safety equipment and the observance of safety precautions, blindness can result. This section presents general safety measures that *must* be observed by personnel working on or around the S320 OCS to reduce or eliminate the risk of injury from laser radiation.

Danger

- Use of controls, adjustments or procedures other than those specified in this guide could result in hazardous radiation exposure.
- The S320 OCS can switch the laser energy supplied by any one of the input fiber-optic cables to any one of the output fiber-optic cables. To avoid injury, all of the switch's optical connectors must either be attached to a fiber-optic cable that is part of a closed optical system or capped with the supplied connector covers.
- **Under no circumstance** should attempts be made to operate this equipment with a fiber-optic connector that is uncapped or disconnected from a fiber-optic cable that is part of a closed optical system.
- All service to this device that requires removal of the chassis panel must be performed by the manufacturer or its authorized agent(s).

Personnel working near, or in the vicinity of, any equipment carrying optical traffic may not be aware of possible exposure to laser light escaping from uncovered connectors.

To avoid possible injury from unintended exposure to laser radiation, make sure to observe the following precautions:

- Always keep fiber cables connected to *all* of the S320 OCS connectors, regardless of whether the fiber termination is providing an active cross-connection. If a cable is not attached to a connector, make sure the connector is capped. In addition to preventing accidental exposure to a light source, capping the connector will help prevent contamination of its fiber-optic surfaces by dust or other particulate matter.
- *Never* look directly into the end of a fiber or into any optical connector. There is no warning when the connector is connected to a light source.
- Always wear the appropriate laser safety glasses when working around a laser source. When evaluating protective eyewear, be sure to consider the laser power, wavelength and manufacturer class warnings for the laser device being used.

2.1.2 Laser Sources

The S320 OCS generates Class 1 laser light, but it passes higher-powered laser light from external sources. The switch passes laser light through its fiber terminations when traffic-carrying fibers are connected to the switch.

2.1.2.1 Class 1 Laser

The S320 OCS uses a Class 1 laser internally as a test source. Light from this laser could potentially be available at a fiber termination.

The S320 OCS is certified as a Class 1 laser product per the requirements of the U.S. Federal Product Performance Standard for Laser Products contained in the regulations in 21 CFR 1040.10. Class 1 laser products are not considered to be hazardous; however, lasers more powerful than Class 1 may be connected to the S320 OCS.

Although the S320 OCS has no laser sources higher than Class 1, the total optical power through the equipment—and potentially available at any one of the fiber terminations, split-out cable connectors, patch-panel cables or patch-panel coupling sleeves—could aggregate to the level of a Class 4 (highly hazardous) source.

2.2 Electrostatic Discharge

System components that contain integrated circuits can be damaged by static electricity. Static electricity potentials develop through the movement of human bodies and are released as Electrostatic Discharges (ESDs) whenever they come in contact with other objects. Dry air allows greater static charges to accumulate, but because potentials high enough to damage circuits can occur anywhere, taking precautions against ESD is imperative when working around the S320 OCS.

The ESD symbol shown here appears on packaging and other items as a reminder to take the necessary precautions to prevent electrostatic damage to the S320 OCS.

To reduce the possibility of ESD damage, most equipment racks provide grounding jacks into which anti-static wrist straps can be plugged. Be sure to observe the following precautions whenever working with the S320 OCS:

- Always wear a tested and verified grounded wrist strap to prevent ESD, making sure the wrist strap is plugged into a grounding jack.
- Observe warning labels on bags and cartons. Whenever possible, do not remove a module from its antistatic packaging until it is to be installed in the rack.
- Always store and transport any module in antistatic packaging.
- Keep all static-generating materials such as plastic foil wrappers, other plastics, Styrofoam and cardboard containers away from the S320 OCS.
- Maintain ambient humidity within the 20% to 85% limits specified for operation of the S320 OCS.

2.3 Optical Connections

2.3.1 Keeping Fiber Connectors Clean

Optical fiber connectors require special handling to mitigate contamination from dust and debris that could increase insertion loss. Contamination during connection of the connector surface perpendicular to the light propagation can increase insertion loss and back-reflection. Once a pair of clean connectors is mated, however, it is unlikely that further contamination will occur until the next time the fibers are disconnected.

To minimize the effects of particulate contamination, the surface of the connector end must be cleaned before connection. This cleaning operation is critical, as an improperly prepared optical surface can cause loss of performance.

2.3.2 Optical Fiber Bend Radius

The Minimum Bend Radius (MBR) for optical fiber cables used on the S320 OCS is 1 inch (25 mm). An optical fiber or fiber-optic cable should not be bent below the MBR; doing so can result in damage to the fiber. Improper handling of optical fiber and cables can have adverse effects on S320 OCS performance. Observe the following precautions for handling fiber and cable:

- Keep optical surfaces clean; only trained personnel should clean optical cables and connectors.
- When optical cables or optical connectors are not connected, make sure the cables and/or connectors are capped. Be sure to use clean caps.
- Handle the fiber cables as little as possible.
- Never eat, drink or smoke around optical equipment.
- Keep cable runs neat and observe the MBR when bending fiber-optic cables.

2.4 Cleaning Substance Hazards

2.4.1 Isopropyl Alcohol

It may be necessary to use a solvent when cleaning optical fiber connectors. The recommended solvent for cleaning optical fiber connectors is isopropyl alcohol (IPA) that is 99.8+% pure.

DOT Hazard Classification: Flammable Liquid

Always observe the following precautions when handling isopropyl alcohol:

- Keep the container closed and away from heat, sparks or open flame.
- Use with adequate ventilation.
- Avoid breathing the vapor.
- Avoid contact with eyes, skin and clothing.
- Wash thoroughly after handling.
- Store in an approved flammable materials cabinet when not in use.
- Dispose of materials soiled with IPA in a clearly marked container approved for such purpose.
- If a spill occurs, clean up the spill and dispose of contaminated materials in accordance with local requirements for hazardous waste.

Emergency First Aid

Isopropyl alcohol is harmful if it is inhaled, ingested or comes into contact with the eyes or skin. Use it only in a well-ventilated area. If exposure occurs, immediately call emergency medical services, followed by your local poison control center. For external exposure (eyes or skin), immediately flush the exposed area with large amounts of clean water for a minimum of 15 minutes.

2.4.2 Leakage and Spill Disposal

In the event of a leak or spill, remove all sources of ignition and ventilate the affected area. Clean-up personnel require protective clothing and respiratory protection from vapors. Dispose of contaminated clean-up materials only at an approved facility in accordance with local requirements for hazardous waste.

2.4.3 Decanting

When decanting isopropyl alcohol from a distribution container to a supply container, make sure the supply container is appropriately labeled to prevent possible contamination of the alcohol with a foreign substance.

Perform the following steps when refilling storage and work containers:

1. Empty the current contents of the supply container into a solvent waste container.
2. Fill the empty supply container 5-10% full with isopropyl alcohol.
3. Cap the container and shake it to clean its interior.
4. Pour the shaken alcohol into the solvent waste container.
5. Refill the supply container 80-90% full.
6. Close the supply container lid.
7. Close the distribution container lid.

Note

Failing to keep supply and distribution containers closed, except when in use, can result in contamination of the IPA cleaning solution.

2.4.4 Nitrogen

CALIENT recommends using small, disposable cylinders of 99.9% pure compressed nitrogen gas when cleaning S320 OCS optical fiber connectors. Attention should be given to the information provided in the cylinder supplier's Material Safety Data Sheet (MSDS).

Nitrogen cylinders contain gas under high pressure that can cause rapid suffocation when released. Nitrogen gas acts as a simple asphyxiant by displacing air necessary for life. If symptoms of asphyxiation occur—such as rapid respiration, loss of muscular coordination, fatigue, dizziness or nausea—move immediately to fresh air. Also, *never* puncture or incinerate nitrogen cylinders.

