



DGS-3308 Series 8-Port Gigabit Layer 3 Switch User's Guide

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ABOUT THIS GUIDE

This User's guide tells you how to install your DGS-3308, how to connect it to your Ethernet network, and how to set its configuration using either the built-in console interface or Web-based management.

Overview of this User's Guide

- Chapter 1, "*Introduction.*" Describes the Switch and its features.
- Chapter 2, "*Unpacking and Setup.*" Helps you get started with the basic installation of the Switch.
- Chapter 3, "*Identifying External Components.*" Describes the front panel, rear panel, and LED indicators of the Switch.
- Chapter 4, "*Connecting the Switch.*" Tells how you can connect the Switch to your Ethernet network.
- Chapter 5, "*Switch Management and Operating Concepts.*" Talks about Local Console Management via the RS-232 DCE console port and other aspects about how to manage the Switch.
- Chapter 6, "*Using the Console Interface.*" Tells how to use the built-in console interface to change, set, and monitor Switch performance and security.
- Chapter 7, "*Web-Based Network Management.*" Tells how to manage the Switch through an Internet browser.
- Appendix A, "*Technical Specifications.*" Lists the technical specifications of the DGS-3308TG and DGS-3308FG.
- Appendix B, "*RJ-45 Pin Specifications.*" Shows the details and pin assignments for the RJ-45 receptacle/connector.
- Appendix C, "*Factory Default Settings.*"
- Appendix D, "*Understanding and Troubleshooting the Spanning Tree Protocol.*"
- Appendix E, "*Brief Review of Bitwise Logical Operations.*"

1

INTRODUCTION

This section describes the Layer 3 functionality and Layer 2 and Layer 3 features of the DGS-3308 Series switches. Some background information about Ethernet/Fast Ethernet, Gigabit Ethernet, and switching technology is presented. This is intended for readers who may not be familiar with the concepts of layered switching and routing but is not intended to be a complete or in-depth discussion.

For a more detailed discussion of the functionality of the DGS-3308, please see Chapter 5, “*Switch Management and Operating Concepts*.”

Layer 3 Switching

Layer 3 switching is the integration of two proven technologies: switching and routing. In fact, Layer 3 switches are running the same routing routines and protocols as traditional routers. The main difference between traditional routing and Layer 3 switching is the addition of a group of Layer 2 switching domains and the execution of routing routines for most packets via an ASIC – in hardware instead of software.

Where a traditional router would have one, or at best a few, Fast Ethernet ports, the DGS-3308 Layer 3 switch has eight Gigabit Ethernet ports, including two which are GBIC-based. Where a traditional router would have one or two high-speed serial WAN connections, the DGS-3308 relies upon Gigabit Ethernet ports to connect to a separate device, which in turn, connects the network to a WAN or the Internet.

The DGS-3308 can be thought of as Fast Ethernet Layer 2 switching domains with a wire-speed router between each domain. It can be deployed in a network between a traditional router and the intranetwork. The traditional router and its associated WAN interface would then handle routing between the intranetwork and the WAN (the Internet, for example) while the Layer 3 switch would handle routing within the LAN (between the Fast Ethernet Layer 2 domains). Any installed Layer 2 switches, and indeed the entire subnetting scheme, would remain in place.

The DGS-3308FG can also replace key traditional routers for data centers and server farms, routing between these locations and the rest of the network, and providing eight ports of Layer 2 switching performance combined with wire-speed routing.

Backbone routers can also be replaced with DGS-3208FG and DGS-3208TG switches and a series of DGS-3308 switches could be linked via the Gigabit Ethernet ports. Routers that service WAN connections would remain in place, but would now be removed from the backbone and connected to the DGS-3308 via a Gigabit Ethernet port. The backbone itself could be migrated to Gigabit Ethernet, or faster technologies as they become available.

Policy services can then be introduced (or enhanced) in the backbone infrastructure and maintained throughout the network – even to the desktop. With a distributed infrastructure and a logical management structure, network performance becomes easier to measure and fine-tune.

With the completion of the migration of the backbone to Gigabit or higher-performance technologies, the result is inherently scalable and easily evolved for future technologies. This core network will also become the termination point for Virtual Private Networks (VPNs) for remote office access to the enterprise infrastructure.

The DGS-3308 can then be thought of as accomplishing two objectives. First as a tool to provide high-performance access to enterprise data servers and infrastructure, and second, to enhance the performance of network equipment already

installed. Many network segments display poor performance, but the Ethernet wire is only carrying a fraction of its total traffic capacity. The problem is not the network, but the ability of the connected devices to utilize the full capacity of the network. The DGS-3308 can eliminate network bottlenecks to high-traffic areas, and improve the utilization of the network's installed bandwidth.

The Functions of a Layer 3 Switch

Traditional routers, once the core components of large networks, became an obstacle to the migration toward next-generation networks. Attempts to make software-based routers forward packets more quickly were inadequate.

A layer 3 switch does everything to a packet that a traditional router does:

- Determines forwarding path based on Layer 3 information
- Validates the integrity of the Layer 3 header via checksum
- Verifies packet expiration and updates accordingly
- Processes and responds to any optional information
- Updates forwarding statistics in the Management Information Base
- Applies security controls

A Layer 3 switch can be placed anywhere within a network core or backbone, easily and cost-effectively replacing the traditional collapsed backbone router. The DGS-3308 Layer 3 switch communicates with a WAN router using a standard Gigabit Ethernet or GBIC-based port. Multiple DGS-3308 switches can be linked via the Gigabit Ethernet ports.

Features

The DGS-3308 was designed for easy installation and high performance in an environment where traffic on the network and the number of users increase continuously.

Switch features include:

Ports

- Six 1000BASE-SX (SC-type fiber transceiver) for the DGS-3308FG or six 1000BASE-T (10/100/1000M Fast/Gigabit Ethernet) for the DGS-3308TG.
- Two GBIC-based Gigabit Ethernet ports.
- Fully compliant with IEEE 802.3z.
- Fully compliant with IEEE 802.3 10BASE-T, IEEE 802.3u 100BASE-TX, and IEEE 802.3ab 1000BASE-T (DGS-3308TG only).
- Support Full Duplex operations.
- Supports auto-negotiation for 10M/100M/1000M speed (DGS-3308TG only).
- IEEE 802.3x compliant Flow Control support for full duplex.
- Supports Head of Line Blocking.

- Per device packet buffer: 512Kbytes.
- RS-232 DCE Diagnostic port (console port) for setting up and managing the Switch via a connection to a console terminal or PC using a terminal emulation program.

Performance Features

Layer 2 Switching Features

- 16 Gbps switching fabric capacity
- Wire speed packet forwarding rate per system.
- Store and forward switching scheme.
- Support 8K MAC address.
- Support Broadcast Storm control function.
- Support Port Mirroring.
- Port Trunking support for Gigabit Ethernet ports.
- 802.1D Spanning Tree support.
- 802.1Q Tagged VLAN support, including GVRP (GARP VLAN Registration Protocol) support for automatic VLAN configuration distribution.
- 802.1p priority support (4 priority queues).
- Support IGMP Snooping.

Layer 3 Switching Features

- Wire speed IP forwarding.
- Hardware-based Layer 3 IP switching.
- IP packet forwarding rate up to 12 Mpps.
- 2K active IP address entry table per device.
- Supports RIP – (Routing Information Protocol) versions I and II.
- Support OSPF routing protocol.
- Supports IP version 4.
- IGMP version 1 and 2 support (RFC 1112 and RFC 2236).
- Supports PIM Dense Mode (draft-ietf-pim-v2-dm-03.txt).
- Supports DVMRP (draft-ietf-idmr-dvmrp-v3-09.txt).
- Supports IP multi-netting.

- Supports IP packet de-fragmentation.
- Supports Path MTU discovery.
- Supports 802.1D frame support.

Traffic Classification and Prioritization

- Based on 802.1p priority bits.
- Based on MAC address.
- 4 priority queues.

Management

- RS-232 console port for out-of-band network management and system diagnosis via a console terminal or PC.
- Spanning Tree Algorithm Protocol for creation of alternative backup paths and prevention of network loops.
- SNMP v.1 Agent.
- Telnet remote control console.
- In-band control and configuration via SNMP based software.
- Flash memory for software upgrades. This can be done in-band via TFTP.
- Built-in SNMP management:
 - RFC 1213 MIB II.
 - RFC 1493 Bridge MIB.
 - RFC 1757 Four groups of RMON: Statistics, History, Alarm, and Event.
 - RFC 1724 RIP v2 MIB.
 - RFC 2737 Entity MIB.
 - RFC 2674 P-Bridge MIB.
 - RFC 2233 IF MIB.
 - RFC 2096 IP Forward MIB.
 - RFC 1907 SNMPv2 MIB
 - IGMP IGMP-STD MIB.
 - PIM MIB. This was extracted from draft-ief-idmr-pim-mib-03.txt.
 - DVMRP MIB. This was extracted from draft-thaler-dvmrp-mib-04.txt.
 - IPMROUTE MIB. This was extracted from draft-ietf-idmr-multicast-routmib-05.txt.
- Supports Web-based management.
- TFTP support.

- BOOTP support.
- IP filtering on the management interface.
- DHCP Client support.
- DHCP Relay Agent.
- Password enabled.

Optional Redundant Power Supply

The DGS-3308 supports the optional DPS-1000 (Redundant Power Supply) to provide automatic power supply monitoring and switchover to a redundant power supply (located in the chassis of the DPS-1000) in case of a failure in the Switch's internal power supply.

Fast Ethernet Technology

100Mbps Fast Ethernet (or 100BASE-T) is a standard specified by the IEEE 802.3 LAN committee. It is an extension of the 10Mbps Ethernet standard with the ability to transmit and receive data at 100Mbps, while maintaining the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Ethernet protocol.

Gigabit Ethernet Technology

Gigabit Ethernet is an extension of IEEE 802.3 Ethernet utilizing the same packet structure, format, and support for CSMA/CD protocol, full duplex, flow control, and management objects, but with a tenfold increase in theoretical throughput over 100Mbps Fast Ethernet and a one hundred-fold increase over 10Mbps Ethernet. Since it is compatible with all 10Mbps and 100Mbps Ethernet environments, Gigabit Ethernet provides a straightforward upgrade without wasting a company's existing investment in hardware, software, and trained personnel.

Gigabit Ethernet enables fast optical fiber connections and Unshielded Twisted Pair connections to support video conferencing, complex imaging, and similar data-intensive applications. Likewise, since data transfers occur 10 times faster than Fast Ethernet, servers outfitted with Gigabit Ethernet NIC's are able to perform 10 times the number of operations in the same amount of time.

UNPACKING AND SETUP

This chapter provides unpacking and setup information for the Switch.

Unpacking

Open the shipping carton of the Switch and carefully unpack its contents. The carton should contain the following items:

- One DGS-3308TG or DGS-3308FG 8-port Gigabit Ethernet Layer 3 Switch
- Mounting kit: 2 mounting brackets and screws
- Four rubber feet with adhesive backing
- One AC power cord
- One Installation Guide
- This User's Guide on CD-ROM with Registration Card

If any item is found missing or damaged, please contact your local D-Link reseller for replacement.

Installation

Use the following guidelines when choosing a place to install the Switch:

- The surface must support at least 3 kg.
- The power outlet should be within 1.82 meters (6 feet) of the device.
- Visually inspect the power cord and see that it is secured to the AC power connector.
- Make sure that there is proper heat dissipation from and adequate ventilation around the switch. Do not place heavy objects on the switch.

Desktop or Shelf Installation

When installing the Switch on a desktop or shelf, the rubber feet included with the device should first be attached. Attach these cushioning feet on the bottom at each corner of the device. Allow adequate space for ventilation between the device and the objects around it.

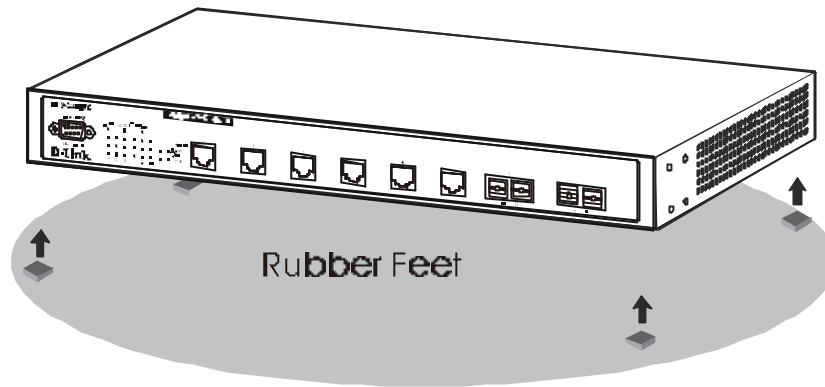


Figure 2-1. Installing rubber feet for desktop installation

Rack Installation

The DGS-3308 can be mounted in an EIA standard-sized, 19-inch rack, which can be placed in a wiring closet with other equipment. To install, attach the mounting brackets on the Switch's side panels (one on each side) and secure them with the screws provided.

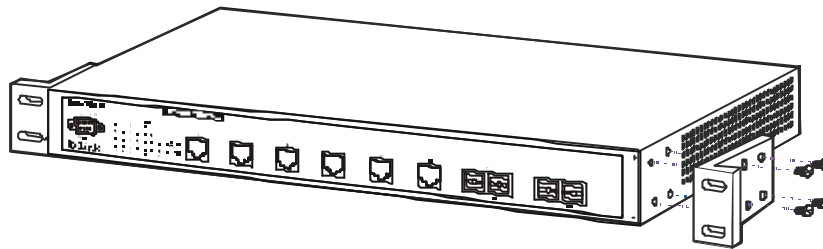


Figure 2- 2A. Attaching the mounting brackets to the Switch

Then, use the screws provided with the equipment rack to mount the switch on the rack.

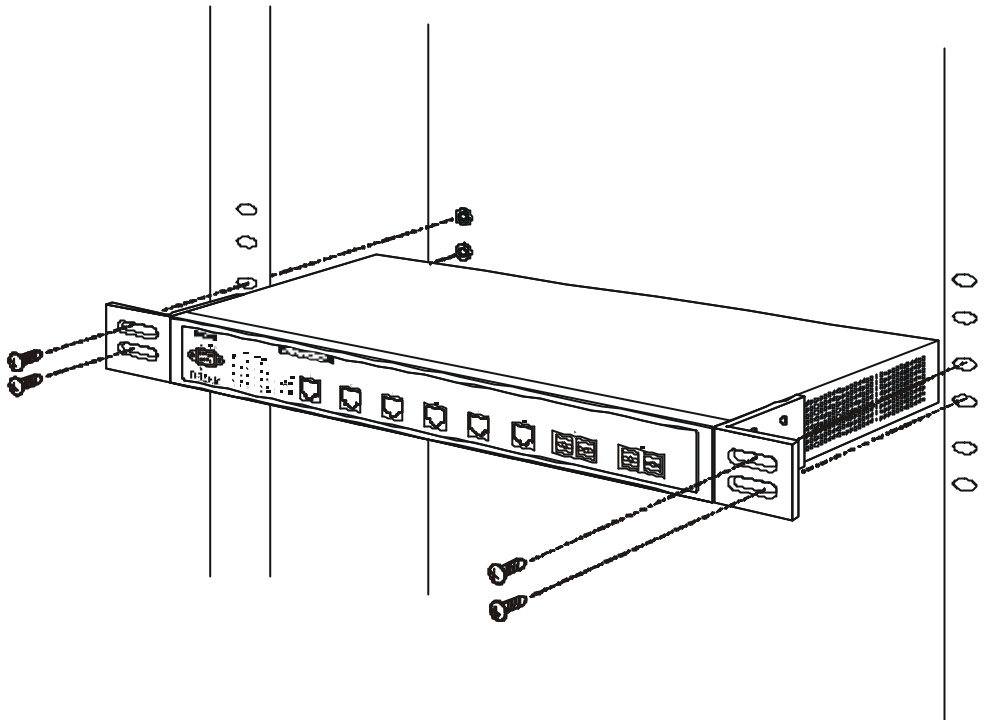


Figure 2-2B. Installing the Switch on an equipment rack

Power on

The DGS-3308 can be used with AC power supply 100 - 240 VAC, 50 - 60 Hz. The Switch's power supply will adjust to the local power source automatically and may be powered on without having any or all LAN segment cables connected.

After the Switch is plugged in, the LED indicators should respond as follows:

- All LED indicators will momentarily blink. This blinking of the LED indicators represents a reset of the system.
- The Power LED indicator will blink while the Switch loads onboard software and performs a self-test. After approximately 20 seconds, the LED will light again to indicate the switch is in a ready state.
- The Console LED indicator will remain ON if there is a connection at the RS-232 port, otherwise this LED indicator is OFF.