2.4.5 Nitrogen Cylinder Precautions

Be sure to observe the following precautions when using an industrial-size compressed nitrogen gas cylinder:

- Keep it from falling over or rolling around to avoid damaging the cylinder valve.
- Open the valve a little at a time. If it cannot be opened by hand, return the cylinder to the supplier. Never use force (e.g., a wrench) when opening or closing a cylinder valve.
- Never heat a cylinder containing liquefied gas to increase the gas flow or the required rate.
- Only use connectors designed specifically for compressed-gas cylinders. Never use intermediate connectors.
- Always check the condition of couplings before use.
- Use only materials compatible with the gas.
- Never allow *any* substance (gas or liquid) to get into a cylinder that is in use. If there is a risk this could happen, mount an anti-return valve. If a foreign substance accidentally gets into a cylinder, notify the supplier immediately.

3 THE CALIENT S320 OCS SYSTEM

3.1 Overview

CALIENT's S320 OCS is at the leading edge of fiber-optic cross-connect systems. It provides transparent, software-controlled fiber-optic switching functionality that will revolutionize the way optical fiber is installed and managed.

The S320 OCS enables dynamic optical layer optimization in next-generation data centers and software-defined networks (SDNs). Datacenter operators and service providers can leverage the system's high-bandwidth capability and flexibility to stay ahead of the runaway pace of fiber deployment to make fiber networks more profitable.

The S320 OCS provides carrier-class reliability, making it suitable for Datacenters, Metro Software-Defined Networks (SDN), FTTx networks and Government deployments. In addition, the system supports a wide range of network applications—from the network core to access—allowing any optical input fiber to be connected at the photonic level to any output fiber, regardless of the data rate or protocol of the signals being carried by the fiber.

3.2 Architecture

The S320 OCS establishes, monitors and changes connections between single-mode optical fibers using Micro-Electro-Mechanical Systems (MEMS) optical switching. Connections are made between fibers carrying signals with any wavelength, data rate or protocol. The S320 architecture is shown in Figure 1.

The core of the S320 OCS is the MEMS Switch Module (MSM). Input fibers are connected to the MSM, which establishes connections with any of the output fibers. Light tapped from the input and output fibers is delivered to the Optical Monitoring Module (OMM) to enable monitoring of existing connections and the establishment and optimization of new connections. Light is tapped using fiber tap couplers, and mirror drivers control each connection by supplying voltage to each MEMS mirror. Users manage and communicate with the S320 OCS via the Control Processor (CP). To ensure high availability, the CPs and power supplies are redundant.

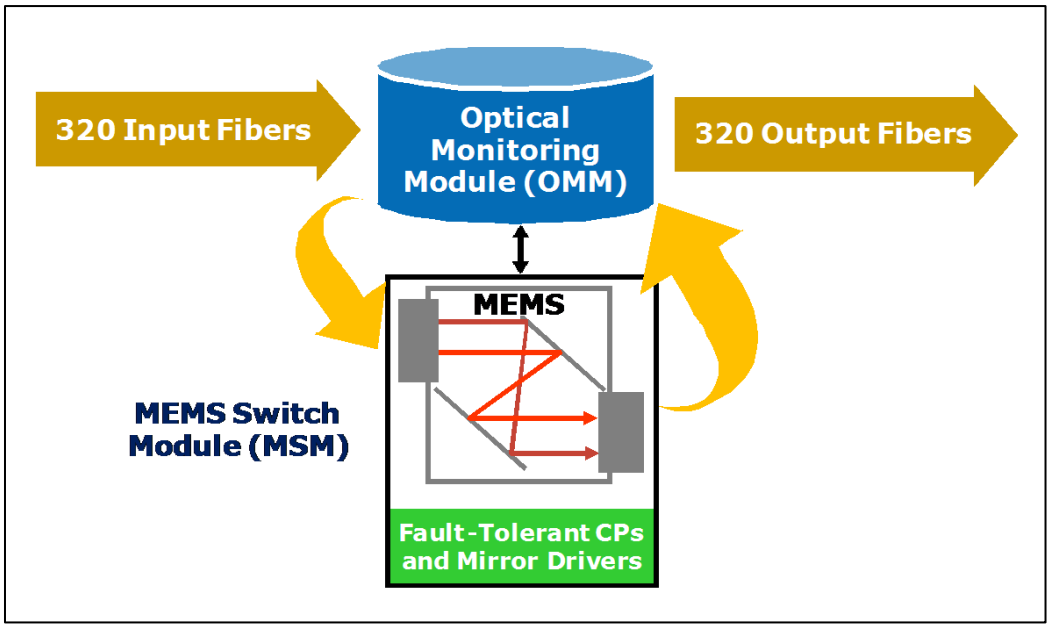

Figure 1 – S320 OCS Architecture

The core of the S320 OCS is the MSM, which establishes the light paths. The light path within the MSM architecture is illustrated in Figure 2.

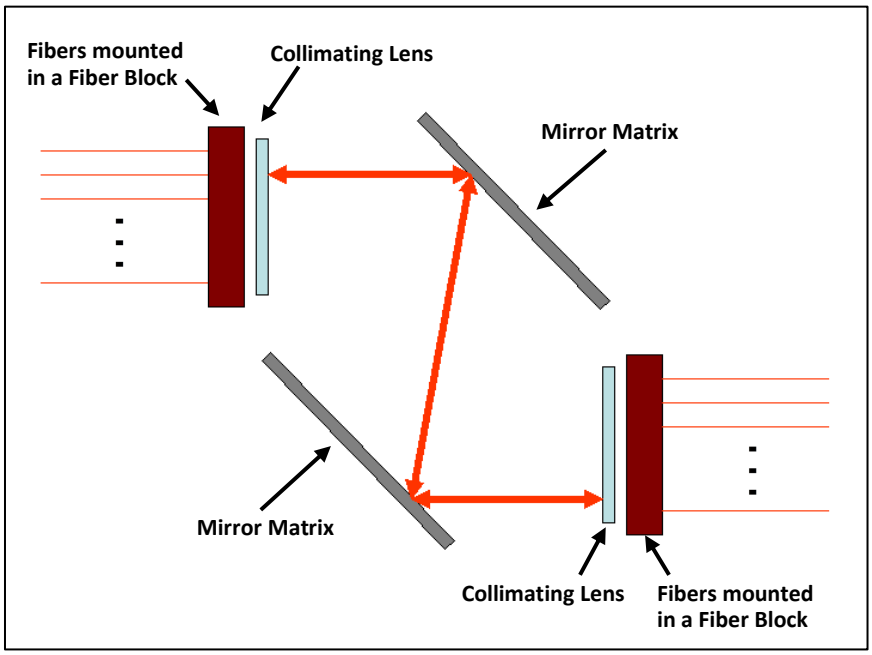

Figure 2 – Light Path within the MSM

Light is directed from the input fibers to the output fibers using arrays of microscopic silicon mirrors that are fabricated using the proven MEMS process. An optical signal transmitted through the S320 OCS passes through three sections of the MSM: the input collimator array, which directs the light from each input fiber to its input mirror; the mirror matrix, an array of MEMS input mirrors and an array of MEMS output mirrors; and the output collimator array, which couples light from each output mirror back into its output fiber. High-quality mirrors and collimators, coupled with precise electrostatic control of the position of each mirror, enable switch times of less than 20 ms and optical loss that is typically less than 2.0 dB.

The MSM shown in Figure 3 is the core of the S320 OCS system. The MSM supports up to 320 input fiber terminations and up to 320 output fiber terminations. It is controlled by the CPs and powered by the Mirror Driver.

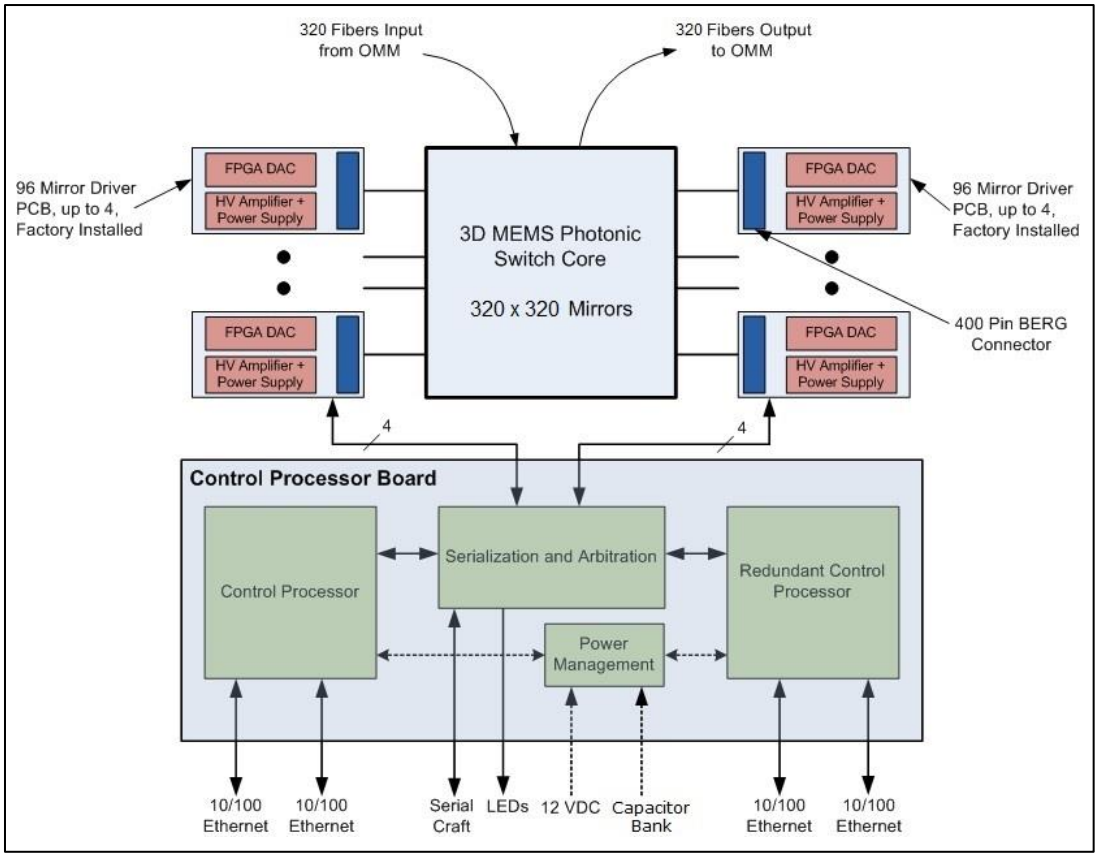

Figure 3 – MSM Block Diagram

The switching matrix in the MSM consists of a dedicated MEMS mirror for each input fiber and a dedicated MEMS mirror for each output fiber. The angular position of each mirror is determined by the voltages applied to the mirror by the mirror drivers. To direct light from an input fiber to an output fiber, voltages are applied to the input fiber's input mirror to point that mirror at the output mirror corresponding to the desired output fiber. The output fiber's output

mirror is aligned by applying the required voltages so that the final reflection is directed with minimum insertion loss to the desired output fiber. The MSM sits on vibration isolators for enhanced protection against environmental impacts.

Within the MSM, there are eight (8) mirror drivers, each one capable of supporting up to 96 MEMS mirrors. These mirror drivers provide the appropriate voltages to each MEMS mirror in the MSM for establishing and maintaining connections. The mirror drivers are controlled by the Control Processor (CP), which is the “brain” of the S320 OCS. The CP establishes and maintains connections and coordinates system management. Because of the vital role of the Control Processor, the S320 OCS is equipped with redundant CPs: active and standby. Configuration and provisioning changes made on the active CP are synchronized to the hot standby CP. If the active CP fails, the standby CP takes over. No existing connections are affected by the CP switchover.

3.3 Front and Rear Panels

This section describes the physical interfaces and connectors located on the front and rear panels of the S320 OCS. Figure 4 and Figure 5 show the front and rear panels of a system configured with the front AC power option. In this configuration, the AC Power Modules are installed in the front panel of the switch, and the rear-panel power module bays are filled with blanks.