Power Failure

As a precaution in the event of a power failure, unplug the switch. When power is resumed, plug the Switch back in.

3

IDENTIFYING EXTERNAL COMPONENTS

This chapter describes the front panel, rear panel, and LED indicators of the DGS-3308.

Front Panel

The front panel of the Switch consists of LED indicators, an RS-232 communication port, two GBIC-based Gigabit Ethernet ports, and either six 1000BASE-SX ports (DGS-3308FG) or six 1000BASE-T ports (DGS-3308TG).

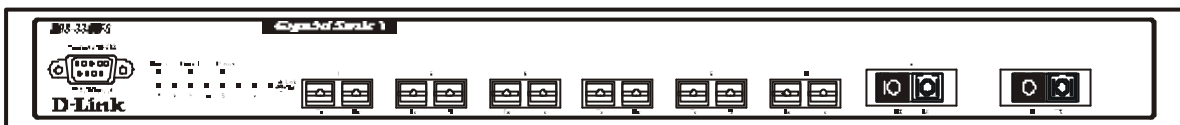


Figure 3-1a. Front panel view of the DGS-3308FG

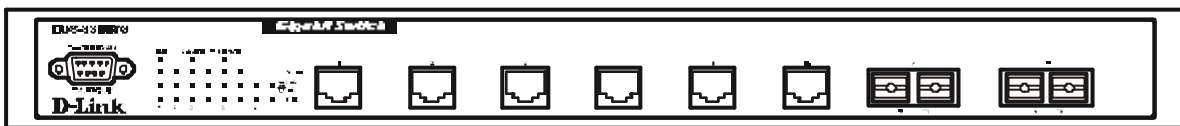


Figure 3-1b. Front panel view of the DGS-3308TG

- Comprehensive LED indicators display the status of the Switch and the network (see the *LED Indicators* section below).
- An RS-232 DCE console port for setting up and managing the switch via a connection to a console terminal or PC using a terminal emulation program.
- Six Gigabit Ethernet ports (1000BASE-SX for DGS-3308FG and 1000BASE-T for DGS-3308TG).
- Two GBIC-based Gigabit Ethernet ports.

Rear Panel

The rear panel of the switch consists of a slot for the optional DPS-1000 (Redundant Power Supply) and an AC power connector.

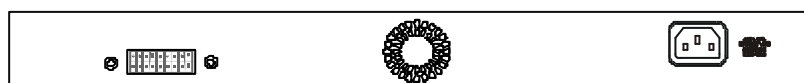


Figure 3-2. Rear panel view of the Switch

- The AC power connector is a standard three-pronged connector that supports the power cord. Plug-in the female connector of the provided power cord into this socket, and the male side of the cord into a power outlet. Supported input voltages range from 100 ~ 240 VAC at 50 ~ 60 Hz.

Side Panels

The right side panel of the Switch contains two system fans (see the top part of the diagram below). The left side panel contains heat vents.

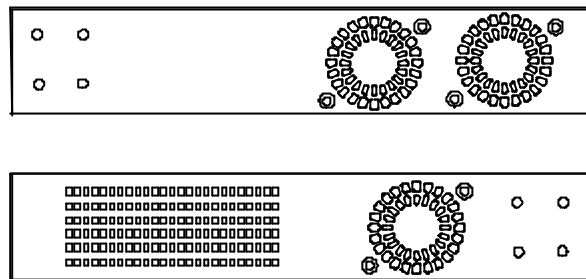


Figure 3-3. Side panel views of the Switch

- The system fans are used to dissipate heat. The sides of the system also provide heat vents to serve the same purpose. Do not block these openings, and leave at least 6 inches of space at the rear and sides of the switch for proper ventilation. Be reminded that without proper heat dissipation and air circulation, system components might overheat, which could lead to system failure.

LED Indicators

The LED indicators of the Switch include Power, Console, Link/Act, and RPS In Use. The following shows the LED indicators for the Switch along with an explanation of each indicator.

- **Power** – This indicator on the front panel should be lit during the Power-On Self Test (POST). It will light green approximately 2 seconds after the Switch is powered on to indicate the ready state of the device.
- **Console** – This indicator is lit green when the Switch is being managed via out-of-band/local console management through the RS-232 console port using a straight-through serial cable.
- **Link/Act** – These indicators are located to the left and right of each port. They are lit when there is a secure connection (or link) to a device at any of the ports. The LEDs blink whenever there is reception or transmission (i.e. Activity--Act) of data occurring at a port.
- **RPS in Use** – This indicator is lit when the optional DPS-1000 Redundant Power Supply is being used.

4

CONNECTING THE SWITCH

This chapter describes how to connect the DGS-3308FG/DGS-3308TG to your Gigabit Ethernet network.

PC to Switch

A PC can be connected to the Switch via a four-pair Category 5 cable or a fiber optic cable. The PC should be connected to any of the eight ports of the DGS-3308FG/DGS-3308TG.

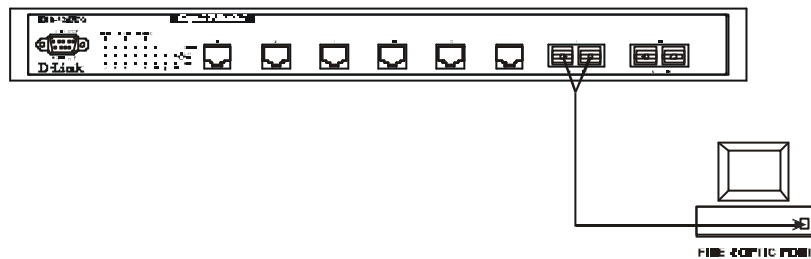


Figure 4-1. Switch connected to a PC or Workstation

The LED indicators for PC connection are dependent on the LAN card capabilities. If LED indicators are not illuminated after making a proper connection, check the PC's LAN card, the cable, Switch conditions, and connections.

The following LED indicator state is possible for a PC to Switch connection:

- The Link/Act LED indicator lights up upon hooking up a PC that is powered on.

Switch to Switch (other devices)

The Switch can be connected to another switch or other devices (routers, bridges, etc.) via a fiber optic cable.



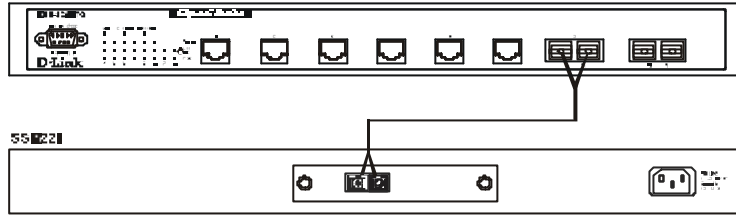


Figure 4-2. Switch to switch connection

5

SWITCH MANAGEMENT AND OPERATING CONCEPTS

This chapter discusses many of the concepts and features used to manage the switch, as well as the concepts necessary for the user to understand the functioning of the Switch. Further, this chapter explains many important points regarding these features.

Configuring the Switch to implement these concepts and make use of its many features is discussed in detail in the next chapters.

Some concepts are presented that are not currently implemented on the Switch. They are included to give a user who is unfamiliar with the concepts a brief overview of IP routing that is more complete – aid in the incorporation of the DGS-3308 in existing IP routed networks.

Local Console Management

A local console is a terminal or a workstation running a terminal emulation program that is connected directly to the switch via the RS-232 console port on the front of the switch. A console connection is referred to as an 'Out-of-Band' connection, meaning that console is connected to the switch using a different circuit than that used for normal network communications. So, the console can be used to set up and manage the switch even if the network is down.

Local console management uses the terminal connection to operate the console program built-in to the Switch (see Chapter 6, "*Using the Console Interface*"). A network administrator can manage, control and monitor the switch from the console program.

The DGS-3308 contains a CPU, memory for data storage, flash memory for configuration data, operational programs, and SNMP agent firmware. These components allow the Switch to be actively managed and monitored from either the console port or the network itself (out-of-band, or in-band).

Diagnostic (console) port (RS-232 DCE)

Out-of-band management requires connecting a terminal, such as a VT-100 or a PC running a terminal emulation program (such as HyperTerminal, which is automatically installed with Microsoft Windows) a to the RS-232 DCE console port of the Switch. Switch management using the RS-232 DCE console port is called *Local Console Management* to differentiate it from management performed via management platforms, such as D-View, HP OpenView, etc. *Web-based Management* describes management of the Switch performed over the network (in-band) using the switch's built-in Web-based management program (see Chapter 7, "*Web-based Network Management*"). The operations to be performed and the facilities provided by these two built-in programs are identical.

The console port is set at the factory for the following configuration:

- Baud rate: 9,600

- Data width: 8 bits
- Parity: none
- Stop bits: 1
- Flow Control: None

Make sure the terminal or PC you are using to make this connection is configured to match these settings.

If you are having problems making this connection on a PC, make sure the emulation is set to VT-100. If you still don't see anything, try hitting <Ctrl> + r to refresh the screen.

IP Addresses and SNMP Community Names

Each Switch must be assigned its own IP Address, which is used for communication with an SNMP network manager or other TCP/IP application (for example BOOTP, TFTP). The Switch's default IP address is 10.90.90.90. You can change the default Switch IP Address to meet the specification of your networking address scheme.

The Switch is also assigned a unique MAC address by the factory. This MAC address cannot be changed, and can be found from the initial boot console screen – shown below.