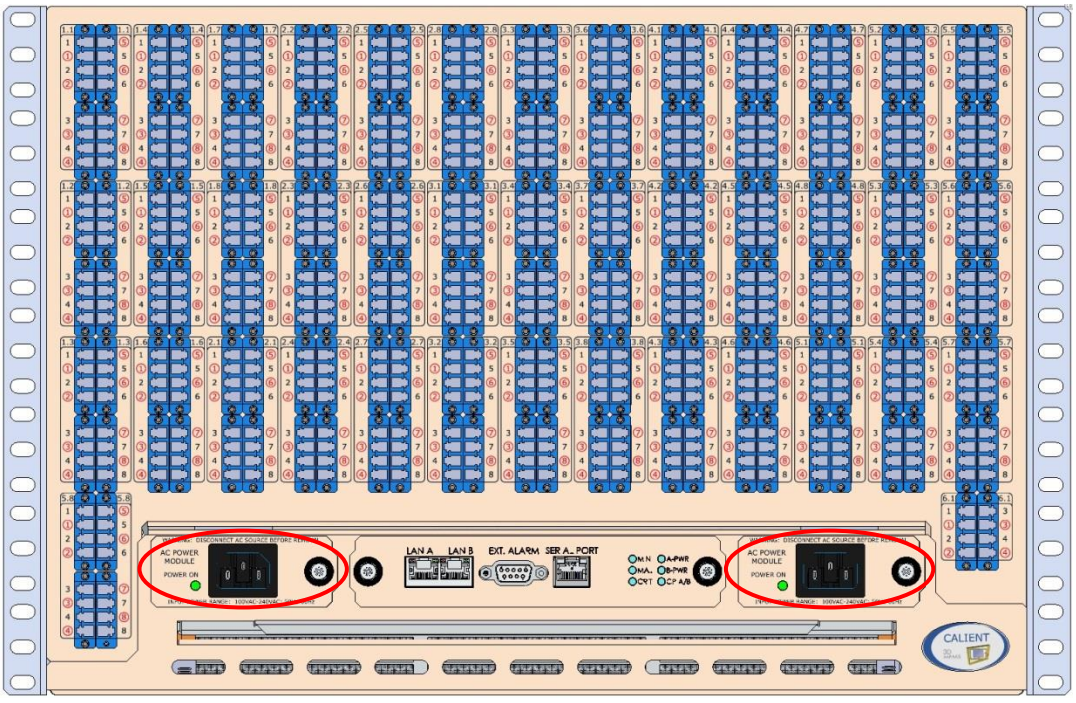

Figure 4 – S320 OCS Front Panel

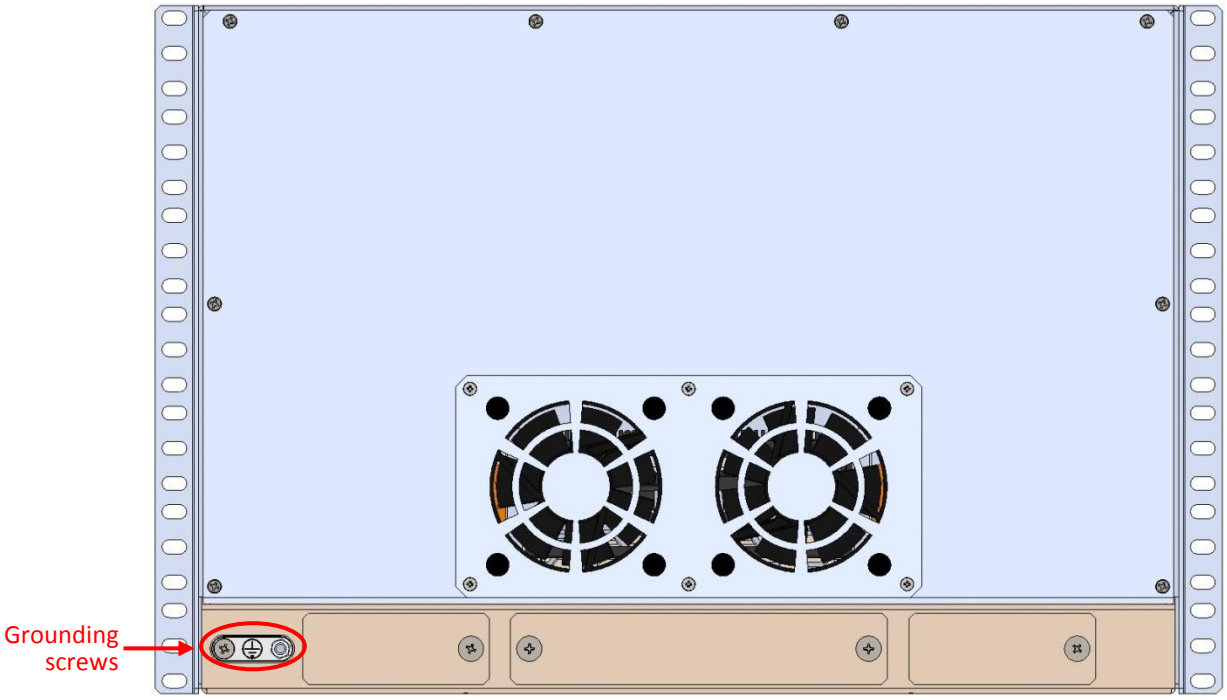

Figure 5 – S320 OCS Rear Panel

3.3.1 Fiber Interface

The Fiber Interface is the optical interface for the S320 OCS. Input and output optical fibers are connected to this interface. The Fiber Interface is configured at the factory for the connector type and mode of operation specified by the user. As shown in Figure 4, a standard S320 OCS Fiber Interface has an array of 320 input and 320 output LC-UPC bulkhead connectors.

3.3.2 Operational Status LEDs

The operational status LEDs for the S320 OCS are positioned at the right of the center panel located at the bottom-front of the chassis, just below the bulkhead connectors and above the fan filter tray (see Figure 4). Six (6) LED indicators (Figure 6) visually alert the user of system-level fault conditions. These LEDs are summarized in Table 1.

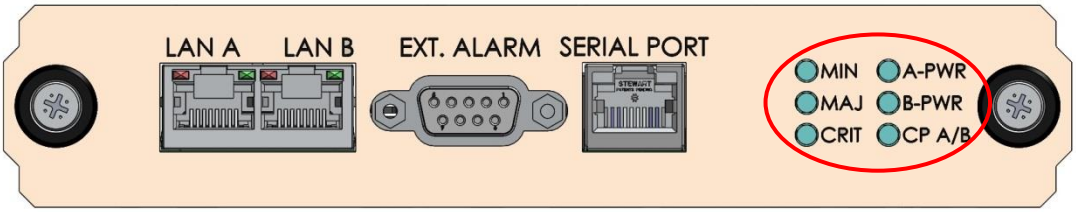

Figure 6 – S320 OCS Center Panel (Close Up)

Table 1 – S320 OCS LED Indicators

LED	Function	Color	Indication
CRIT, MAJ, MIN	Alarm status	Red	One or more alarms (critical, major or minor) are occurring.
A PWR, B PWR	Power status	Green	The system is receiving power from the indicated power source. Source A is the primary power source; source B is the backup power source.
CP A/B	CP status	Green (A) Amber (B)	If the LED is green, Control Processor A (active CP) is controlling the system; if the LED is amber, Control Processor B (standby CP) is controlling the system.

Please refer to the CALIENT *S320 OCS Troubleshooting and Alarm Reference Guid*e for detailed information on S320 OCS alarm behavior.

3.3.3 External Alarm Interface

The S320 OCS External Alarm interface is a DB9 connector located to the left of the LED status indicators, between the Serial Port interface and the LAN A/LAN B interfaces.

The External Alarm interface has three (3) relays available for connections to facility or exchange scan equipment that can signal the occurrence of Critical, Major and Minor alarms. A pinout for the DB9 external alarm interface is listed in Table 2.

Table 2 – DB9 External Alarm Interface Pinout

Pin	Net Name	Text Name
1	CRITV_NC	Critical Alarm Visual Normally Closed
2	CRITV_RET	Critical Alarm Visual Common
3	CRITV_NO	Critical Alarm Visual Normally Open
4	MAJV_NC	Major Alarm Visual Normally Closed
5	MAJV_RET	Major Alarm Visual Common
6	MAJV_NO	Major Alarm Visual Normally Open
7	MINV_NC	Minor Alarm Visual Normally Closed
8	MINV_RET	Minor Alarm Visual Common
9	MINV_NO	Minor Alarm Visual Normally Open

3.3.4 Management Interfaces

The management interfaces on the S320 OCS provide Ethernet and serial connectivity: two (2) Ethernet connections are used to control the switch using TL1 via a Telnet session, or using the browser-based graphical user interface (GUI); a single serial connection provides the means for retrieving or setting the switch's IP address and performing TL1 operations.

S320 OCS management interfaces (Figure 6) include:

- Two (2) Gigabit Ethernet (GbE) RJ45 connectors, labeled LAN A and LAN B. These interfaces are arranged horizontally and located to the left of the External Alarm interface.
- One (1) RJ45 connector—labeled SERIAL PORT—is located to the right of the External Alarm interface.

Please refer to CALIENT's *Optical Circuit Switch (OCS) TL1 Reference Guide* and *Software Application Interfaces Guide* for detailed information on managing the S320 OCS.

3.3.5 Power Source Interfaces

The S320 OCS is powered by redundant power source inputs: Power Source A (located in the lower-left corner of the switch) and Power Source B (located in the lower-right corner of the switch). Each input holds a single Power Module, which can be either AC or -48 VDC, depending on customer preference.

Once both power source inputs are populated with power modules, system power is redundant: that is, if the Primary power source (Power Source A) fails, the system will automatically draw all required power from the Backup power source (Power Source B) without affecting existing cross-connections or management connectivity.

LEDs indicating power source status are located at the right of the center panel (Figure 6) located at the bottom-front of the switch (Figure 4). In addition, each power module has an LED located at the lower-left of the module faceplate (Figure 7 and Figure 8) that indicates whether the module is on (LED is lit) or off (LED is unlit).