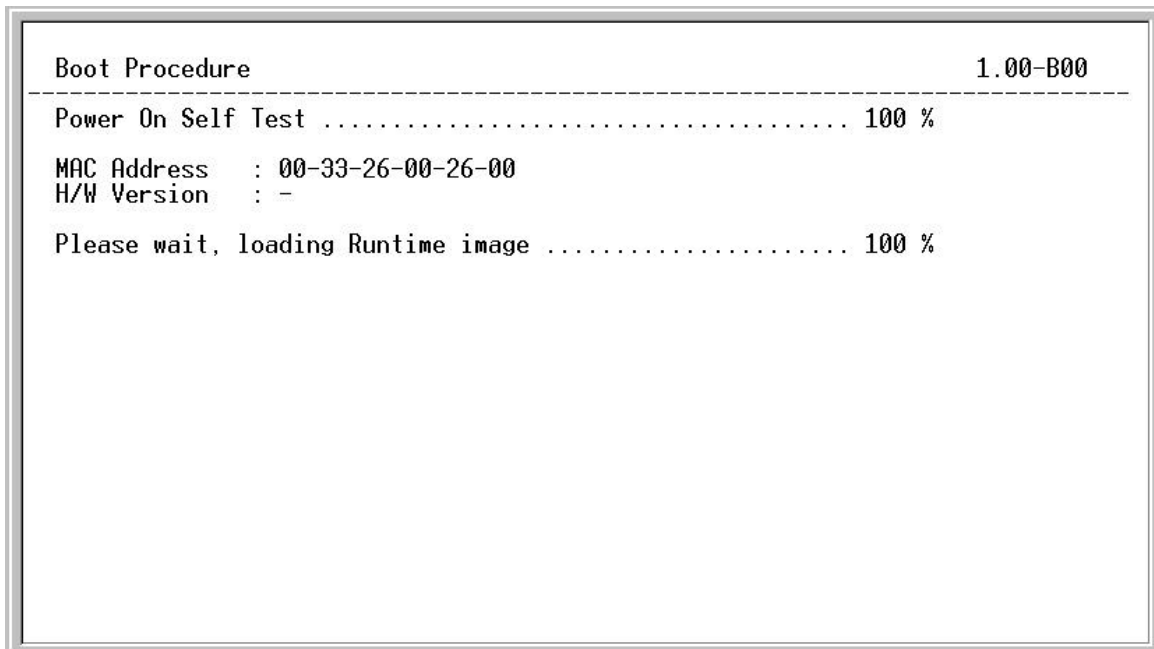


Figure 5-1. Boot screen

The Switch's MAC address can also be found from the console program under the **Switch Information** menu item, as shown below.

```

Switch Information                                     Layer 2 Switch
-----
Device Type      : DGS-3308 Layer 3 Gigabit Ethernet Switch
MAC Address      : 00-01-F4-DB-06-C0
Boot PROM Version: 0.2
Firmware Version : 0.62
Hardware Version : v1.00
Device S/N       : 12345678

System Name      : [Gigabit Ethernet L2/L3 Switch ]
System Location  : [53 Discovery Dr, Irvine CA 92620 ]
System Contact   : [D-Link Systems Inc.           ]

Power Supply and Cooling Fan Status

APPLY

*****
Function: Sets a name for identification purposes.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 5-2. Switch Information screen

In addition, you can also set an IP Address for a gateway router. This becomes necessary when the network management station is located on a different IP network from the Switch, making it necessary for management packets to go through a router to reach the network manager, and vice-versa.

For security, you can set in the Switch a list of IP Addresses of the network managers that you allow to manage the Switch. You can also change the default SNMP Community Strings in the Switch and set the access rights of these Community Strings. In addition, a VLAN may be designated as a Management VLAN.

Traps

Note: Traps are messages that alert you of events that occur on the Switch. The events can be as serious as a reboot (someone accidentally turned OFF the Switch), or less serious like a port status change. The Switch generates traps and sends them to the network manager (trap recipient).

Trap recipients are special users of the network who are given certain rights and access in overseeing the maintenance of the network. Trap recipients will receive traps sent from the Switch; they must immediately take certain actions to avoid future failure or breakdown of the network.

You can also specify which network managers may receive traps from the Switch by entering a list of the IP addresses of authorized network managers. Up to four trap recipient IP addresses, and four corresponding SNMP community strings can be entered.

Note: SNMP community strings function like passwords in that the community string entered for a given IP address must be used in the management station software, or a trap will be sent.

The following are trap types the Switch can send to a trap recipient:

- **Cold Start** – This trap signifies that the Switch has been powered up and initialized such that software settings are reconfigured and hardware systems are rebooted. A cold start is different from a factory reset in that configuration settings saved to non-volatile RAM used to reconfigure the switch.
- **Warm Start** – This trap signifies that the Switch has been rebooted, however the POST (Power On Self-Test) is skipped.
- **Authentication Failure** – This trap signifies that someone has tried to logon to the switch using an invalid SNMP community string. The Switch automatically stores the source IP address of the unauthorized user.
- **New Root** – This trap indicates that the Switch has become the new root of the Spanning Tree, the trap is sent by the switch soon after its election as the new root. This implies that upon expiration of the Topology Change Timer the new root trap is sent out immediately after the Switch's election as the new root.
- **Topology Change (STP)** – A Topology Change trap is sent by the Switch when any of its configured ports transitions from the Learning state to the Forwarding state, or from the Forwarding state to the Blocking state. The trap is not sent if a new root trap is sent for the same transition.
- **New Root (STP)** – A New Root trap is sent by the switch whenever a new root port is elected within an STP group.
- **Link Up** – This trap is sent whenever the link of a port changes from link down to link up.
- **Link Down** – This trap is sent whenever the link of a port changes from link up to link down.

MIBs

Management and counter information are stored in the Switch in the Management Information Base (MIB). The Switch uses the standard MIB-II Management Information Base module. Consequently, values for MIB objects can be retrieved from any SNMP-based network management software. In addition to the standard MIB-II, the Switch also supports its own proprietary enterprise MIB as an extended Management Information Base. These MIBs may also be retrieved by specifying the MIB's Object-Identity (OID) at the network manager. MIB values can be either read-only or read-write.

Read-only MIBs variables can be either constants that are programmed into the Switch, or variables that change while the Switch is in operation. Examples of read-only constants are the number of port and type of ports. Examples of read-only variables are the statistics counters such as the number of errors that have occurred, or how many kilobytes of data have been received and forwarded through a port.

Read-write MIBs are variables usually related to user-customized configurations. Examples of these are the Switch's IP Address, Spanning Tree Algorithm parameters, and port status.

If you use a third-party vendors' SNMP software to manage the Switch, a diskette listing the Switch's propriety enterprise MIBs can be obtained by request. If your software provides functions to browse or modify MIBs, you can also get the MIB values and change them (if the MIBs' attributes permit the write operation). This process however can be quite involved, since you must know the MIB OIDs and retrieve them one by one.

SNMP

Simple Network Management Protocol (SNMP) is an OSI layer 7 (the application layer) protocol for remotely monitoring and configuring network devices. SNMP enables network management stations to read and modify the settings of gateways, routers, switches, and other network devices. SNMP can be used to perform many of the same functions as a directly connected console, or can be used within an integrated network management software package such as DView.

The Switch has a software program called an 'agent' that processes SNMP requests, but the user program that makes the requests and collects the responses runs on a management station (a designated computer on the network). The SNMP agent and the user program both use the UDP/IP protocol to exchange packets.

Authentication

The authentication protocol ensures that both the router SNMP agent and the remote user SNMP application program discard packets from unauthorized users. Authentication is accomplished using 'community strings', which function like passwords. The remote user SNMP application and the router SNMP must use the same community string. SNMP community strings of up to 20 characters may be entered under the *Remote Management Setup* menu of the console program.

Packet Forwarding

The Switch enters the relationship between destination MAC or IP addresses and the Ethernet port or gateway router the destination resides on into its forwarding table. This information is then used to forward packets. This reduces the traffic congestion on the network, because packets, instead of being transmitted to all ports, are transmitted to the destination port only. Example: if Port 1 receives a packet destined for a station on Port 2, the Switch transmits that packet through Port 2 only, and transmits nothing through the other ports. This process is referred to as 'learning' the network topology.

MAC Address Aging Time

The Aging Time affects the learning process of the Switch. Dynamic forwarding table entries, which are made up of the source and destination MAC addresses and their associated port numbers, are deleted from the table if they are not accessed within the aging time.

The aging time can be from 10 to 1,000,000 seconds with a default value of 300 seconds. A very long aging time can result in dynamic forwarding table entries that are out-of-date or no longer exist. This may cause incorrect packet forwarding decisions by the Switch.

If the Aging Time is too short however, many entries may be aged out too soon. This will result in a high percentage of received packets whose source addresses cannot be found in the forwarding table, in which case the switch will broadcast the packet to all ports, negating many of the benefits of having a switch.

Static forwarding entries are not affected by the aging time.

Filtering

The Switch uses a filtering database to segment the network and control communication between segments. It can also filter packets off the network for intrusion control. Static filtering entries can be made by MAC Address or IP Address filtering.

Each port on the Switch is a unique collision domain and the switch filters (discards) packets whose destination lies on the same port as where it originated. This keeps local packets from disrupting communications on other parts of the network.

For intrusion control, whenever a switch encounters a packet originating from or destined to a MAC address or an IP Address entered into the filter table, the switch will discard the packet.

Some filtering is done automatically by the switch:

- Dynamic filtering – automatic learning and aging of MAC addresses and their location on the network. Filtering occurs to keep local traffic confined to its segment.
- Filtering done by the Spanning Tree Protocol, which can filter packets based on topology, making sure that signal loops don't occur.
- Filtering done for VLAN integrity. Packets from a member of a VLAN (VLAN 2, for example) destined for a device on another VLAN (VLAN 3) will be filtered.

Some filtering requires the manual entry of information into a filtering table:

- MAC address filtering – the manual entry of specific MAC addresses to be filtered from the network. Packets sent from one manually entered MAC address can be filtered from the network. The entry may be specified as either a source, a destination, or both.
- IP address filtering – the manual entry of specific IP addresses to be filtered from the network (switch must be in IP Routing mode). Packets sent from one manually entered IP address to another can be filtered from the network. The entry may be specified as either a source, a destination, or both (switch must be in IP Routing mode).

IP Addressing and Subnetting

This section gives basic information needed to configure your Layer 3 switch for IP routing. The information includes how IP addresses are broken down and how subnetting works. You will learn how to assign each interface on the router an IP address with a unique subnet.

Definitions

- **IP Address** – the unique number ID assigned to each host or interface on a network. IP addresses have the form xxx.xxx.xxx.xxx.
- **Subnet** – a portion of a network sharing a particular network address.
- **Subnet mask** – a 32-bit number used to describe which portion of a Network Address refers to the subnet and which portion refers to the host. Subnet masks have the form xxx.xxx.xxx.xxx.
- **Interface** – a network connection
- **IP Interface** – another name for subnet.
- **Network Address** – the resulting 32-bit number from a bitwise logical AND operation performed between an IP address and a subnet mask.
- **Subnet Address** – another name for network address.

Note: In a subnetted network, all addresses consist of **two** parts: an IP address and a subnet mask. The two are used together and one is meaningless without the other.

IP Addresses

The Internet Protocol (IP) was designed for routing data between network sites. Later, it was adapted for routing between networks (referred to as “subnets”) within a site. The IP defines a way of generating an unique number that can be assigned each network in the internet and each of the computers on each of those networks. This number is called the IP address.

IP addresses use a “dotted decimal” notation. Here are some examples of IP addresses written in this format:

1. 210.202.204.205
2. 189.21.241.56
3. 125.87.0.1

This allows IP address to be written in a string of 4 decimal (base 10) numbers. Computers can only understand binary (base 2) numbers, and these binary numbers are usually grouped together in bytes, or eight bits. (A bit is a binary digit – either a “1” or a “0”). The dots (periods) simply make the IP address easier to read. A computer sees an IP address not as four decimal numbers, but as a long string of binary digits (32 binary digits or 32 bits, IP addresses are 32-bit addresses).

The three IP addresses in the example above, written in binary form are:

1. 11010010.11001010.11001100.11001101
2. 10111101.00010101.11110001.00111000
3. 01111101.01010111.00000000.00000001

The dots are included to make the numbers easier to read.

Eight binary bits are called a 'byte' or an 'octet'. An octet can represent any decimal value between '0' (00000000) and '255' (11111111). IP addresses, represented in decimal form, are four numbers whose value is between '0' to '255'. The total range of IP addresses are then:

Lowest possible IP address - 0.0.0.0
 Highest possible IP address - 255.255.255.255

To convert decimal numbers to 8-bit binary numbers (and vice-versa), you can use the following chart:

Binary Octet Digit	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
Decimal Equivalent	128	64	32	16	8	4	2	1
Binary Number 128+64+32+16+8+4+2+1= 255	1	1	1	1	1	1	1	1

Table 5-1. Binary to Decimal Conversion

Each digit in an 8-bit binary number (an octet) represents a power of two. The left-most digit represents 2 raised to the 7th power ($2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 128$) while the right-most digit represents 2 raised to the 0th power (any number raised to the 0th power is equal to one, by definition).

IP addresses actually consist of two parts, one identifying the network and one identifying the destination (node) within the network. The IP address discussed above is one part and a second number called the Subnet mask is the other part. To make this a bit more confusing, the subnet mask has the same numerical form as an IP address.

Address Classes

Address classes refer to the range of numbers in the subnet mask. Grouping the subnet masks into classes makes the task of dividing a network into subnets a bit easier.

There are 5 address classes. The first 4 bits in the IP address determine which class the IP address falls in.

- Class A addresses begin with 0xxx, or 1 to 126 decimal.
- Class B addresses begin with 10xx, or 128 to 191 decimal.
- Class C addresses begin with 110x, or 192 to 223 decimal.
- Class D addresses begin with 1110, or 224 to 239 decimal.
- Class E addresses begin with 1111, or 240 to 254 decimal.

Addresses beginning with 01111111, or 127 decimal, are reserved. They are used for internal testing on a local machine (called loopback). The address 127.0.0.1 can always be pinged from a local node because it forms a loopback and points back to the same node.

Class D addresses are reserved for multicasting.

Class E Addresses are reserved for future use. They are not used for node addresses.

The part of the IP address that belongs to the network is the part that is 'hidden' by the '1's in the subnet mask. This can be seen below:

- Class A NETWORK.node.node.node
- Class B NETWORK.NETWORK.node.node
- Class C NETWORK.NETWORK.NETWORK.node

For example, the IP address 10.42.73.210 is a Class A address, so the Network part of the address (called the *Network Address*) is the first octet (10.x.x.x). The node part of the address is the last three octets (x.42.73.210).

To specify the network address for a given IP address, the node part is set to all "0"s. In our example, 10.0.0.0 specifies the network address for 10.42.73.210. When the node part is set to all "1"s, the address specifies a broadcast address. So, 10.255.255.255 is the broadcast address for the network 10.0.0.0.

Subnet Masking

A subnet mask can be applied to an IP address to identify the network and the node parts of the address. A bitwise logical AND operation between the IP address and the subnet mask results in the *Network Address*.

For example:

00001010.00101010.01001001.11010010 10.42.73.210 Class A IP address

11111111.00000000.00000000.00000000 255.0.0.0 Class A Subnet Mask

00001010.00000000.00000000.00000000 10.0.0.0 Network Address

The Default subnet masks are:

- Class A – 11111111.00000000.00000000.00000000 255.0.0.0
- Class B – 11111111.11111111.00000000.00000000 255.255.0.0
- Class C – 11111111.11111111.11111111.00000000 255.255.255.0

Additional bits can be added to the default subnet mask for a given Class to further subnet a network. When a bitwise logical AND operation is performed between the subnet mask and the IP address, the result defines the *Subnet Address*.

Some restrictions apply to subnet addresses. Addresses of all “0”s and all “1”s are reserved for the local network (when a host does not know its network address) and for all hosts on the network (the broadcast address). This also applies to subnets. A subnet address cannot be all “0”s or all “1”s. A 1-bit subnet mask is also not allowed.

Calculating the Number of Subnets and Nodes

To calculate the number of subnets and nodes, use the formula $(2^n - 2)$ where n = the number of bits in either the subnet mask or the node portion of the IP address. Multiplying the number of subnets by the number of nodes available per subnet gives the total number of nodes for the entire network.

Example

00001010.00101010.01001001.11010010 10.42.73.210 Class A IP address

11111111.11100000.00000000.00000000 255.224.0.0 Subnet Mask

00001010.00100000.00000000.00000000 10.32.0.0 Network Address