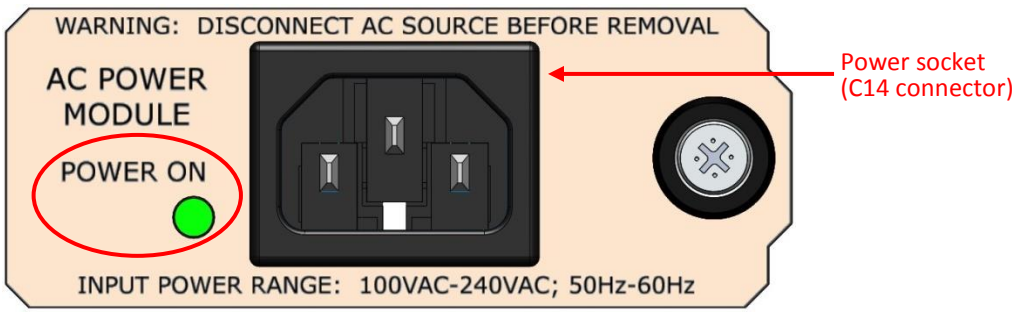

Figure 7 – S320 OCS AC Power Module

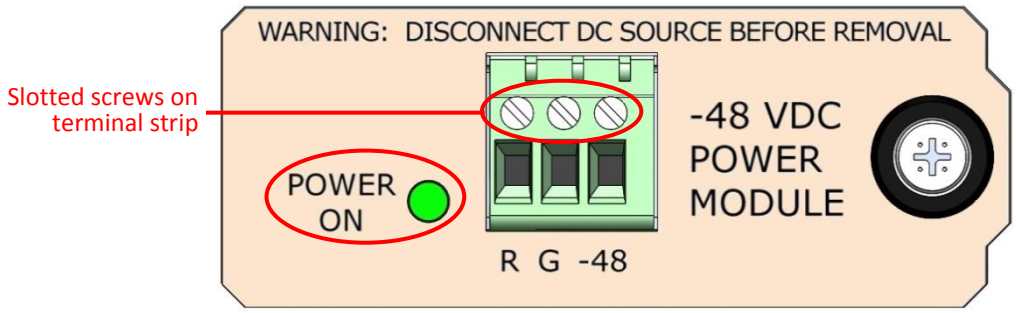

Figure 8 – S320 OCS -48 VDC Power Module

The S320 OCS chassis is equipped with four (4) power source inputs—two (2) on the front and two (2) on the rear—to accommodate front or rear installation of the power modules, depending on customer preference. Initially, the power modules are installed at the factory in the customer-specified (front or rear) power source inputs. Blank patch panels are placed over the unused inputs to protect the inside of the switch from contamination by dust and other particulate matter. Figure 4 and Figure 5 show a switch configured with front power source inputs (populated with AC power modules) and rear patch panels.

Power modules are field-replaceable. There is also an AC power supply option (Table 3), external to the switch, that can be used in conjunction with the -48 VDC module. The AC power supply has a nominal DC output of -48 VDC and only connects to the -48 VDC input of the power module (Figure 8).

Table 3 – Power Supply Input Voltage Tolerances

Power Supply	Minimum Input Voltage	Nominal Input Voltage	Maximum Input Voltage
-48 VDC	-42 VDC	-54 VDC	-58 VDC
External AC Power Supply	100 VDC	110 VDC	240 VDC

4 UNPACKING THE S320 OCS

This section of the guide covers the personnel, tools and procedure required to unpack the S320 OCS correctly, so that no damage to the switch or injury to staff occurs.

4.1 Personnel Required

The S320 OCS exceeds the OSHA-recommended, safe-lifting weight for one person. Accordingly, CALIENT recommends *at least two persons* take part any time the switch is lifted or moved.

4.2 Tools Needed for Unpacking

The following tools are recommended for opening the S320 OCS shipping containers:

- Utility knife
- Phillips head screw driver #1 and #2

4.3 Unpacking the S320 OCS

The S320 OCS is shipped from the factory in a single package consisting of two containers: an inner container and an outer container. For added protection, the S320 OCS is first packed inside the inner container, which is then packed in the outer container. The dimensions of the outer container are 24.5” W x 27.5” D x 22” H. The shipping weight of the packaged switch is 61 lbs. (27.7 kg).

Note

When unpacking the S320 OCS, remove and keep the shipping lockdown baseplate (Figure 9), packing materials and containers for future shipment. The switch should only be shipped using the original lockdown baseplate and containers; otherwise, its warranty will be void.

Electro Static Discharge

The S320 OCS is sensitive to electrostatic discharge (ESD). Be sure to wear either a wrist or ankle ESD grounding strap when handling switch components.

The proper procedure for unpacking the S320 OCS includes the following steps:

1. Carefully inspect the exterior of each shipping container for any obvious signs of damage that may have occurred during shipping.
2. Cut the band straps wrapped around the container.

Including shipping containers and contents, the S320 OCS weighs approximately 61 lbs. This weight exceeds the OSHA-recommended, safe-lifting weight for one person. Accordingly, CALIENT recommends *at least two persons* take part any time the switch is lifted or moved. In addition, always make sure the switch is right-side up and level when lifting or handling it.

3. Remove and set aside the accessories box containing the cables, mounting screws and ESD grounding strap.
4. Carefully lift the chassis out of the inner container.
5. Remove the anti-ESD bag from the chassis and keep it for future shipping needs.
6. Compare the contents of the shipment against the packing list. If any items are missing, contact CALIENT immediately at http://support.calient.net.

4.4 Contents Inventory

The shipment should include the following contents:

- **System Hardware:** The CALIENT S320 OCS chassis.
- **Cables:** USB-to-DB9 serial cable (1), RJ45-to-DB9 cable and adapter (1), Ethernet cables (2).
- **Documentation and Software:** A one-sheet (front and back) *S320/160 Optical Circuit Switch Quick Start Guide*.

  Comprehensive user documentation for the S320 OCS—including a *Hardware User Guide*, *Getting Started Guide, TL1 Reference Guide, Troubleshooting and Alarm Reference Guide* and *Release Notes*—is available online at www.calient.net/library.

  Every S320 OCS ordered from CALIENT is loaded with the most current release of system software available at the time the switch is shipped.

- **Miscellaneous:** Type 12-24 rack-mounting screws (12), slotted screwdriver (1) for terminal strip screws on -48 VDC power modules (Figure 8).

4.4.1 Missing or Damaged Contents

If any items are missing from the shipment or damage is detected, contact CALIENT Service and Support immediately. Returned contents require a Return Material Authorization (RMA), which can be provided by Service and Support personnel.

4.4.2 Unlocking the S320 OCS

The S320 OCS is unlocked by removing the shipping lockdown baseplate. Performing this task requires two people. The following procedure describes how to remove the shipping lockdown baseplate (Figure 9):

1. Person 1 presses down firmly on the shipping lockdown baseplate.
2. Person 2 lifts the S320 OCS while Person 1 continues pressing down on the baseplate.

As noted in section 4.3, be sure to retain the shipping lockdown baseplate, anti-ESD bag and other materials included in the container for future shipment. The S320 OCS should only be shipped using the original shipping lockdown baseplate and container.

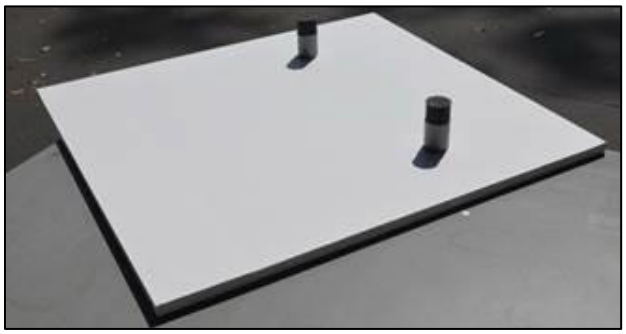

Figure 9 – Shipping Lockdown Baseplate

4.4.3 Environmental Requirements

Table 4 lists environmental requirements for storing and transporting the S320 OCS.