00001010.00101010.11111111.11111111 10.32.255.255 Broadcast Address

This example uses an 11-bit subnet mask. (There are 3 additional bits added to the default Class A subnet mask). So the number of subnets is:

$$2^3 - 2 = 8 - 2 = 6$$

Subnets of all “0”s and all “1”s are not allowed, so 2 subnets are subtracted from the total.

The number of bits used in the node part of the address is $24 - 3 = 21$ bits, so the total number of nodes is:

$$2^{21} - 2 = 2,097,152 - 2 = 2,097,150$$

Multiplying the number of subnets times the number of nodes gives 12,582,900 possible nodes. Note that this is less than the 16,777,214 possible nodes that an unsubnetted class A network would have.

Subnetting reduces the number of possible nodes for a given network, but increases the segmentation of the network.

Classless InterDomain Routing – CIDR

Under CIDR, the subnet mask notation is reduced to a simplified shorthand. Instead of specifying all of the bits of the subnet mask, it is simply listed as the number of contiguous “1”s (bits) in the network portion of the address. Look at the subnet mask of the above example in binary - 11111111.11100000.00000000.00000000 – and you can see that there are 11 “1”s or 11 bits used to mask the network address from the node address. Written in CIDR notation this becomes:

10.32.0.0/11

# of Bits	Subnet Mask	CIDR Notation	# of Subnets	# of Hosts	Total Hosts
2	255.192.0.0	/10	2	4194302	8388604
3	255.224.0.0	/11	6	2097150	12582900
4	255.240.0.0	/12	14	1048574	14680036
5	255.248.0.0	/13	30	524286	15728580
6	255.252.0.0	/14	62	262142	16252804
7	255.254.0.0	/15	126	131070	16514820
8	255.255.0.0	/16	254	65534	16645636
9	255.255.128.0	/17	510	32766	16710660
10	255.255.192.0	/18	1022	16382	16742404
11	255.255.224.0	/19	2046	8190	16756740
12	255.255.240.0	/20	4094	4094	16760836
13	255.255.248.0	/21	8190	2046	16756740
14	255.255.252.0	/22	16382	1022	16742404
15	255.255.254.0	/23	32766	510	16710660
16	255.255.255.0	/24	65534	254	16645636
17	255.255.255.128	/25	131070	126	16514820
18	255.255.255.192	/26	262142	62	16252804
19	255.255.255.224	/27	525286	30	15728580
20	255.255.255.240	/28	1048574	14	14680036
21	255.255.255.248	/29	2097150	6	12582900
22	255.255.255.252	/30	4194302	2	8388604

Table 5-2. Class A Subnet Masks

# of Bits	Subnet Mask	CIDR Notation	# of Subnets	# of Hosts	Total Hosts
2	255.255.192	/18	2	16382	32764
3	255.255.224.0	/19	6	8190	49140
4	255.255.240.0	/20	14	4094	57316
5	255.255.248.0	/21	30	2046	61380
6	255.255.252.0	/22	62	1022	63364
7	255.255.254.0	/23	126	510	64260
8	255.255.255.0	/24	254	254	64516
9	255.255.255.128	/25	510	126	64260
10	255.255.255.192	/26	1022	62	63364
11	255.255.255.224	/27	2046	30	61380
12	255.255.255.240	/28	4094	14	57316
13	255.255.255.248	/29	8190	6	49140
14	255.255.255.252	/30	16382	2	32764

	2				
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Table 5-3. Class B Subnet Masks

# of Bits	Subnet Mask	CIDR Notation	# of Subnets	# of Hosts	Total Hosts
2	255.255.255.192	/26	2	62	124
3	255.255.255.224	/27	6	30	180
4	255.255.255.240	/28	14	14	196
5	255.255.255.248	/29	30	6	180
6	255.255.255.252	/30	62	2	124

Table 5-4. Class C Subnet Masks

802.1Q VLANs

A VLAN is a collection of end nodes grouped by logic instead of physical location. End nodes that frequently communicate with each other are assigned to the same VLAN, regardless of where they are physically on the network. Logically, a VLAN can be equated to a broadcast domain, because broadcast packets are forwarded to only members of the VLAN on which the broadcast was initiated.

Notes About VLANs

1. No matter what basis is used to uniquely identify end nodes and assign these nodes VLAN membership, packets **cannot** cross VLANs without a network device performing a routing function between the VLANs.
2. The DGS-3308 supports only IEEE 802.1Q VLANs. The port untagging function can be used to remove the 802.1 tag from packet headers to maintain compatibility with devices that are tag-unaware.
3. The Switch's default - in both **Layer 2 Only** mode and **IP Routing** mode - is to assign all ports to a single 802.1Q VLAN named DEFAULT_VLAN. As new VLANs are created, the member ports assigned to the new VLAN will be removed from the DEFAULT_VLAN port member list.
4. The DEFAULT_VLAN has a VID = 1. An IP interface called **System** in the IP interface entry menu also has a VID = 1, and therefore corresponds to the DEFAULT_VLAN.
5. There is no difference in the creation, deletion, configuration, or editing of 802.1Q VLANs whether the Switch is in **Layer 2 Only**, or **IP Routing** mode.
6. There is a difference in the behavior of VLANs when the Switch is in **Layer 2 Only** or **IP Routing** mode. In **Layer 2 Only** mode, network resources cannot be shared across VLANs. In **IP Routing** mode, network resources are shared via routing. The Switch allows the assignment of an IP interface to each VLAN, in **IP Routing** mode. The VLANs must be configured before setting up the IP interfaces. In addition, an IP addressing scheme must be determined. Some consideration is required to arrive at a suitable combination of VLANs and IP interfaces. See the section titled **IP Addressing and Subnetting** in **Chapter 5** for more information.

A VLAN that is not assigned an IP interface will behave as a layer 2 VLAN – and IP routing will not be possible on this VLAN regardless of the Switch's operating mode.

IEEE 802.1Q VLANs

Some relevant terms:

- **Tagging** – The act of putting 802.1Q VLAN information into the header of a packet.

- **Untagging** – The act of stripping 802.1Q VLAN information out of the packet header.
- **Ingress port** – A port on a switch where packets are flowing into the switch and VLAN decisions must be made.
- **Egress port** – A port on a switch where packets are flowing out of the switch, either to another switch or to an end station, and tagging decisions must be made.

IEEE 802.1Q (tagged) VLANs are implemented on the Switch. 802.1Q VLANs require tagging, which enables them to span the entire network (assuming all switches on the network are IEEE 802.1Q-compliant). IEEE 802.1Q VLANs also allow for dynamic VLAN registration using GVRP.

VLANs can also provide a level of security to your network. IEEE 802.1Q VLANs will only deliver packets between stations that are members of the VLAN.

Any port can be configured as either *tagging* or *untagging*. The *untagging* feature of IEEE 802.1Q VLANs allow VLANs to work with legacy switches that don't recognize VLAN tags in packet headers. The *tagging* feature allows VLANs to span multiple 802.1Q-compliant switches through a single physical connection and allows Spanning Tree to be enabled on all ports and work normally.

The IEEE 802.1Q standard restricts the forwarding of untagged packets to the VLAN the receiving port is a member of.

The main characteristics of IEEE 802.1Q are as follows:

- Assigns packets to VLANs by filtering.
- Assumes the presence of a single global spanning tree.
- Uses an explicit tagging scheme with one-level tagging.

802.1Q VLAN Packet Forwarding

Packet forwarding decisions are made based upon the following three types of rules:

- Ingress rules – rules relevant to the classification of received frames belonging to a VLAN.
- Forwarding rules between ports – decides filter or forward the packet
- Egress rules – determines if the packet must be sent tagged or untagged.

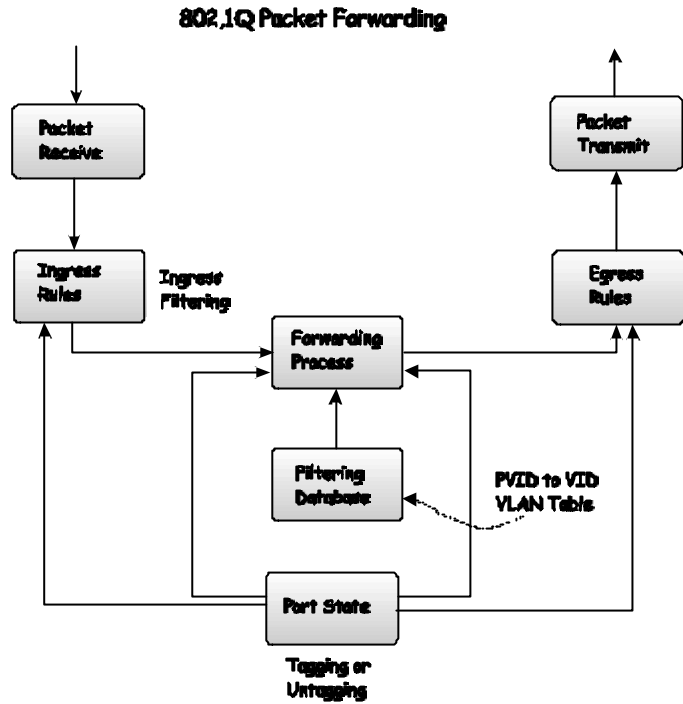


Figure 5-3. IEEE 802.1Q Packet Forwarding

802.1Q VLAN Tags

The figure below shows the 802.1Q VLAN tag. There are four additional octets inserted after the source MAC address. Their presence is indicated by a value of 0x8100 in the EtherType field. When a packet's EtherType field is equal to 0x8100, the packet carries the IEEE 802.1Q/802.1p tag. The tag is contained in the following two octets and consists of 3 bits of user priority, 1 bit of Canonical Format Identifier (CFI – used for encapsulating Token Ring packets so they can be carried across Ethernet backbones) and 12 bits of VLAN ID (VID). The 3 bits of user priority are used by 802.1p. The VID is the VLAN identifier and is used by the 802.1Q standard.

The tag is inserted into the packet header making the entire packet longer by 4 octets. All of the information contained in the packet originally is retained.

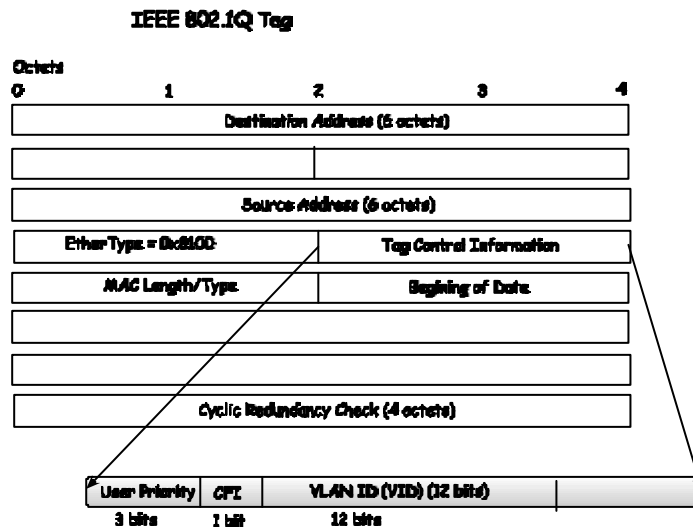


Figure 5-4. IEEE 802.1Q Tag

The EtherType and VLAN ID are inserted after the MAC source address, but before the original EtherType/Length or Logical Link Control. Because the packet is now a bit longer than it was originally, the Cyclic Redundancy Check (CRC) must be recalculated.

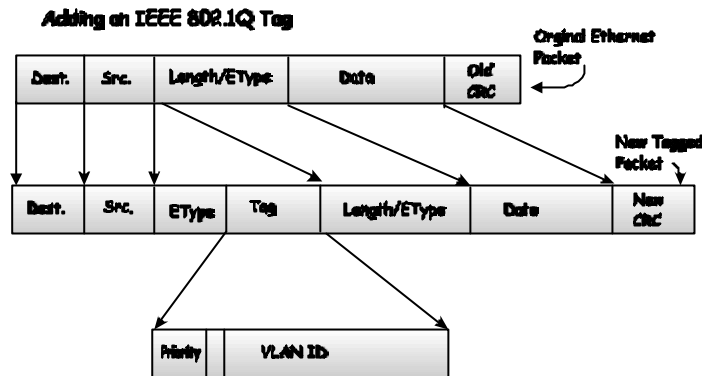


Figure 5-5. Adding an IEEE 802.1Q Tag

Port VLAN ID

Packets that are tagged (are carrying the 802.1Q VID information) can be transmitted from one 802.1Q compliant network device to another with the VLAN information intact. This allows 802.1Q VLANs to span network devices (and indeed, the entire network – if all network devices are 802.1Q compliant).

Every physical port on a switch has a PVID. 802.1Q ports are also assigned a PVID, for use within the switch. If no VLANs are defined on the switch, all ports are then assigned to a default VLAN with a PVID equal to 1. Untagged packets are assigned the PVID of the port on which they were received. Forwarding decisions are based upon this PVID, in so far as VLANs are concerned. Tagged packets are forwarded according to the VID contained within the tag. Tagged packets are also assigned a PVID, but the PVID is not used to make packet forwarding decisions, the VID is.

Tag-aware switches must keep a table to relate PVIDs within the switch to VIDs on the network. The switch will compare the VID of a packet to be transmitted to the VID of the port that is to transmit the packet. If the two VIDs are different, the switch will drop the packet. Because of the existence of the PVID for untagged packets and the VID for tagged packets, tag-aware and tag-unaware network devices can coexist on the same network.

A switch port can have only one PVID, but can have as many VIDs as the switch has memory in its VLAN table to store them.

Because some devices on a network may be tag-unaware, a decision must be made at each port on a tag-aware device before packets are transmitted – should the packet to be transmitted have a tag or not? If the transmitting port is connected to a tag-unaware device, the packet should be untagged. If the transmitting port is connected to a tag-aware device, the packet should be tagged.

Tagging and Untagging

Every port on an 802.1Q compliant switch can be configured as *tagging* or *untagging*.

Ports with tagging enabled will put the VID number, priority and other VLAN information into the header of all packets that flow into and out of it. If a packet has previously been tagged, the port will not alter the packet, thus keeping the VLAN information intact. The VLAN information in the tag can then be used by other 802.1Q compliant devices on the network to make packet forwarding decisions.

Ports with untagging enabled will strip the 802.1Q tag from all packets that flow into and out of those ports. If the packet doesn't have an 802.1Q VLAN tag, the port will not alter the packet. Thus, all packets received by and forwarded by an untagging port will have no 802.1Q VLAN information. (Remember that the PVID is only used internally within the switch). Untagging is used to send packets from an 802.1Q-compliant network device to a non-compliant network device.

Ingress Filtering

A port on a switch where packets are flowing into the switch and VLAN decisions must be made is referred to as an *ingress port*. If ingress filtering is enabled for a port, the switch will examine the VLAN information in the packet header (if present) and decide whether or not to forward the packet.

If the packet is tagged with VLAN information, the ingress port will first determine if the ingress port itself is a member of the tagged VLAN. If it is not, the packet will be dropped. If the ingress port is a member of the 802.1Q VLAN, the switch then determines if the destination port is a member of the 802.1Q VLAN. If it is not, the packet is dropped. If the destination port is a member of the 802.1Q VLAN, the packet is forwarded and the destination port transmits it to its attached network segment.

If the packet is not tagged with VLAN information, the ingress port will tag the packet with its own PVID as a VID (if the port is a tagging port). The switch then determines if the destination port is a member of the same VLAN (has the same VID) as the ingress port. If it does not, the packet is dropped. If it has the same VID, the packet is forwarded and the destination port transmits it on its attached network segment.

This process is referred to as *ingress filtering* and is used to conserve bandwidth within the switch by dropping packets that are not on the same VLAN as the ingress port at the point of reception. This eliminates the subsequent processing of packets that will just be dropped by the destination port.

Layer 3-Based VLANs

The DGS-3308 allows an IP subnet to be configured for each 802.1Q VLAN that exists on the switch.

Even though a switch inspects a packet's IP address to determine VLAN membership, no route calculation is performed, the RIP or OSPF protocols are not employed, and packets traversing the switch are bridged using the Spanning Tree algorithm.

A switch that implements layer 3 (or 'subnet') VLANs without performing any routing function between these VLANs is referred to as performing 'IP Switching'.

IP switching does not allow packets to cross VLANs (in this case – IP subnets) without a network device performing a routing function between the VLANs (IP subnets).

The DGS-3308 does not directly support IP switching, however it is possible to do the equivalent by assigning IP subnets to configured VLANs and then disabling the Routing Information Protocol (RIP). This will prevent packets from crossing IP subnets without going through an external router.

VLANs in Layer 2 Only Mode

The switch initially configures one VLAN, VID = 1, called the DEFAULT_VLAN. The factory default setting assigns all ports on the switch to the DEFAULT_VLAN. As new VLANs are configured, their respective member ports are removed from the DEFAULT_VLAN. If the DEFAULT_VLAN is reconfigured, all ports are again assigned to it. Ports that are not desired to be part of the DEFAULT_VLAN are removed during the configuration.

Packets cannot cross VLANs if the switch is in **Layer 2 Only** mode. If a member of one VLAN wants to connect to another VLAN, the link must be through an external router.

When the switch is in **Layer 2 Only** mode, 802.1Q VLANs are supported.

Setting up IP Interfaces

The Layer 3 switch allows ranges of IP addresses (OSI layer 3) to be assigned to VLANs (OSI layer 2). Each VLAN must be configured prior to setting up the corresponding IP interface. An IP addressing scheme must then be established, and implemented when the IP interfaces are set up on the switch.

An example is presented below:

VLAN Name	VID	Switch Ports
System (default)	1	7, 8
Engineering	2	1, 2
Marketing	3	5, 6
Shipping	4	3,4

Table 5-5. VLAN Example – Assigned Ports

In this case, 4 IP interfaces are required, so a CIDR notation of 10.32.0.0/10 (or a 10-bit) addressing scheme will work. This addressing scheme will give a subnet mask of 11111111.11000000.00000000.00000000 (binary) or 255.192.0.0 (decimal).

Using a 10.xxx.xxx.xxx IP address notation, the above example would give 4 network addresses and 4 subnets.

Any IP address from the allowed range of IP addresses for each subnet can be chosen as an IP address for an IP interface on the switch.

For this example, we have chosen the next IP address above the network address:

VLAN Name	VID	Network Address	IP Address
System (default)	1	10.0.0.0	10.0.0.1
Engineering	2	10.64.0.0	10.64.0.1
Marketing	3	10.128.0.0	10.128.0.1
Shipping	4	10.192.0.0	10.192.0.1

Table 5-6. VLAN Example – Assigned IP Addresses

The 4 IP interfaces, each with an IP address (listed in the table above), and a subnet mask of 255.192.0.0 can be entered into the **Setup IP Interface** menu.

Spanning Tree Protocol

The IEEE 802.1D Spanning Tree Protocol allows for the blocking of links between switches that form loops within the network. When multiple links between switches are detected, a primary link is established. Duplicated links are blocked from use and become standby links. The protocol allows for the duplicate links to be used in the event of a failure of the primary link. Once the Spanning Tree Protocol is configured and enabled, primary links are established and duplicated links are blocked automatically. The reactivation of the blocked links (at the time of a primary link failure) is also accomplished automatically – without operator intervention.

This automatic network reconfiguration provides maximum uptime to network users. However, the concepts of the Spanning Tree Algorithm and protocol are a complicated and complex subject and must be fully researched and understood. It is possible to cause serious degradation of the performance of the network if the Spanning Tree is incorrectly configured. Please read the following before making any changes from the default values.

The DGS-3308 STP allows two levels of spanning trees to be configured. The first level constructs a spanning tree on the links between switches. This is referred to as the **Switch** or **Global** level. The second level is on a port group basis. Groups of ports are configured as being members of a spanning tree and the algorithm and protocol are applied to the group of ports. This is referred to as the **Port** or **VLAN** level.

The Switch STP performs the following functions:

- Creates a single spanning tree from any combination of switching or bridging elements.
- Creates multiple spanning trees – from any combination of ports contained within a single switch, in user-specified groups.
- Automatically reconfigures the spanning tree to compensate for the failure, addition, or removal of any element in the tree.
- Reconfigures the spanning tree without operator intervention.

STP Operation Levels

The Switch allows for two levels of operation: the switch level and the port level. The switch level forms a spanning tree consisting of links between one or more switches. The port level constructs a spanning tree consisting of groups of one or more ports. The STP operates in much the same way for both levels.

Note: On the switch level, STP calculates the Bridge Identifier for each switch and then sets the Root Bridge and the Designated Bridges.

Note: On the port level, STP sets the Root Port and the Designated Ports.

The following are the user-configurable STP parameters for the switch level:

Parameter	Description	Default Value
Bridge Identifier (Not user-configurable except by setting priority below)	A combination of the User-set priority and the switch's MAC address. The Bridge Identifier consists of two parts: a 16-bit priority and a 48-bit Ethernet MAC address	32768 + MAC
Priority	A relative priority for each	32768

		switch – lower numbers give a higher priority and a greater chance of a given switch being elected as the root bridge	
Hello Time		The length of time between broadcasts of the hello message by the switch	2 seconds
Maximum Age Timer		Measures the age of a received BPDU for a port and ensures that the BPDU is discarded when its age exceeds the value of the maximum age timer.	20 seconds
Forward Delay Timer	Delay	The amount time spent by a port in the learning and listening states waiting for a BPDU that may return the port to the blocking state.	15 seconds

Table 5-7. STP Parameters – Switch Level

The following are the user-configurable STP parameters for the port or port group level:

Variable	Description	Default Value
Port Priority	A relative priority for each port – lower numbers give a higher priority and a greater chance of a given port being elected as the root port	32768
Port Cost	A value used by STP to evaluate paths – STP calculates path costs and selects the path with the minimum cost as the active path.	19 – 100Mbps Fast Ethernet ports 4 – 1000Mbps Gigabit Ethernet ports

Table 5-8. STP Parameters – Port Group Level

Bridge Protocol Data Units

For STP to arrive at a stable network topology, the following information is used:

- The unique switch identifier
- The path cost to the root associated with each switch port
- The port identifier

STP communicates between switches on the network using Bridge Protocol Data Units (BPDUs). Each BPDU contains the following information:

- The unique identifier of the switch that the transmitting switch currently believes is the root switch

- The path cost to the root from the transmitting port
- The port identifier of the transmitting port

The switch sends BPDUs to communicate and construct the spanning-tree topology. All switches connected to the LAN on which the packet is transmitted will receive the BPDU. BPDUs are not directly forwarded by the switch, but the receiving switch uses the information in the frame to calculate a BPDU, and, if the topology changes, initiates a BPDU transmission.

The communication between switches via BPDUs results in the following:

- One switch is elected as the root switch
- The shortest distance to the root switch is calculated for each switch
- A designated switch is selected. This is the switch closest to the root switch through which packets will be forwarded to the root.
- A port for each switch is selected. This is the port providing the best path from the switch to the root switch.
- Ports included in the STP are selected.

Creating a Stable STP Topology

to make the fastest link the root port. If all switches have STP enabled with default settings, the switch with the lowest MAC address in the network will become the root switch. By increasing the priority (lowering the priority number) of the best switch, STP can be forced to select the best switch as the root switch.

When STP is enabled using the default parameters, the path between source and destination stations in a switched network might not be ideal. For instance, connecting higher-speed links to a port that has a higher number than the current root port can cause a root-port change.

STP Port States

The BPDUs take some time to pass through a network. This propagation delay can result in topology changes where a port that transitioned directly from a Blocking state to a Forwarding state could create temporary data loops. Ports must wait for new network topology information to propagate throughout the network before starting to forward packets. They must also wait for the packet lifetime to expire for BPDU packets that were forwarded based on the old topology. The forward delay timer is used to allow the network topology to stabilize after a topology change. In addition, STP specifies a series of states a port must transition through to further ensure that a stable network topology is created after a topology change.

Each port on a switch using STP exists in one of the following five states:

- Blocking – the port is blocked from forwarding or receiving packets
- Listening – the port is waiting to receive BPDU packets that may tell the port to go back to the blocking state
- Learning – the port is adding addresses to its forwarding database, but not yet forwarding packets
- Forwarding – the port is forwarding packets
- Disabled – the port only responds to network management messages and must return to the blocking state first

A port transitions from one state to another as follows:

- From initialization (switch boot) to blocking
- From blocking to listening or to disabled

- From listening to learning or to disabled
- From learning to forwarding or to disabled
- From forwarding to disabled
- From disabled to blocking

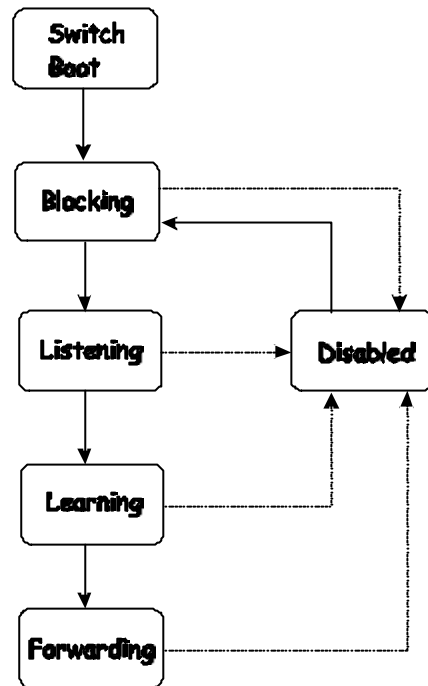


Figure 5-6. STP Port State Transitions

You can modify each port state by using management software. When you enable STP, every port on every switch in the network goes through the blocking state and then transitions through the states of listening and learning at power up. If properly configured, each port stabilizes to the forwarding or blocking state.

No packets (except BPDUs) are forwarded from, or received by, STP enabled ports until the forwarding state is enabled for that port.

Default Spanning-Tree Configuration

Feature	Default Value
Enable state	STP enabled for all ports
Port priority	128
Port cost	19
Bridge Priority	32,768

Table 5-9. Default STP Parameters

User-Changeable STA Parameters

The factory default setting should cover the majority of installations. However, it is advisable to keep the default settings as set at the factory; unless, it is absolutely necessary. The user changeable parameters in the Switch are as follows:

- **Priority** – A Priority for the switch can be set from 0 to 65535. 0 is equal to the highest Priority.
- **Hello Time** – The Hello Time can be from 1 to 10 seconds. This is the interval between two transmissions of BPDU packets sent by the Root Bridge to tell all other Switches that it is indeed the Root Bridge. If you set a Hello Time for your Switch, and it is not the Root Bridge, the set Hello Time will be used if and when your Switch becomes the Root Bridge.

Note: *The Hello Time cannot be longer than the Max. Age. Otherwise, a configuration error will occur.*

- **Max. Age** – The Max. Age can be from 6 to 40 seconds. At the end of the Max. Age, if a BPDU has still not been received from the Root Bridge, your Switch will start sending its own BPDU to all other Switches for permission to become the Root Bridge. If it turns out that your Switch has the lowest Bridge Identifier, it will become the Root Bridge.
- **Forward Delay Timer** – The Forward Delay can be from 4 to 30 seconds. This is the time any port on the Switch spends in the listening state while moving from the blocking state to the forwarding state.

Note: *Observe the following formulas when setting the above parameters:*

Max. Age $2 \times (\text{Forward Delay} - 1 \text{ second})$

Max. Age $2 \times (\text{Hello Time} + 1 \text{ second})$

- **Port Priority** – A Port Priority can be from 0 to 255. The lower the number, the greater the probability the port will be chosen as the Root Port.
- **Port Cost** – A Port Cost can be set from 1 to 65535. The lower the number, the greater the probability the port will be chosen to forward packets.

Illustration of STP

A simple illustration of three switches connected in a loop is depicted in Figure 5-7. In this example, you can anticipate some major network problems if the STP assistance is not applied. If switch A broadcasts a packet to switch B, switch B will broadcast it to switch C, and switch C will broadcast it to back to switch A ... and so on. The broadcast packet will be passed indefinitely in a loop, potentially causing a network failure.

In this example, STP breaks the loop by blocking the connection between switch B and C. The decision to block a particular connection is based on the STP calculation of the most current Bridge and Port settings. Now, if switch A broadcasts a packet to switch C, then switch C will drop the packet at port 2 and the broadcast will end there.

Setting-up STP using values other than the defaults, can be complex. Therefore, you are advised to keep the default factory settings and STP will automatically assign root bridges/ports and block loop connections. Influencing STP to choose a particular switch as the root bridge using the **Priority** setting, or influencing STP to choose a particular port to block using the **Port Priority** and **Port Cost** settings is, however, relatively straight forward.

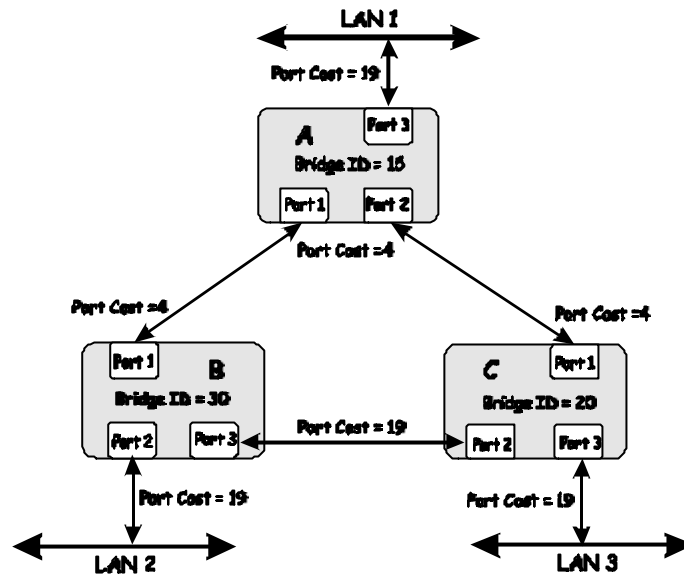


Figure 5-7. Before Applying the STA Rules

In this example, only the default STP values are used.

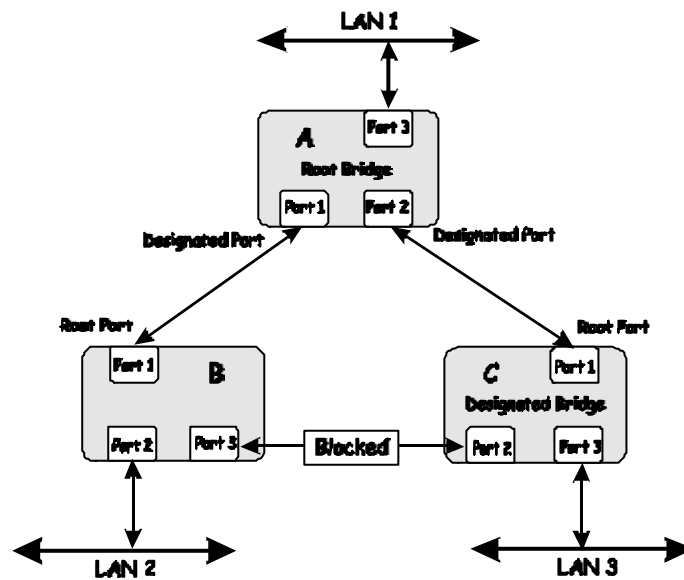


Figure 5-8. After Applying the STA Rules

The switch with the lowest Bridge ID (switch C) was elected the root bridge, and the ports were selected to give a high port cost between switches B and C. The two (optional) Gigabit ports (default port cost = 4) on switch A are connected to one (optional) Gigabit port on both switch B and C. The redundant link between switch B and C is deliberately chosen as a 100 Mbps Fast Ethernet link (default port cost = 19). Gigabit ports could be used, but the port cost should be increased from the default to ensure that the link between switch B and switch C is the blocked link.

Internet Protocols

This is a brief introduction to TCP/IP, or the collection of Internet protocols that are commonly called TCP/IP. It is intended to give the reader some understanding of the terminology and the resources available. It is not intended to be a complete description.

Protocol Layering

The task of connecting users to networks, and then networks to networks, is made somewhat easier by dividing up the overall job into simpler, but related, tasks. Each task is structured to be resilient to failures in the connecting hardware, software, data loss, data corruption, and data received out of order. Taken together, these tasks are referred to as a protocol suite.

Each task, or protocol, must communicate with other protocols. To manage this communication, the concept of layering was introduced as a way of structuring the overall network. The idea of protocol layering is to start with the most basic layer, the physical (or hardware) layer, and to define data formats and functions for that layer. The physical layer passes data to next higher layer, the data link layer, and so on until one user is connected to another.

Protocol layering then provides clearly defined breaks in the process of communicating over a network. Each break in the process has a clearly defined data format so that the layer below can perform its task in any way that is suitable, so long as the data it generates is in the format expected by the next layer. The advantage of this approach is that the exact method and tools (or software and hardware) used to accomplish the task at each layer is not critically important. Hardware and software designers are free to improve the performance or to reduce the cost of accomplishing the task of each protocol layer, so long as the data format between layers conforms to the defined formats (and of course, the layer's task is accomplished).

The protocol layer concept currently used by the Internet, the OSI seven-layer model, was developed from earlier, simpler layered models. Much of the current layer model owes its origin to the Xerox Network Systems (XNS) model.

The OSI (Open Systems Interconnection) model actually refers to a system of protocols proposed by ISO (the International Standards Organization) that are themselves not widely used or supported. The layered model itself is, however, taken as the framework for nearly all modern networking.

A diagram of the OSI model is shown below (note that this is not a complete listing of the protocols contained within each layer of the model):

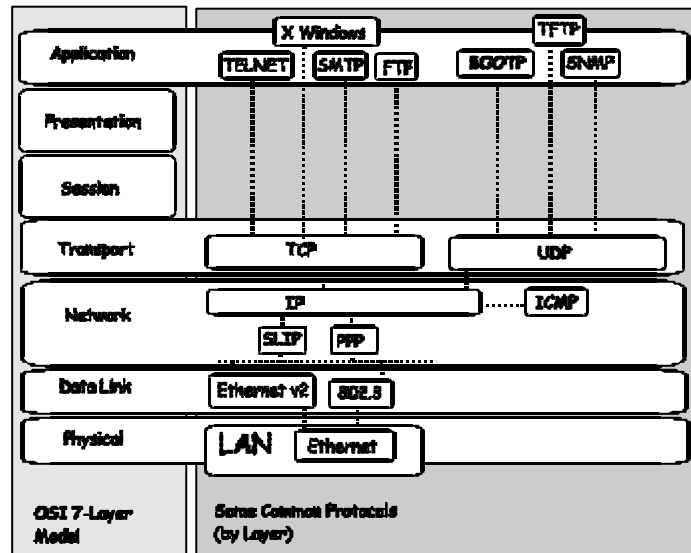


Figure 5-8. OSI Seven Layer Network Model

Each layer has a distinct set of tasks to accomplish and clearly defined formats in which to receive and forward data and messages. A distinct set of programs, executing a distinct set of protocols, is required to accomplish the task set by each layer.

Although the layers are separated from other layers in the model, they must all communicate and interoperate. For this to work, there must be very well-defined and well-known methods for transferring messages and data. Within a device connected to a network, this inter-layer communication is managed by the device's protocol stack.

Using the protocol layering model to visualize the organization of the network software, Layer 2 represents switching and Layer 3 represents routing. In fact, the protocol layering model gives only guidelines for writing programs to accomplish certain tasks and functions. How the layers communicate within a protocol stack (for example, within a network device or a computer) is determined by the operating system programmers. So long as the communication between devices on the network follows the well-defined and well-known methods and data formats, the protocol stack can accomplish its tasks in any way suitable.

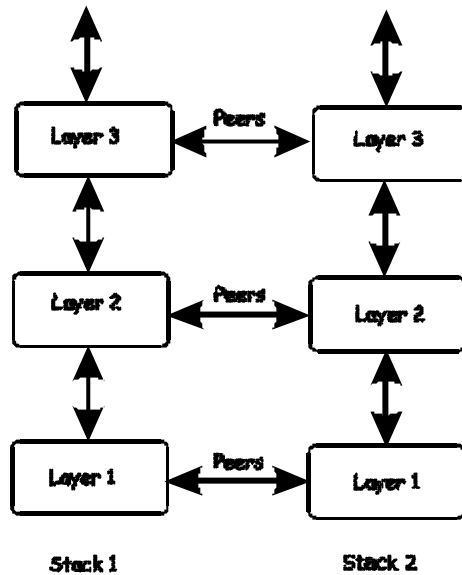


Figure 5-9. The Protocol Stack

Elements on the same layer of a protocol stack are known as peers. They communicate with other peers, in other protocol stacks (on other network devices) using the well-defined and well-known methods and formats. Messages and data are transferred via published (and therefore well-known) protocols.

Elements within the same stack communicate using an internal interface. This interface is part of the operating system and is usually not published (and therefore not well-known). In addition, internal protocol stack interfaces are generally proprietary. This means that communication within the protocol stack has the same characteristics as a protocol in that two protocol stacks from the same operating system vendor will communicate (within the stack) in the same way. The difference from a protocol is that stacks from different operating system vendors (or two different operating system products from the same vendor) may communicate within the stack in completely different ways.

The result is that communication between layers in within a protocol stack (and within a given network device) are often proprietary and different from communication within a second protocol stack.

Communication between peers (between two protocol stacks, but at the same layer) is accomplished by well-known and published protocols. So, peers communicate in an open and consistent way, and peers from completely different systems from different vendors can communicate easily. This principle has allowed the rapid growth of layered networking.

A brief description of the most commonly used layers of the OSI model is helpful to understand the scope of how protocol layering works.

Layer 1

Layer 2

This is commonly called the switching layer. It allows for the addressing of end stations and for the interconnection of end stations. This allows a practical way to construct simple but high-performance networks connecting thousands of end stations.

Switching forwards packets based on the unique Media Access Control (MAC) address of each end station. Switches records the MAC address and the port number of end stations and enter the information into a lookup table. In this way, a switch 'learns' the location of end stations and other switches attached to its ports.

Switching is usually limited to the Local Area Network (LAN) and requires a routing function to connect to the Internet or to a Wide Area Network (WAN).

Layer 3

This is commonly called the routing layer. The backbone of the Internet, along with the backbones of the networks of many large organizations, is built on a layer 3 foundation. The Internet Protocol (IP) is the most important layer 3 protocol. In addition to layer 2 MAC addresses, each IP packet contains source and destination IP addresses.