Table 4 – S320 OCS Environmental Requirements

Temperature[1]	Operating	5° to 55° C (41° to 131° F)
	Non-operating	-40° to 70° C (-40° to 158° F)
	Shock	Max Rate of Change 20° C/min
Humidity	Operating	10-90% RH non-condensing
	Non-operating	5-93% RH non-condensing
Altitude	Operating	Up to 1600 meters
	Non-operating	Up to 12,000 meters
Vibration	Operating	a). GR-63 – x/y/z-axis: 5Hz-100Hz-5Hz at 0.1G amplitude swept at 0.25 octaves/minute b). 0.16Grms, 5 Hz to 250 Hz: 0.0001 g^2/Hz (flat)
	Packaged (for shipping)	ATSM composite Truck, Rail, Air. 5Hz-20Hz at 0.01g^2/Hz, 20-200Hz -3dB/octave
Shock[2]	Operating	IEC 60068-2-27; +/- 3.5G, 11 msec, half-sine shocks in the x, y, and z axes; run pre- and post-diagnostic tests
	Non-operating	IEC 60068-2-27; +/- 10G, 11 msec, half-sine shocks in the x, y, and z axes; run pre- and post-diagnostic tests
Drop	Unpackaged Drop Test	GR-63 Unpackaged Drop: 3.0” on practical resting surfaces
	Packaged Drop Test	GR-63 Packaged Category A Drop: 23.6”
		GR-63 Packaged Category B (palletized) Drop: 3.9”
Dust	All fiber connector terminations must be cleaned and capped	

[1]The S320 will be certified to the criteria specified in NEBS-63, including the long-term and short-term requirements detailed in Section 4.1.2 of NEBS-63.

[2]Optical connections will be maintained throughout operation and then meet full optical specification post-event.

5 HARDWARE INSTALLATION

Note

Before installing the S320 OCS for the first time, look online at *library.calient.net* for the latest product installation and configuration guides. In case you are unable to access the Internet, CALIENT includes a copy of the *S320/160 Optical Circuit Switch Quick Start Guide* with every switch it ships.

5.1 Overview

Installing the S320 OCS includes the following tasks:

- Physically installing the switch in a rack
- Connecting the configuration interfaces (i.e., serial cable and Ethernet cables) of the switch
- Connecting the power interfaces of the switch
- Booting up the switch
- Installing the fiber interfaces of the switch

5.1.1 General Requirements

Before the S320 OCS is installed, make sure the following requirements are met:

- 7 RU of rack space in a 19”, 23” or ETSI rack to house the switch
- A mounting shelf for use with two-post racks, or a support bracket set for use with four-post racks
- Power accessible to the switch
- Input and output optical fiber cables with LC-UPC connectors, accessible at the installed switch (i.e., in the rack)
- Computer resources providing VT-100 terminal emulation and a serial interface accessible at the installed switch (i.e., in the rack)

5.1.2 Safety Requirements

Warning

Failure to correctly follow the safety rules and instructions in this guide could result in bodily injury.

Observe the following precautions to ensure safe installation of the equipment:

- Review the safety information provided in section 2 of this guide, and comply with all Caution, Warning and ESD statements.
- Installation of the equipment should be in a restricted-access location (i.e., dedicated equipment room or electrical closet) in accordance with the National Electrical Code.
- The equipment must be provided with a readily accessible disconnect device in the building installation power supply circuit.
- The equipment shall be provided with a branch circuit breaker or fuse (rated at 10 A maximum) in the building installation supply circuit.
- Elevated ambient operating temperature – if the S320 OCS is installed in a closed or multi-unit rack assembly, the ambient operating temperature of the rack environment may be greater than the ambient room temperature. Make sure the ambient operating temperature of racked equipment does not exceed the specified maximum operating temperature of the S320 OCS by having adequate ventilation/cooling in the equipment installation area.
- Reduced air flow – installation of the S320 OCS in a rack must be such that the amount of air flow required for safe operation of the equipment is not compromised.
- Mechanical loading – mounting of the equipment in the rack must be such that a hazardous condition does not occur due to uneven mechanical loading.
- Circuit overloading – consideration must be given to the rated current requirements of the S320 OCS and any other equipment connected to the same current protection and supply wiring circuit, so that the total rating does not overload the supply.
- Grounding – reliable grounding of rack-mounted equipment must be maintained. Particular attention must be given to providing connections other than direct connections (e.g., a power strip) to the branch circuit.

5.1.3 Required Tools

The following tools are needed to properly install the S320 OCS:

- #1 and #2 Phillips screwdrivers
- Wire stripper, crimp tool and pliers
- ESD mats
- Wrist grounding straps
- Anti-ESD examination gloves

5.1.4 Installing the S320 OCS in a Rack

The S320 OCS is a 7-RU switch that fits in a 19-inch, 23-inch or ETSI rack. Prior to installation, a pair of installation brackets, or "rack ears" (Figure 10), must be affixed to the S320 OCS chassis; the proper method for doing this is described in step 1 of the procedure below.

Caution

To avoid possible injury to personnel and/or damage to equipment, CALIENT *strongly recommends* that two people install the S320 OCS in a rack—one person to support the switch and a second person to secure the rack screws. For the same reasons, CALIENT also recommends using a shelf when mounting the S320 OCS in a rack.

The following procedure describes how to install the S320 OCS in a rack:

1. Attach the rack ears to the switch—one on each side of the chassis—using the M3 Phillips flathead screws provided with the system. Sixteen (16) M3 screws—eight (8) for each rack ear—are included in the accessories box that comes with the S320 OCS.

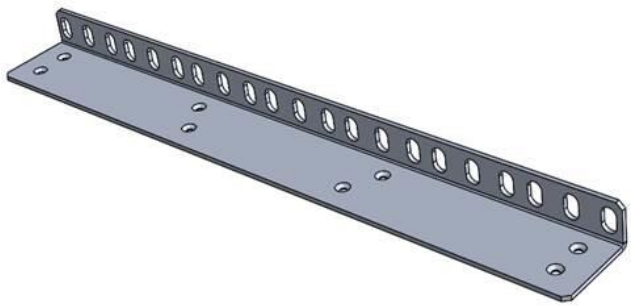

Figure 10 – S320 OCS Rack Ear

a. Align the eight (8) countersunk holes in a rack ear with the corresponding holes on the right or left side of the chassis. To prevent incorrect installation, each rack ear is symmetrical and directional—that is, the left rack ear only fits the left side of the chassis, and the right rack ear only fits the right side of the chassis.

b. Insert an M3 screw through each hole in the rack ear and into the corresponding hole on the chassis.

c. Tighten each screw with a Phillips screwdriver.

d. Repeat steps a, b and c on the opposite side of the chassis.

Figure 11 shows the S320 OCS chassis with the rack ears mounted on it.

Figure 11 – S320 OCS with Rack Ears (Rear View)

2. Attach a shelf to the rack, one screw hole below the desired location of the switch. This shelf will support the S320 OCS while it is being secured to the rack.

3. Lift the S320 OCS onto the shelf.

4. Secure the S320 OCS to the rack using the mounting screws provided with the switch. There should be 12 screws in the accessories box that came with the switch—6 per rack ear on each side of the switch.

5.2 Connecting Communication Interfaces

This section explains how to connect to the communication interfaces of the S320 OCS.

5.2.1 Connecting the Serial Cable

A serial cable is used to connect to the serial interface located on the front of the S320 OCS. The serial cable connection enables you to retrieve (or set) the switch's IP address and perform TL1 operations.

5.2.1.1 Serial Port Pinouts

The cabling used to connect to the serial interface on the S320 OCS uses an RJ45 connector, which requires a combination USB-to-DB9, RJ45-to-DB9 adapter cable (Figure 13). Table 5 lists the pinouts for the RJ45 connector used for the S320 OCS's serial interface.