IP itself is not a very complex protocol. The IP suite of protocols do, however, provide an extensive range of functions. Some examples are: the Dynamic Host Configuration Protocol (DHCP) which can assign IP configurations to network devices, the Domain Name System (DNS) which manages the association of IP addresses with text names, the Routing Information Protocol (RIP) which enables layer 3 network devices to direct data to destinations in other networks. IP also allows for transmitting packets from a single point to multiple destinations (known as IP multicasting).

Layer 4

This is commonly called the transport layer. It is responsible for the communication path between user applications and the network. The Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP) are the most well-known layer 4 protocols. TCP is a 'connection-oriented' protocol. It requires a connection to be established before data is exchanged. UDP is a 'connection-less' protocol. It requires on connection to be setup before it transmits data.

Because UDP does not have the overhead of establishing a connection before transmitting data, it is frequently used for multicast transmissions.

TCP and UDP also have very different error recovery mechanisms. Both TCP and UDP are layered on top of IP, but IP has very limited error recovery or detection. TCP keeps track of the transmitted data and retransmits lost or corrupted data. UDP relies upon the application (at a higher layer) to keep track of transmitted data.

Layer 7

This commonly called the application layer. It provides access to application software running either on a computer or other network device. Application software usually does not communicate directly with the transport layer, but uses other software from a communication library, such as the WinSock library.

The application software designers must decide on the type of transport protocol that is most suitable for their task. Databases, for example, require error-free transmission, so TCP would be the best choice. Multimedia is much less sensitive to errors, so the low overhead of UDP becomes the best choice.

TCP/IP

Transmission Control Protocol/Internet Protocol (TCP/IP) is the official name of a suite of protocols designed to allow computers to communicate and share resources across a network. TCP and IP are only the two best known protocols of the suite, but TCP/IP is used to refer to the entire suite.

TCP/IP is itself a layered set of protocols. For two computers to communicate across a network, there is first a protocol that defines a set of commands used by the two computers to identify the sender, the recipient, and the content of the message. The application then relies on TCP/IP to actually transmit and receive the packets that make up the message.

TCP keeps track of what was sent and received, and retransmits any lost or corrupted packets. If the message is too large for a single packet, TCP divides the message into as many packets as are necessary. TCP also makes sure these packets are receive and reassembled in the correct order.

IP routes the packets generated by TCP from their source to their destinations. This may require the packets to cross other networks. IP can route packets through networks connected with gateways so that a user on one network can communicate with any user on any connected network.

IP is not aware of the relationship between individual packets, or the contents of the packet – except for the source and destination IP addresses. This is called demultiplexing.

The information required by IP is contained in a series of headers which are added to or removed from the packet as it travels from network to network. A header is a few octets of data added to the beginning of a packet to keep track of it. As more data is required for the packet to cross a network, a new header is added. When the data is no longer required, the header is removed and the data in the previous header is used to forward the packet. This process is called encapsulation.

To send a packet over the internet, many levels of encapsulation may be used, and IP does all of this transparently to the user.

TCP and UDP Well-Known Ports

Network devices and computers connected to a network can have multiple connections with other devices and computers simultaneously. Received packets must be directed to the appropriate application at the receiving end. TCP and UDP use IP addresses to keep track of which devices are part of the connection, and port numbers to keep track of which applications within each device are communicating.

To retrieve a file from a server using the File Transfer Protocol (FTP), a connection from the user, at 10.0.0.1 (for example) to an FTP Server, at 10.0.0.2 (for example). TCP then opens a connection on the user's computer using some random port number, 1234. The connection on the FTP server is opened using the well-known port number 21 for the FTP application. So, FTP is running on 10.0.0.1 port number 1234, and FTP Server is running on 10.0.0.1 port number 21 (the well-known port for FTP). There is a published list of well-known ports (sometimes called sockets) for many applications.

There is no need for a well-known port to be chosen for 10.0.0.1. It is only necessary for TCP to know which port has been chosen. The FTP Server, on the other hand, must have a well-known port number so that connections can be made, commands sent, and messages exchanged.

Note that the connection is actually described by a set of four numbers, the IP address and the TCP port number for the local end and the IP address and the TCP port number for the remote end. The Internet address is in the IP header and the TCP port number is in the TCP header.

No two connections can have the same set of numbers, but only one number of the four must be different. This allows two different users to send files to the same destination, at the same time.

Two FTP Server Connections	TCP ports	Internet addresses
-------------------------------	--------------	--------------------

Connection 1	1234, 21	10.42.73.23	210.128.12.1
Connection 2	1235, 21	10.42.73.23	210.128.12.1

So the local computer, 10.42.73.23 has two connections to the FTP Server, 210.128.12.1. Commands sent from 10.42.73.23 are received by the FTP Server on the well-known TCP port number 21, but the transmitted files are received by 10.42.73.23 on either TCP port number 1234 or 1235, depending on which port issued the command.

FTP actually uses two different connections. One for sending commands and a second one opened when a request to send data is issued. This is done to allow the user to continue sending commands (such as, abort the file transfer).

Connections with a remote terminal use a single connection. When a command is to be sent, a special character is sent that indicates the next character is part of a command.

UDP and ICMP

TCP will divide large messages into several packets and manage the sending and receiving of all of these packets.

Many applications do not require messages that must be divided into many smaller packets.

The User Datagram Protocol (UDP) is designed for applications that do not need sequences of packets to be put together. UDP also does not keep track of what is sent and cannot resend data. UDP does use port numbers in much the same way as TCP. UDP allows several programs to make connections to a server at the same time. UDP port numbers are used just like TCP port numbers and there are well-known port numbers for servers that use UDP.

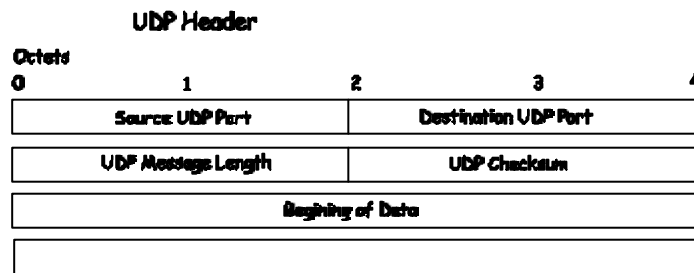


Figure 5-10. UDP Packet Header

Note that a UDP header is shorter than a TCP header, but it still has source and destination port numbers, and a checksum.

The Internet Control Message Protocol (ICMP) is alternative protocol. It is used for messages intended for the TCP/IP software itself, such as error messages, rather than by any particular user program. ICMP can also be used for find information about the network. There are no port numbers since ICMP messages are processed by the network software itself.

Packet Headers

TCP

TCP takes messages and data that are too long to fit into a single packet and divides the transmission up among a series of packets, transmits them, and reassembles them in the correct order when they are received.

To do this, TCP needs to know how large a packet the network can handle. The TCPs at either end of a connection tell each other how large a packet they can process. The smaller of the two sizes is selected.

The TCP header is added to the beginning of each packet. This header contains at least 20 octets including the source and destination TCP port numbers.

Each packet is given a sequence number that is used to ensure that the packets are received in the correct order. The packets themselves are not numbered, instead, the octets the packet contains is numbered. So if there are 100 octets of data in each packet, the first packet would be numbered 0, the second 100, the third 200, and so on.

A checksum is calculated by adding up all the octets in the packet and the result is put in the header. The receiving TCP calculates its own checksum and if the two checksums differ, the packet is dropped.

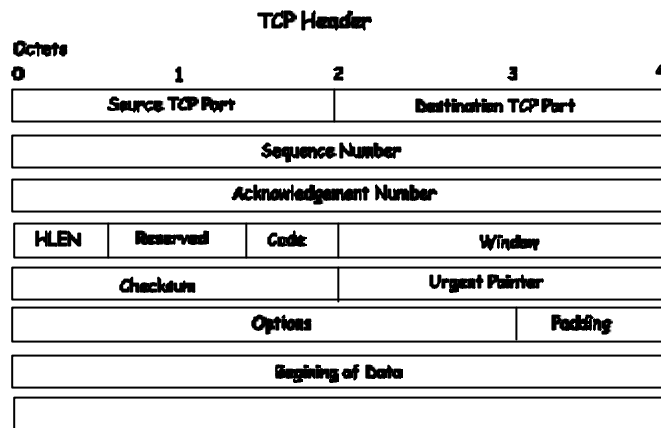


Figure 5-11. TCP Packet Header

An acknowledgement is sent to indicate that the packets have been received. This is simply a packet with its acknowledgement number field filled in. The acknowledgement number is the number of octets of data received at the time the acknowledgement packet is sent.

If the sender does not receive an acknowledgement within a reasonable amount of time, the data is resent.

The window field controls the amount of data in transit at any one time. Each end of a connection indicates how much data it is currently able to receive by putting that number of octets in the window field.

As the computer receives data, the number in the window field is decremented and when it reaches zero, the sender must stop transmitting. As the recipient processes data, it increases its window, indicating that it is ready to receive more data.

IP

TCP sends packets to IP, along with source and destination IP addresses. IP is not concerned with the contents of the packets or with the TCP header.

IP routes the packet from the source to the destination. IP adds its own header to the packet to allow intermediate gateways or other network devices to forward the packet.

The header contains the source and destination IP addresses, a protocol number, and a checksum.

The protocol number allows IP to pass the packet to the appropriate protocol (usually TCP) at the receiving end.

The checksum is calculated in same way as the TCP checksum and allows IP to verify that the data was not corrupted in transit.

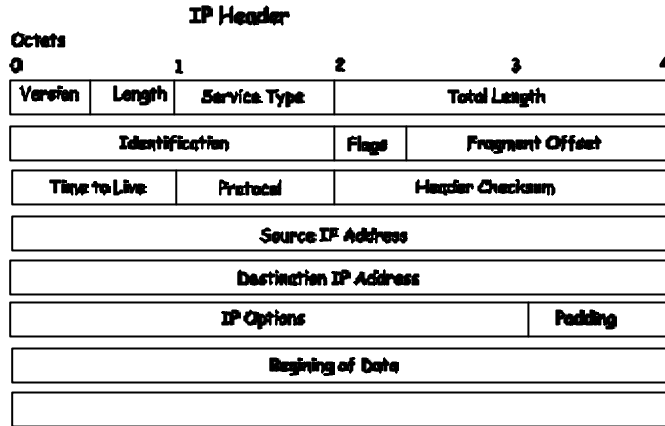


Figure 5-12. IP Packet Header

Flags and Fragment Offset are used when a packet must be divided into smaller pieces by a network device. This is sometimes necessary for a packet to cross a network that can not process large packet sizes.

Time-to-Live (TTL) is the maximum number of gateways a packet can pass through. This number is decremented each time a packet is forwarded through a gateway. When the TTL reaches zero, the packet is dropped.

Ethernet

Ethernet uses its own headers and addresses. Each Ethernet device or NIC card has a 48 bit Media Access Control (MAC) address assigned to it by the manufacturer.

An Ethernet header is a 14 octets and includes the source and destination MAC addresses and a type code.

For a computer or network device to have an IP address, a database must exist somewhere on the network to keep track of which MAC address corresponds to which IP address.

The type code is used to specify one of several protocol families that may be in use on the network.

A checksum is calculated and put at the end of the packet. A receiving device recalculates the checksum and if the two numbers are different, the packet is dropped.

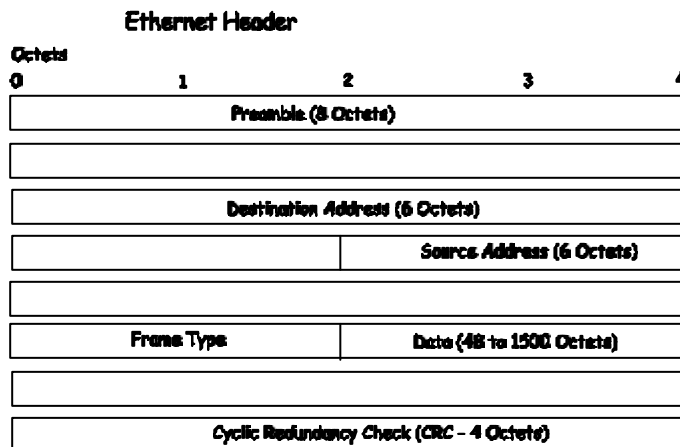


Figure 5-13. Ethernet Packet Header

When the packet is received, these headers are removed. The Ethernet NIC removes the Ethernet header and checks the checksum. It looks at the type code. Since the type code is assigned to IP, the Ethernet device driver passes the packet to IP.

IP removes the IP header. It looks at the IP protocol field. Since the protocol type is TCP, it passes the packet to TCP. TCP now looks at the sequence number and uses it to recombine the packets in the correct order.

The Domain Name System

Most network software uses a 32 bit IP address to identify network devices and computers on the network. User's generally prefer to use text names for network nodes. So, a database is established that contains the text names and the corresponding IP addresses. The network software can then use the text name to look up an IP address. This database is located in a Domain Name System (DNS) server.

DNS is used to associate IP addresses to text names throughout the Internet. The same method has been adapted for use within intranets.

Resolving Domain Names

To resolve a domain name, a query is sent to a DNS server. This server then checks if the name is in its database. If it is, the DNS server translates the text name into an IP address and sends the answer back by appending the answer to the original query. If the DNS server can not resolve the name, it checks to see what type of resolution is specified in the query. The query can specify a complete translation (recursive resolution). In this case, the DNS server contacts another DNS server and forwards the query. If the query specifies iterative resolution, the DNS server replies that it cannot resolve the name and specifies the DNS server that should be contacted next to resolve the name.

Each client must be able to contact at least one DNS server, and each DNS server must be able to contact at least one root DNS server.

The IP address of a local DNS server is often supplied by a DHCP or BOOTP server.

DHCP Servers

The Dynamic Host Configuration Protocol (DHCP) is used to dynamically assign a TCP/IP network configuration to network devices and computers on the network. It also ensures that IP address conflicts do not occur.

IP addresses are assigned from a pool of free addresses. Each IP address assigned has a 'lease' and a 'lease expiration period'. The lease must be periodically renewed. If the lease expires, the IP address is returned to the pool of available IP addresses.

Usually, it is a network policy to assign the same IP address to a given network device or computer each time.

If the IP address lease expires, the network device sends a message to the DHCP server requesting a lease renewal. The DHCP server can send an acknowledgement containing a new lease and updated configuration information.

If an IP address lease cannot be renewed, the network device or computer sends a request to all local DHCP servers attempting to renew the lease. If the DHCP returns a negative acknowledgement, the network device must release its TCP/IP configuration and reinitialize.

When a new TCP/IP configuration is received from a DHCP server, the network device checks for a possible IP address conflict by sending an Address Resolution Protocol (ARP) request that contains its new IP address.

Routing

The task of determining how a packet should get from a source to a destination is referred to as routing.

IP assumes that the networks a packet would be sent across are connected by gateways (also called routers).

The software in a traditional router (or the hardware in a layer 3 switch) is designed to forward packets from one network to another.

Routing is based upon the Network Address of the destination IP address. Each network device or computer has at least one gateway address (the default gateway) and this is generally the best way to send packets out of the local network and into the WAN or the Internet.

The network device or computer does not have to know the gateway address of the gateway to the destination network, only the local gateway out of the local network. When there is no specific gateway address to send the packet to, it is sent to the default gateway.

The gateway itself must know a lot more about which routes are available and where they go. To do this, a gateway develops a routing table using a routing protocol that is designed to help gateways find each other and exchange information about their local routes to other gateways.

ARP

The Address Resolution Protocol (ARP) is used to determine the association of IP addresses and MAC addresses for network devices and computers.

When a packet is to be transmitted, the destination's IP address is first resolved into a MAC address. Network devices and computers (that operate on layer 3) maintain a local ARP cache. This is a local database of IP addresses and corresponding MAC addresses. If the destination IP address has an entry in the local ARP cache, the MAC address is written to the packet's destination field and the packet is sent.

If the destination IP address does not have an entry in the local ARP cache, an ARP request must be sent to resolve the IP address into a MAC address. The packet must wait for a response from the destination before being sent.

ARP requests that are received from the network have their IP and MAC address pair extracted. The local ARP cache is then checked to see if there is already an entry for this pair. If an entry does not exist, the pair are added to the local ARP cache. If the entry already exists, the ARP request is dropped.

If an ARP request is received and the receiving network device has the IP address the ARP request is trying to resolve, the receiving device replies by giving its MAC address.

Multicasting

Multicasting allows a single network device to transmit packets to multiple destinations. These connections typically are used over a considerable period of time. End nodes that are receiving the multicast transmissions are referred to as a multicast group. Multicast group members can reside on different subnets and even on different networks.

Multicast Addressing

A multicast group is given an IP address where the first four bits of the address are set to '1110'. This is a Class D IP address. The 28 bit number following the '1110' are referred to as the multicast group ID.

Some Class D addresses are reserved for special purposes. Addresses from 224.0.0.1 to 224.0.0.255 is reserved for use by routing protocols and some low-level protocols. Addresses from 239.0.0.0 to 239.255.255.255 are used by administrative applications for local networks.

The Class D IP address format is shown below:



Figure 5-14. Class D Multicast Address

Some of the assigned IP multicast addresses:

Address	Assignment
224.0.0.0	Base Address (reserved)
224.0.0.1	All Systems on this subnet
224.0.0.2	All Routers on this subnet
224.0.0.3	Unassigned
224.0.0.4	DVMRP Routers
224.0.0.5	OSPF IGP Routers
224.0.0.6	OSPF IGP Designated Routers
224.0.0.7	ST Routers
224.0.0.8	ST Hosts
224.0.0.9	All RIP2 Routers
224.0.0.10	All IGRP Routers
224.0.0.11	Mobile Agents
224.0.0.12	DHCP Servers and Relay Agents
224.0.0.13	All PIM Routers
224.0.0.14	RSVP Encapsulation
224.0.0.15	All CBT Routers
224.0.0.16	Designated Sbm
224.0.0.17	All Sbms
224.0.0.18	VRRP
224.0.0.19 through	Unassigned
224.0.0.225	
224.0.0.21	DVMRP on MOSPF

Table 5-10. Some Permanent Multicast Address Assignments

Internet Group Management Protocol (IGMP)

Computers and network devices that want to receive multicast transmissions need to inform nearby routers that they will become members of a multicast group. The Internet Group Management Protocol (IGMP) is used to communicate this information. IGMP is also used to periodically check the multicast group for members that are no longer active.

In the case where there is more than one multicast router on a subnetwork, one router is elected as the 'querier'. This router then keeps track of the membership of the multicast groups that have active members. The information received from IGMP is then used to determine if multicast packets should be forwarded to a given subnetwork or not. The router can check, using IGMP, to see if there is at least one member of a multicast group on a given subnetwork. If there are no members on a subnetwork, packets will not be forwarded to that subnetwork.

IGMP Versions 1 and 2

Multicast groups allow members to join or leave at any time. IGMP provides the method for members and multicast routers to communicate when joining or leaving a multicast group.

IGMP version 1 is defined in RFC 1112. It has a fixed packet size and no optional data.

The format of an IGMP packet is shown below:

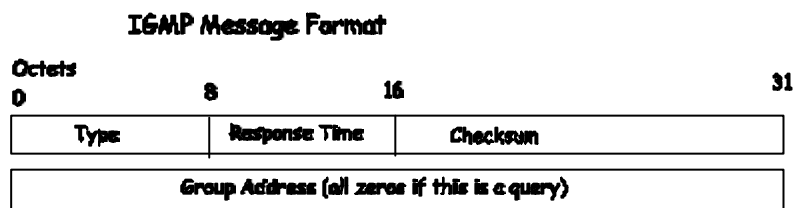


Figure 5-15. IGMP Message Format

The IGMP Type codes are shown below:

Type	Meaning
0x11	Membership Query (if Group Address is 0.0.0.0)
0x11	Specific Group Membership Query (if Group Address is Present)
0x16	Membership Report (version 2)
0x17	Leave a Group (version 2)
0x12	Membership Report (version 1)

Table 5-11. IGMP Type Codes

IGMP packets enable multicast routers to keep track of the membership of multicast groups, on their respective subnetworks. The following outlines what is communicated between a multicast router and a multicast group member using IGMP.

- A host sends an IGMP "report" to join a group
- A host will never send a report when it wants to leave a group (for version 1).
- A host will send a "leave" report when it wants to leave a group (for version 2).
- Multicast routers send IGMP queries (to the all-hosts group address: 224.0.0.1) periodically to see whether any group members exist on their subnetworks. If there is no response from a particular group, the router assumes that there are no group members on the network.

The Time-to-Live (TTL) field of query messages is set to 1 so that the queries will not be forwarded to other subnetworks.

IGMP version 2 introduces some enhancements such as a method to elect a multicast querier for each LAN, an explicit leave message, and query messages that are specific to a given group.

The states a computer will go through to join or to leave a multicast group are shown below:

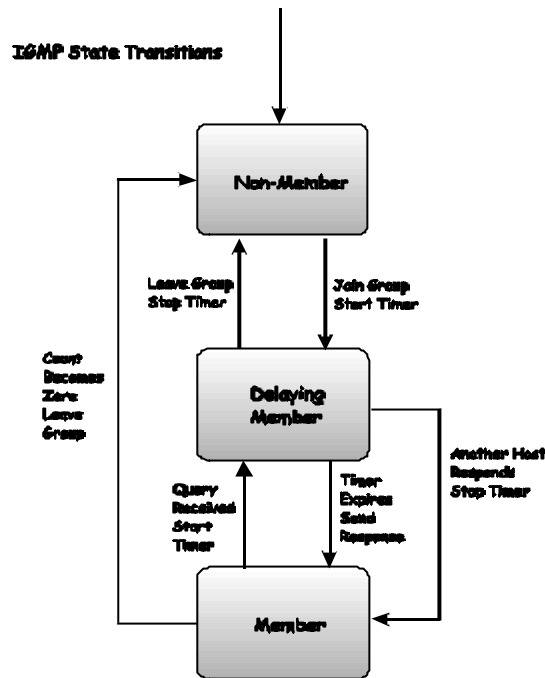


Figure 5-16. IGMP State Transitions

Multicast Routing Algorithms

Multicast routing is based on a tree concept where the multicast source is the trunk and the multicast group members are the leaves. Branches can be thought of as subnetworks. There are several algorithms that can be used to construct the multicast tree and then to prune it branches for the efficient delivery of multicast transmissions.

Flooding

Flooding is the simplest way to deliver multicast packets. When a multicast packet is received by a router, it checks to see if it has received this packet before. If it has not, the packet is forwarded to all ports except the one the packet was received on. Otherwise, the router drops the packet. This way, all routers on a network will receive at least one copy of the packet.

Flooding generates a large number of duplicated packets and wastes network bandwidth. It also requires multicast routers to keep an entry in their table of recently received multicast packets, wasting some of the router's memory.

Multicast Spanning Trees

Spanning Trees are constructed from a subset of links between routers and a number of these links are selectively blocked such that there is only one active link between any two routers. The blocked links then act to provide some redundant links that may become active in the future, if the currently active link fails.

When a router receives a multicast packet, it floods the packet to all ports belonging to the spanning tree, except the one it was received on. This guarantees the packet will reach all routers on the network.

The spanning tree does not consider group membership in forwarding decisions.

Reverse Path Broadcasting (RPB)

The RPB algorithm is a modification of the spanning tree algorithm. Instead of building a network-wide spanning tree, a virtual spanning tree is constructed for each multicast source.

When a router receives a multicast packet from a source, the router will check to see if the link on which the packet was received is the shortest path to the source. If it is, the packet is forwarded to all ports except the one on which it was received. If it is not, the packet is dropped.

If a link-state routing protocol is in use (such as OSPF), the router can determine if it is on the shortest path between itself and a neighboring router. If it is not, then the packet would be discarded at the next router. A link-state routing protocol would provide this information, so the first router could discard the packet.

If a distance-vector routing protocol (such as RIP) is being used, the neighboring router can advertise its previous hop for the source as part of its routing table update messages or it can 'poison-reverse' the route.

RPB does not use multicast membership information in the construction of multicast distribution trees.

Truncated Reverse Path Broadcasting (TRPB)

The TRPB algorithm is a modification of the RPB algorithm. It uses IGMP to determine if members of a multicast group are present on the router's subnetwork. If the subnetwork has no multicast members and it is a leaf router (the only router on the subnetwork), TRPB will truncate the distribution tree. If the router is not a leaf router, the tree is not changed.

TRPB does use multicast group membership information in the construction of distribution trees.

Reverse Path Multicasting (RPM)

The RPM algorithm is an enhancement of the RPB and TRPB algorithms. RPM constructs delivery trees that span only subnetworks with group members or subnetworks along the shortest path to routers attached to subnetworks that have group members.

The RPM tree is then 'pruned' so that multicast packets are forwarded only along paths that lead to group members.

The first multicast packet received by the router is forwarded according to the RPB algorithm. Leaf routers that receive a multicast packet for which they have no group members will send a 'prune' message back to the router from which the message was received.

Prune messages indicate that multicast packets for a given membership group should not be forwarded on the link as there are no group members. Prune messages have a TTL of one, so they are only sent back one hop from the router that sends them.

The router one hop closer to the multicast source records the prune information in its memory. If the closer router has no group members on its subnetwork, it will send its own prune message to the next router on the path back to the multicast source, and so on. This is continued until multicast packets from a given source are only forwarded on paths that lead to multicast group members for that source.

The group membership and the topology of the network and the multicast distribution trees can change dynamically. To accommodate this, the RPM algorithm periodically removes all the prune information from the router's memory. The next multicast packet received by the router gives new multicast group members on its subnet a chance to join the multicast group and leaf routers with new members on their subnetworks also get a chance to join.

RPM requires a relatively large amount of router memory space to maintain all the information for the multicast source and group members.

Multicast Routing Protocols

This section gives a brief review of two multicast routing protocols – the Distance Vector Multicast Routing Protocol (DVMRP) and the Protocol Independent Multicast – Dense Mode (PIM-DM).

Distance Vector Multicast Routing Protocol (DVMRP)

DVMRP was derived from the Routing Information Protocol (RIP). The main difference is the RIP forwards unicast packets based on information about the next-hop (next router) on the path to its destination, but DVMRP constructs delivery trees based on previous-hop (last router) toward the multicast source.

DVMRP uses the RPM algorithm. The first multicast packet receive from a given source is flooded to all ports (except the one on which it was received). Prune messages are then used to identify links which do not have group members. These links are then pruned from the delivery tree.

A new message is added that allows a previously pruned link to be grafted back onto the multicast delivery tree, to accommodate new group members. Graft messages are forwarded only one hop back toward the multicast source.

If there is more than one router on a given subnetwork, the router closest to the multicast source is elected to forward that source's multicast messages. All other routers will drop multicast messages from this source.

DVMRP supports tunnel interfaces (that is, interfaces connecting two multicast routers through one or more multicast-unaware routers). Each tunnel interface must be configured with the IP address of the local router's tunnel interface and the IP address of the remote router's tunnel interface.

Protocol-Independent Multicast – Dense Mode

The Protocol-Independent Multicast – Dense Mode (PIM-DM) routing protocol also uses the RPM algorithm for constructing distribution trees, but PIM-DM requires the presence of a unicast routing protocol for finding routes back to the multicast source.

PIM-DM is, however, independent of the mechanisms used by the unicast routing protocol. It floods multicast messages until it receives prune messages and also uses graft messages similar to DVMRP.

Routing Protocols

Routing Information Protocol (RIP)

The RIP protocol is a straightforward implementation of distance-vector routing. It partitions participants into active and passive. Active participants advertise their routes to others; passive participants listen to RIP messages and use them to update their routing table, but do not advertise. Only a router can run RIP in active mode; a host must use passive mode.

A router running RIP in active mode broadcasts a routing update message every 30 seconds. The update contains a set of pairs, where each pair contains an IP network address and an integer distance to that network. RIP uses a hop count metric to measure distances. The update contains information taken from the router's current routing database. Each update contains a set of pairs, where each pair contains an IP network address and an integer distance to that network. RIP uses a hop count metric to measure distances. In the RIP metric, a router is defined to be one hop from a directly connected network, two hops from a network that is reachable through one other router, and so on. Thus, the number of hops, or hop count, along a path from a given source to a given destination refers to the number of routers that a datagram encounters along a path.

Both active and passive RIP participants listen to all broadcast messages, and update their tables according to the distance-vector algorithm described earlier.

RIP specifies a few rules to improve performance and reliability. Once a router learns a route from another router, it must apply hysteresis, meaning that it does not replace the route with an equal cost route. In other words, to prevent oscillation among equal cost paths, RIP specifies that existing routes should be retained until a new route has a strictly lower cost.

RIP specifies that all listeners must timeout routes they learn via RIP. When a router installs a route in its table, it starts a timer for that route. The timer must be restarted whenever the router receives another RIP message advertising the route. The route becomes invalid if 180 seconds pass without the route being advertised again.

There are three potential errors that can arise using the RIP algorithm. First, because the algorithm does not explicitly detect routing loops, RIP must either assume participants can be trusted or take precautions to prevent such loops. Second, to prevent instabilities RIP must use a low value for the maximum possible distance (RIP uses 16). Thus, for internets in which legitimate hop counts approach 16, managers must divide the internet into sections or use an alternative protocol. Third, the distance-vector algorithm used by RIP can create a slow convergence or count to infinity problem, in which inconsistencies arise because routing update messages propagate slowly across the network.

Routing table inconsistency is a fundamental problem that occurs with any distance-vector protocol in which update messages carry only pairs of destination network and distance to that network.

The slow convergence problem is solved using a technique known as split horizon update. When using split horizon, a router does not propagate information about a route back over the same interface from which the route arrived. With split horizon, no routing loop appears. Instead, after a few rounds of routing updates, all routers will agree that the network is unreachable. However, the split horizon heuristic does not prevent routing loops in all possible topologies as one of the exercises suggests.

Another way to think of the slow convergence problem is in terms of information flow. If a router advertises a short route to some network, all receiving routers respond quickly to install that route. If a router stops advertising a route, the protocol must depend on a timeout mechanism before it considers the route unreachable. Once the time out occurs, the router finds an alternative route and starts propagating that information. Unfortunately, a router cannot know if the alternate route depended on the route that just disappeared. Thus, negative information does not always propagate quickly.

Another technique used to solve the slow convergence problem employs hold down. Hold down forces a participating router to ignore information about a network for a fixed period of time following the receipt of a message that claims a network is unreachable. Typically, the hold down period is set to 60 seconds. The idea is to wait long enough to ensure that all machines receive the message that a network is unreachable and that the message is not out of date. It should be noted that all machines participating in a RIP exchange need to use identical hold down period, or routing loops can occur. The disadvantage of a hold down technique is that if routing loops occur, they will be preserved for the duration of the hold down period. More important, incorrect routes will be preserved for the hold down period, even when alternatives exist.

A final technique for solving the slow convergence problem is called poison reverse. Once a connection disappears, the router advertising the connection retains the entry for several update periods, and includes an infinite cost (hop count of 16) in its broadcasts. To make poison reverse most effective, it must be combined with triggered updates. Triggered updates force a router to send an immediate broadcast when receiving a message that a network is unreachable, instead of waiting for the next periodic broadcast. By sending an update immediately, a router minimizes the time it is vulnerable to believing inaccurate routes.

Unfortunately, while triggered updates, poison reverse, hold down, and split horizon techniques all solve some problems, they introduce others. For example, consider what happens with triggered updates when many routers share a common network. A single broadcast may change all their routing tables, triggering a new round of broadcasts. If the second round of broadcasts changes tables, it will trigger even more broadcasts. A broadcast storm can result.