Table 5 – RJ45 Serial Interface Pinout

Pin	Description
2	Transmitted data
3	Received data
5	Ground
7	Clear to send
8	Request to send

5.2.1.2 Connection Procedure

The following procedure describes how to properly connect the combination serial cable provided with the S320 OCS:

1. Connect the USB-to-DB9 serial cable to the RJ45-to-DB9 adapter cable (Figure 12).

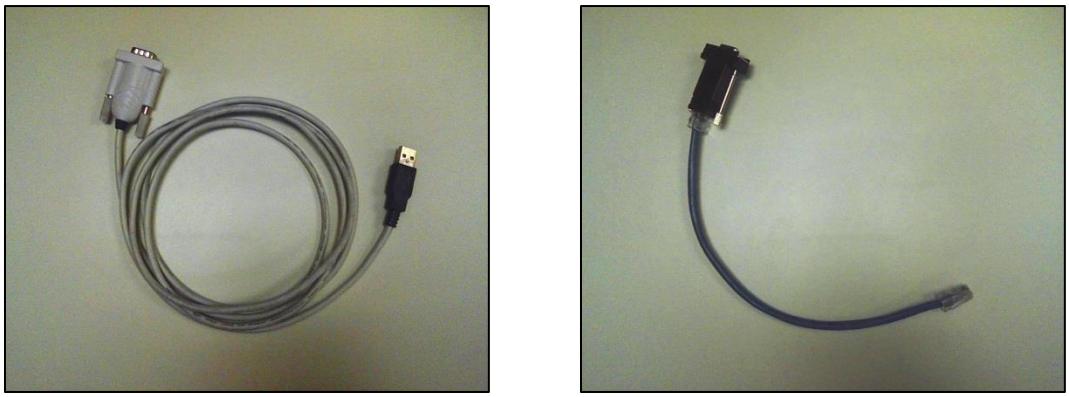

Figure 12 – USB-to-DB9 Cable (L) and RJ45-to-DB9 Adapter Cable (R)

2. Connect the RJ45 end of the assembled serial cable (Figure 13) to the RJ45 connector labeled SERIAL PORT on the center panel (Figure 6) at the bottom of the S320 OCS chassis (Figure 4).

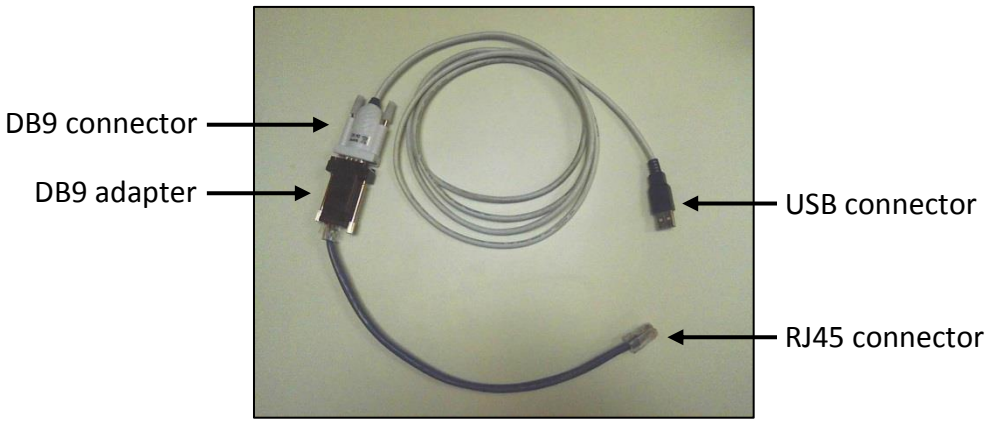

Figure 13 – Assembled Serial Cable

3. Connect the USB end of the assembled cable to the serial connector on the host PC.

Once connected, the assembled serial cable appears as a COM port in the Windows Control Panel Device Manager. If you are unsure which of the COM ports listed in the Device Manager represents the serial cable, unplug the cable while viewing the Device Manager: whichever COM port disappears is the serial cable port. The COM port will reappear in the Device Manager when the cable is reconnected to the switch.

Note

If a driver for the serial cable is not available, it can be downloaded online at http://www.ftdichip.com/Drivers/VCP.htm.

5.2.2 Connecting Ethernet

The S320 OCS has two Gigabit Ethernet (GbE) RJ45 connectors located on the center panel at the bottom of the switch chassis (Figure 4). These connectors are labeled LAN A and B (Figure 6). The Ethernet connection enables you to control the switch using TL1 via a Telnet session or using the browser-based graphical user interface (GUI).

Note

Use shielded Ethernet cables with the shields grounded at both ends. The S320 OCS is approved for installation in a common bonded network (CBN).

5.3 Power Connections

External power is connected to the S320 OCS through either two AC or two -48 VDC power modules. If AC modules are used, power is delivered to the switch via an AC power socket (Figure 7); if -48 VDC modules are used, power is delivered via a -48 VDC terminal strip (Figure 8). For detailed information on both types of module, refer to section 3.3.5 herein.

5.3.1 Connecting an External Power Supply

The procedure for connecting an external power supply to the S320 OCS varies, depending on which type of power module (AC or -48 VDC) is being connected to.

5.3.1.1 Connecting to an AC Power Module

Connecting an external power supply to an S320 OCS configured with AC power modules is straightforward, provided you use the proper cabling. Specifically, each cable used to connect external power to the switch must have a C13 connector (Figure 14) on the end that will attach to the AC power module.

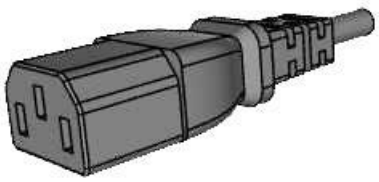

Figure 14 – C13 Connector

The following steps describe how to connect an external power supply to an S320 OCS configured with AC power modules:

1. Plug the end of the power cable with the C13 (female) connector onto the C14 (male) connector (Figure 7) on the AC power module.
2. Plug the other end of the cable into the power source.
3. Activate the power source for both power modules (primary and backup) to deliver electrical power to the S320 OCS.

5.3.1.2 Connecting to a -48 VDC Power Module

Connecting an external power supply to an S320 OCS configured with -48 VDC power modules involves more steps than connecting to a switch equipped with AC modules. The following procedure describes how to connect external power to an S320 OCS configured with -48 VDC power modules:

1. Use wire strippers to strip the insulation from each end of the three (3) wires that comprise the power supply cabling. (CALIENT recommends using 18-gauge wire for this cabling.)

2. Insert one exposed end of each wire into the appropriate input on the cam-over terminal strip located at the center of each power module on the S320 OCS.

   As shown in Figure 15, the black (negative) cabling wire should be inserted in the -48 (VDC) input, the green-yellow (chassis ground) wire should be inserted in the G (Ground) input, and the red (positive) wire should be inserted in the R (Return/+48 VDC) input.

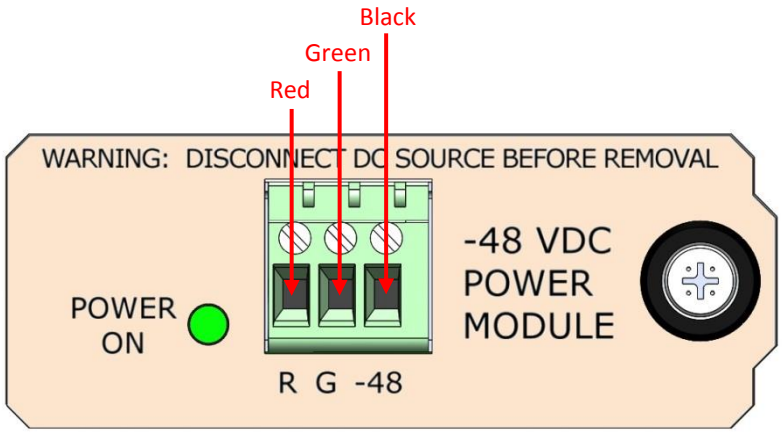

Figure 15 – S320 OCS Power Supply Connector

3. Secure each wire by tightening the screw beside each input with the slotted screwdriver included in the accessories box that comes with the switch.

4. Give each wire a light tug after securing it to ensure that it is firmly attached to the terminal strip.

5. Attach the remaining exposed end of each cabling wire to the appropriate terminal on the power supply.

6. Activate the power source for both power modules (primary and backup) to deliver electrical power to the S320 OCS.

Caution

To avoid possible injury to personnel and/or damage to the switch, make sure the S320 OCS is properly grounded *before* powering up the system. CALIENT recommends doing this by stripping one end of insulated copper wire and attaching it to one of the two grounding screws located in the lower-left corner on the rear of the chassis (Figure 5), then attaching the other end of the wire to a grounded circuit.

A SYSTEM SPECIFICATIONS

This appendix provides system specifications for regulatory, reliability, space, optical and environmental requirements pertaining to the S320 OCS.

A.1 Regulatory Compliance

The following sections list the various standards and/or regulations with which the S320 OCS is compliant.

A.1.1 Safety

The S320 OCS has been tested and found compliant with the following safety standards:

- UL 60945
- UL/CSA/IEC/EN 60950-1
- IEC/EN 60825
- FDA/CFR 21.1040

A.1.2 Electromagnetic Compatibility (EMC)

The S320 OCS has been tested and found compliant with the following EMC standards:

- FCC Part 15 Class A (Emissions)
- CISPR 22 Class A (Emissions)
- EN 55022 Class A (Emissions)
- EN 61000-4-2, -4-3, -4-4, -4-5, -4-6 and -4-8 (Immunity)

A.1.3 Environmental

The S320 OCS has been tested and found compliant with the following environmental standards:

- GR-63-CORE
- GR-1073-CORE

A.2 Reliability, Accessibility and Serviceability (RAS)

A.2.1 Reliability

The S320 OCS has been tested and found compliant with the Telcordia SR-332 reliability standard.

The Mean Time Between Failures (MTBF) for an S320 OCS equipped with redundant control processors and power modules is greater than 14.4 years.

A.2.2 Accessibility and Serviceability

The physical characteristics of the S320 OCS affecting accessibility and serviceability are listed in Table 6.

Table 6 – S320 OCS Physical Dimensions

Feature	Description
Dimensions	17.5” W x 13.9” H x 19” D (445 x 353 x483 mm)
Weight	46 lbs. (20.9 kg)
Shipping Weight	61 lbs. (27.7 kg)
Form Factor	320 ports in 7 RU chassis
Installation	Installable in 19”, 23” or ETSI rack

A.3 Optical Specifications

Optical specifications for the S320 OCS are listed in Table 7.

Table 7 – S320 OCS Optical Specifications

Parameter		Min.	Typical	Max.	Unit	Note
Ports				320		
Wavelength range, λ_{OP}		1270-1630			nm	Calibration for internal power reading at 1310 and 1550 nm
Insertion loss over entire T_{OP}	1270-1360 nm	0.8	1.8	3.5	dB	Using LC connector[1]
	1360-1410 nm	1.0	3.3	4.15		
	1410-1590 nm	0.8	1.8	3.5		
	1590-1630 nm	1.2	2.0	3.8		

Parameter	Min.	Typical	Max.	Unit	Note
Wavelength-dependent loss (not including 1360-1410 nm band)			1.0	dB	
Connection switching time	28	38	50	msec	
Bulk Switch reconfiguration time for all ports (back-to-back)[2]		200	500	msec	See Note 2 below.
Polarization-dependent loss		0.1	0.3	dB	
Static Crosstalk			-60	dB	
Dynamic Crosstalk		-45	-38	dB	
Isolation		-50	-40	dB	
Repeatability		0.1	0.5	dB	
IL Uniformity		1.5	2.2	dB	
Return loss		-41	-35	dB	
Input optical power	-20		5	dBm	
Power-Monitoring Tracking Accuracy			1	dB	
Insertion Loss Reporting Accuracy			2	dB	
Switch lifetime	10^12			Cycles	

[1]Using an MTP12 connector instead of an LC connector will increase the maximum insertion loss +0.5 dB.

[2]Bulk reconfiguration of connections between any two sets (back-to-back) involves detecting conflicts, deleting some or all connections from the existing set, and remaking a new set of connections. Each bulk set for CALIENT takes up to 200 msec. If an external controller were to manage these conflicts and send deletes of the first set, followed by the making of a new set, the S320 OCS would be able to complete the reconfiguration in less than 200 msec. If, however, S320 software were to manage these tasks, the time could be increased up to 500 msec in a worst-case scenario.

A.4 Environmental Requirements

Table 4 in section 4.4.3 of this document provides detailed information on environmental requirements for the S320 OCS.

B ORDERING INFORMATION

This appendix provides the part numbers necessary for ordering additional S320 OCS systems, spare parts for installed systems, and the latest generally available software release used to run the system.

B.1 System Part Numbers

Table 8 lists the part numbers pertaining to S320 OCS systems.

Table 8 – S320 OCS System Part Numbers

CALIENT Part Number	Product Description
CT-S320-2S-LA0-AC0R-01-00	S320 Optical Circuit Switch, 320 x 320, Standard Shelf Configuration, +5 to -20 dBm DR, LC/APC Connectors, AC Rear Power
CT-S320-2S-LU0-AC0R-01-00	S320 Optical Circuit Switch, 320 x 320, Standard Shelf Configuration, +5 to -20 dBm DR, LC/UPC Connectors, AC Rear Power
CT-S320-2A-M12-AC0R-01-00	S320 Optical Circuit Switch, 320 x 320, Access Shelf Configuration, +5 to -20 dBm DR, MTP12 Connectors (Male Output, Female Input), AC Rear Power
CT-S320-2S-LA0-48TR-01-00	S320 Optical Circuit Switch, 320 x 320, Standard Shelf Configuration, +5 to -20 dBm DR, LC/APC Connectors, -48 VDC Rear Power
CT-S320-2S-LU0-48TR-01-00	S320 Optical Circuit Switch, 320 x 320, Standard Shelf Configuration, +5 to -20 dBm DR, LC/UPC Connectors, -48 VDC Rear Power
CT-S320-2A-M12-48TR-01-00	S320 Optical Circuit Switch, 320 x 320, Access Shelf Configuration, +5 to -20 dBm DR, MTP12 Connectors (Male Output, Female Input), -48 VDC Rear Power

B.2 Spare Part Numbers

Table 9 lists the part numbers pertaining to spare components for the S320 OCS.

Table 9 – S320 OCS Spare Part Numbers

CALIENT Part Number	Product Description
CT-S-FMA7-00-01	S-Series Fiber Management Assembly, 7 RU
700540-00	S-Series AC Power Module
700608-00	S-Series -48 VDC Power Module
700489-02	S-Series Fan Module
280898-00	S-Series Air Filter
221089-00	23-inch Rack Ear (for 7 RU systems)

B.3 Software Part Number

Table 10 lists the part number for the system software used to operate the S320 OCS.

Table 10 – S320 OCS Software Part Number

CALIENT Part Number	Product Description
CT-SW-XYZ-000-00-00	S-Series System Software, Latest Standard GA Release

Note

For custom part numbers, please contact CALIENT Sales or Customer Service.