The use of broadcast, potential for routing loops, and the use of hold down to prevent slow convergence can make RIP extremely inefficient in a wide area network. Broadcasting always takes substantial bandwidth. Having all machines broadcast periodically means that the traffic increases as the number of routers increases. The potential for routing loops can also be deadly when line capacity is limited. Once lines become saturated by looping packets, it may be difficult or impossible for routers to exchange the routing messages needed to break the loops. Also, in a wide area network, hold down periods are so long that the timers used by higher level protocols can expire and lead to broken connections. Despite these well-known problems, many groups continue to use RIP and an IGP in wide area networks.

RIP Version 1 Message Format

RIP messages can be classified into two types: routing information messages and messages used to request information. Both use the same format which consist of a fixed header followed by an optional list of network and distance pairs. The message format used by version 1 is shown below.

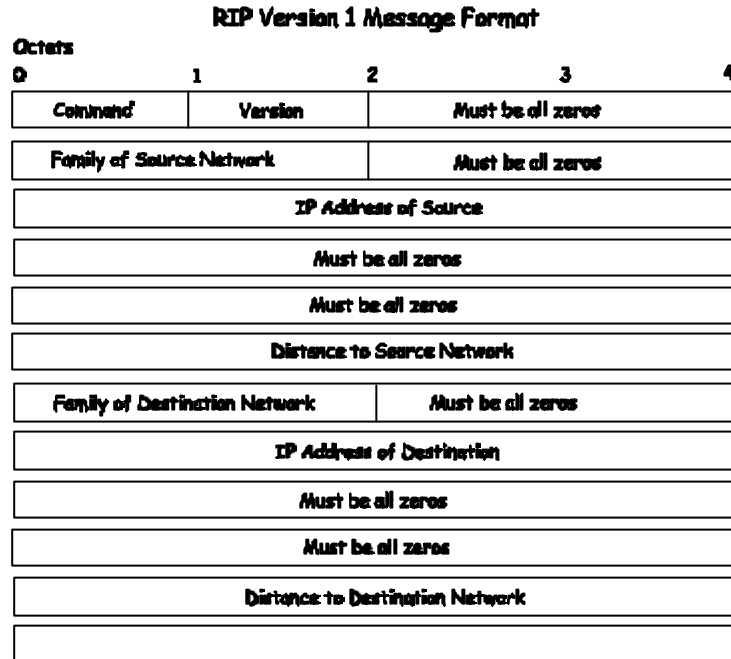


Figure 5-17. RIP v.1 Message Format

The COMMAND field specifies an operation according the following table:

Command	Meaning
1	Request for partial or full routing information
2	Response containing network-distance pairs from sender's routing table
3	Turn on trace mode (obsolete)
4	Turn off trace mode (obsolete)
5	Reserved for Sun Microsystem's internal use
9	Update Request

10	Update Response
11	Update Acknowledgement

Table 5-12. RIP Command Codes

A router or host can ask another router for routing information by sending a request command. Routers reply to requests using the response command. In most cases, however, routers broadcast unsolicited response messages periodically. The field VERSION contains the protocol version number (1 in this case), and is used by the receiver to verify it will interpret the message correctly.

RIP 1 Address Conventions

The generality of RIP is also evident in the way it transmits network addresses. The address format is not limited to use by TCP/IP. It can be used with multiple network protocol suites. Each network address reported by RIP can have an address of up to 14 octets. Of course, IP addresses need only 4. RIP specifies that the remaining octets must be zero. The field labeled FAMILY OF NET 1 identifies the protocol family under which the network address should be interpreted. RIP uses values assigned to address families under the 4BSD UNIX operating system (IP addresses are assigned a value of 2).

In addition to normal IP addresses, RIP uses the convention that address 0.0.0.0 denotes a default route. RIP attaches a distance metric to every route it advertises, including default routes. Thus, it is possible to arrange for two routers to advertise a default route (for example, a route to the Internet) at different metrics, making one of them a primary path and the other a backup.

The final field of each entry in a RIP message, DISTANCE TO NET 2, contains an integer count of the distance to the specified network. Distances are measured in router hops, but values are limited to the range 1 through 16, with the distance 16 used to signify infinity (unreachable).

RIP 1 Route Interpretation and Aggregation

Because RIP was originally designed to be used with classful addresses, version 1 did not include any provision for a subnet mask. When subnet addressing was added to IP, version 1 of RIP was extended to permit routers to exchange subnetted addresses. However, because RIP 1 update messages do not contain explicit mask information, an important restriction was added – a router can include host-specific or subnet-specific address in routing updates as long as all receivers can unambiguously interpret the addresses. In particular, subnet routes can be included in updates sent across a network that is part of the subnetted prefix, and only if the subnet mask used with the network is the same as the subnet mask used with the address. The restriction means the RIP 1 cannot be used to propagate variable-length subnet addresses or classless addresses.

Note: *RIP 1 can only be used with classful or fixed-length subnet addresses.*

If a router running RIP 1 connects to one or more networks that are subnets of a prefix N as well as to one or more networks that are not part of N, the router must prepare different update messages for the two types of interfaces. Updates sent over the interfaces that are subnets of N can include subnet routes, but updates sent over other interfaces cannot. Instead, when sending over other interfaces the router is required to aggregate the subnet information and advertise a single route to network N.

RIP Version 2 Extensions

The restriction on address interpretation means that version 1 of RIP cannot be used to propagate either variable length subnet addresses or the classless addresses used with CIDR. When version 2 of RIP (*RIP2*) was defined, the protocol was extended to include an explicit subnet mask along with each address. In addition, RIP2 updates include explicit next-hop information, which prevents routing loops and slow convergence. As a result, RIP2 offers significantly increased functionality as well as improved resistance to errors.

RIP2 Message Format

The message format used with RIP2 is an extension of the RIP1 format, with additional information occupying unused octets of the address field. In particular, each address includes an explicit next hop as well as an explicit subnet mask.

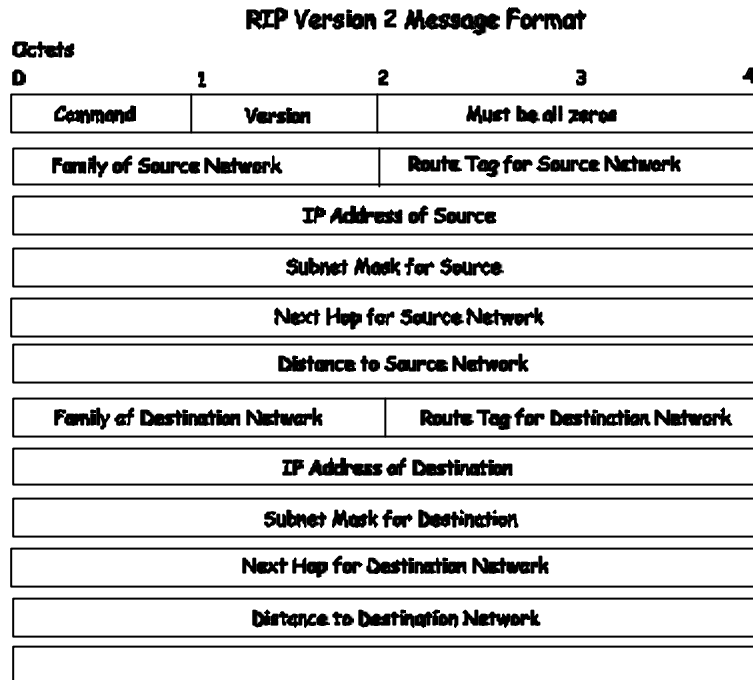


Figure 5-18. Rip Message Format

RIP 2 also attaches a 16-bit *Route Tag* to each entry. A router must send the same tag it receives when it transmits the route. Thus, the tag provides a way to propagate additional information such as the origin of the route. In particular, if RIP2 learns a route from another autonomous system, it can use the *Route Tag* to propagate the autonomous system's number.

Because the version number in RIP2 occupies the same octet as in RIP1, both versions of the protocols can be used on a given router simultaneously without interference. Before processing an incoming message, RIP software examines the version number.

Transmitting RIP Messages

RIP messages do not contain an explicit length field or an explicit count of entries. Instead, RIP assumes that the underlying delivery mechanism will tell the receiver the length of an incoming message. In particular, when used with TCP/IP, RIP messages rely on UDP to tell the receiver the message length. RIP operates on UDP port 520. Although a RIP request can originate at other UDP ports, the destination UDP port for requests is always 520, as is the source port from which RIP broadcast messages originate.

The Disadvantage of RIP Hop Counts

Using RIP as an interior router protocol limits routing in two ways. First, RIP restricts routing to a hop-count metric. Second, because it uses a small value of hop count for infinity, RIP restricts the size of any network using it. In particular, RIP restricts the span of a network to 16 hops (or 15 routers, because 16 represents an unreachable destination). So an internet can have at most 15 routers between any two hosts.

Note that the limit on network span is neither a limit on the total number of routers nor a limit on density. In fact, most campus networks have a small span even if they have many routers because the topology is arranged as a hierarchy.

Consider, for example, a typical corporate intranet. Most use a hierarchy that consists of a high-speed backbone network with multiple routers each connecting the backbone to a workgroup, where each workgroup occupies a single LAN. Although the corporation can include dozens of workgroups, the span of the entire intranet is only 2. Even if each workgroup is extended to include a router that connects one or more additional LANs, the maximum span only increases to 4. Similarly, extending the hierarchy one more level only increases the span to 6. Thus, the limit that RIP imposes affects large autonomous systems or autonomous systems that do not have a hierarchical organization.

Even in the best cases, however, hop counts provide only a crude measure of network capacity or responsiveness. Thus, using hop counts does not always yield routes with the least delay or highest capacity. Furthermore, computing routes on the basis of minimum hop counts has the severe disadvantage that it makes routing relatively static because routes cannot respond to changes in network load.

6

CONFIGURING THE SWITCH USING THE CONSOLE INTERFACE

Your 8port Gigabit Ethernet Layer 3 Switch supports a console management interface that allows you to set up and control your Switch, either with an ordinary terminal (or terminal emulator), or over the network using the TCP/IP Telnet protocol. You can use this facility to perform many basic network management functions. In addition, the console program will allow you to configure the Switch for management using an SNMP-based network management system. This chapter describes how to use the console interface to access the Switch, change its settings, and monitor its operation.

Notes are added where clarification is necessary.

Where there is a difference in the setup of the switch between its two operational modes **Layer 2 Only** and **IP Routing**, the sections are divided to correspond with the Switch operating mode that is applicable.

Note: *IP Routing mode switch configuration settings that are saved to non-volatile RAM using **Save Changes** from the **Main Menu** are retained in the Switch's memory when the operational mode is changed. IP Routing mode settings are simply inactive when the Switch is in **Layer 2 Only** mode.*

Before You Start

The DGS-3308 Layer 3 Switch supports a wide array of functions and gives great flexibility and increased network performance by eliminating the routing bottleneck between the WAN or Internet and the Intranet. Its function in a network can be thought of as a new generation of router that performs routing functions in hardware, rather than software. It is a router that also has up to 8 independent Ethernet collision domains – each of which can be assigned an IP subnet.

This flexibility and rich feature set requires a bit of thought to arrive at a deployment strategy that will maximize the potential of the DGS-3308.

General Deployment Strategy

1. Determine how the network would be best segmented. This is probably done using VLANs in an existing layer 2 switched network.
2. Develop an IP addressing scheme. This involves allocating a block of IP addresses to each network segment. Each network subnet is then assigned a network address and a subnet mask. See Chapter 5, “*Switch Management Concepts*” section titled **IP Addressing and Subnetting** for more information.
3. Determine which network resources must be shared by the subnets. Shared resources may be connected directly to the Layer 3 switch, if need be. Static routes to each of the shared resources should be determined.
4. Determine how each subnet will communicate with the WAN or Internet. Again, static routes should be determined and default gateways identified.

5. Develop a security scheme. Some subnets on the network need more security or should be isolated from the other subnets. IP or MAC filtering can be used. Also, one or more VLANs on the Layer 3 switch can be configured without an IP subnet – in which case, these VLANs will function as a layer 2 VLAN and would require an external router to connect to the rest of the network.
6. Develop a policy scheme. Some subnets will have a greater need for multicasting bandwidth, for example. A policy is a mechanism to alter the normal packet forwarding in a network device, and can be used to intelligently allocate bandwidth to time-critical applications such as the integration of voice, video, and data on the network.
7. Develop a redundancy scheme. Planning redundant links and routes to network critical resources can save valuable time in case of a link or device failure. The Spanning Tree function can be used to block the redundant link until it is needed.

VLAN Layout

VLANs on the DGS-3308 have rather more functions than on a traditional layer 2 switch, and must therefore be laid-out and configured with a bit more care. Layer 3 VLANs could be thought of as network links – not just as a collection of associated end users. Further, Layer 3 VLANs are assigned an IP network address and subnet mask to enable IP routing between them.

Layer 3 VLANs must be configured on the switch before they can be assigned IP subnets. Further, the static VLAN configuration is specified on a per port basis. On the DGS-3308, a VLAN can consist of end-nodes – just like a traditional layer 2 switch, but a VLAN can also consist of one or more layer 2 switches – each of which is connected to multiple end-nodes or network resources.

So, a Layer 3 VLAN, consisting of 4 ports, could be connected to 4 layer 2 switches. If these layer 2 switches each have 8 ports, then the Layer 3 VLAN would contain $4 \times 8 = 32$ end nodes. Assigning an IP subnet to the Layer 3 VLAN would allow wire-speed IP routing from the WAN to each end node and between end nodes.

So, the IP subnets for a network must be determined first, and the VLANs configured on the switch to accommodate the IP subnets. Finally, the IP subnets can be assigned to the VLANs.

Assigning IP Network Addresses and Subnet Masks to VLANs

The DGS-3308 allows the assignment of IP subnets to individual VLANs. Any VLAN configured on the switch that is not assigned an IP subnet, will behave as a layer 2 VLAN and will not be capable of IP routing – even if the switch is in IP Routing mode.

Developing an IP addressing scheme is a complex subject, but it is sufficient here to mention that the total number of anticipated end nodes – for each Layer 3 VLAN – must be accommodated with a unique IP address. It should be noted that the switch regards a VLAN with an IP network address and corresponding subnet mask assigned as an IP interface in IP Routing mode.

Note: See the section titled **IP Addressing and Subnetting** in Chapter 5 for more information.

Defining Static Routes

Routes between the IP interfaces and a default gateway or other router with a WAN connection should be determined beforehand and entered into the static/default routing table on the DGS-3308.

Existing WAN or Internet connections will probably have a router to connect the interface device to the network. This router can be connected to the DGS-3308 using a port designated as a 'router port'. Designating a port as a router port allows multicasting messages to be passed to the router with a WAN or Internet connection without flooding these messages throughout the network. This saves considerable bandwidth and increases performance without additional investment in network equipment.

Connecting to the Switch

You can use the console interface by connecting the Switch to a VT100-compatible terminal or a computer running an ordinary terminal emulator program (e.g., the terminal program included with the Windows operating system) using an RS-232C serial cable. Your terminal parameters will need to be set to:

- VT-100/ANSI compatible
- 9,600 baud
- 8 data bits
- No parity
- One stop bit
- No flow control

You can also access the same functions over a Telnet interface. Once you have set an IP address for your Switch, you can use a Telnet program (in VT-100 compatible terminal mode) to access and control the Switch. All of the screens are identical, whether accessed from the console port or from a Telnet interface.

Console Usage Conventions

The console interface makes use of the following conventions:

1. Items in *<angle brackets>* can be toggled between several choices using the space bar.
2. Items in *[square brackets]* can be changed by typing in a new value. You can use the backspace and delete keys to erase characters behind and in front of the cursor.
3. The up and down arrow keys, the left and right arrow keys, the tab key and the backspace key, can be used to move between selected items.
4. Items in **UPPERCASE** are commands. Moving the selection to a command and pressing **Enter** will execute that command, e.g. **APPLY**, etc.

Please note that the command **APPLY** only applies for the current session. Use **Save Changes** from the main menu for permanent changes. **Save Changes** enters the current switch configuration into non-volatile ram, and then reboots the switch.

First Time Connecting To The Switch

The Switch supports user-based security that can allow you to prevent unauthorized users from accessing the Switch or changing its settings. This section tells how to log onto the Switch.

Note: *The passwords used to access the Switch are case-sensitive; therefore, "S" is not the same as "s."*

When you first connect to the Switch, you will be presented with the first login screen (shown below).

Note: *Press Ctrl+R to refresh the screen. This command can be used at any time to force the console program in the switch to refresh the console screen.*

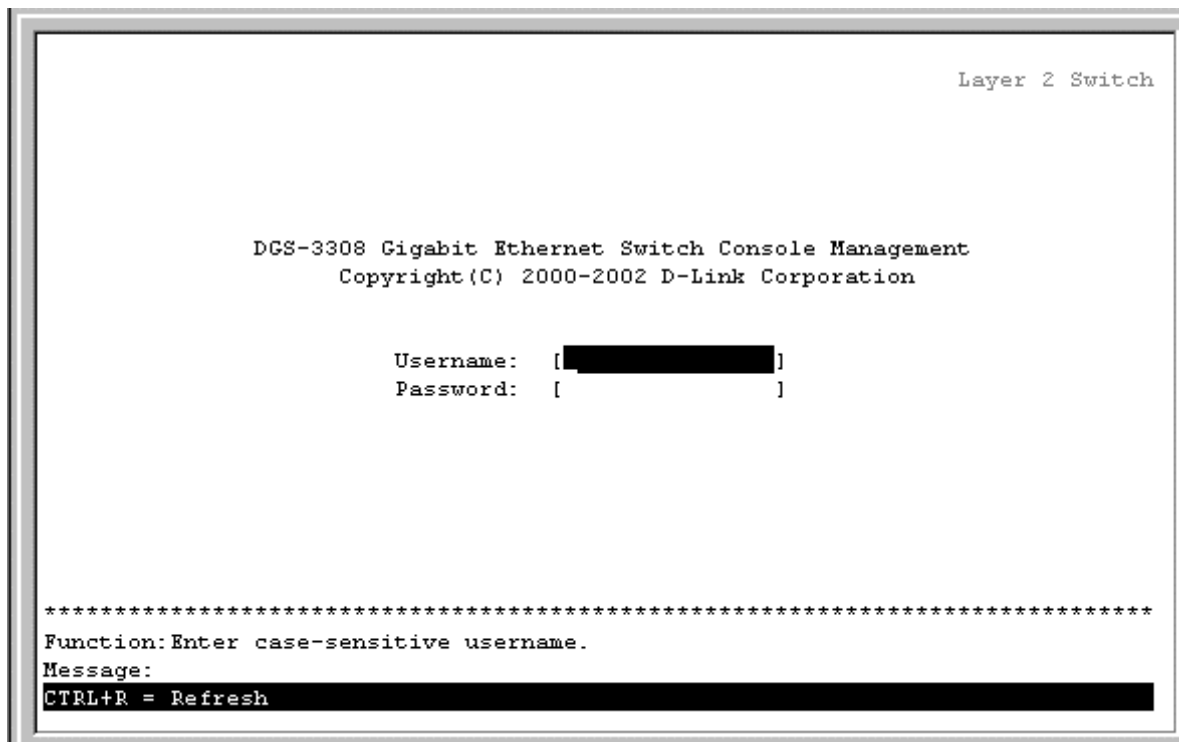


Figure 6-1. Initial screen, first time connecting to the Switch

Note: There is no initial username or password. Leave the **username** and **password** fields blank.

Note: The Switch's operational mode (**Layer 3** or **Layer 2**) is displayed in the upper right-hand corner of every menu in the console. The switch operational mode is changed under **Switch Settings** from the **Main Menu** and is described later in this manual.

Press **Enter** in both the username and password fields. You will be given access to the main menu shown below:

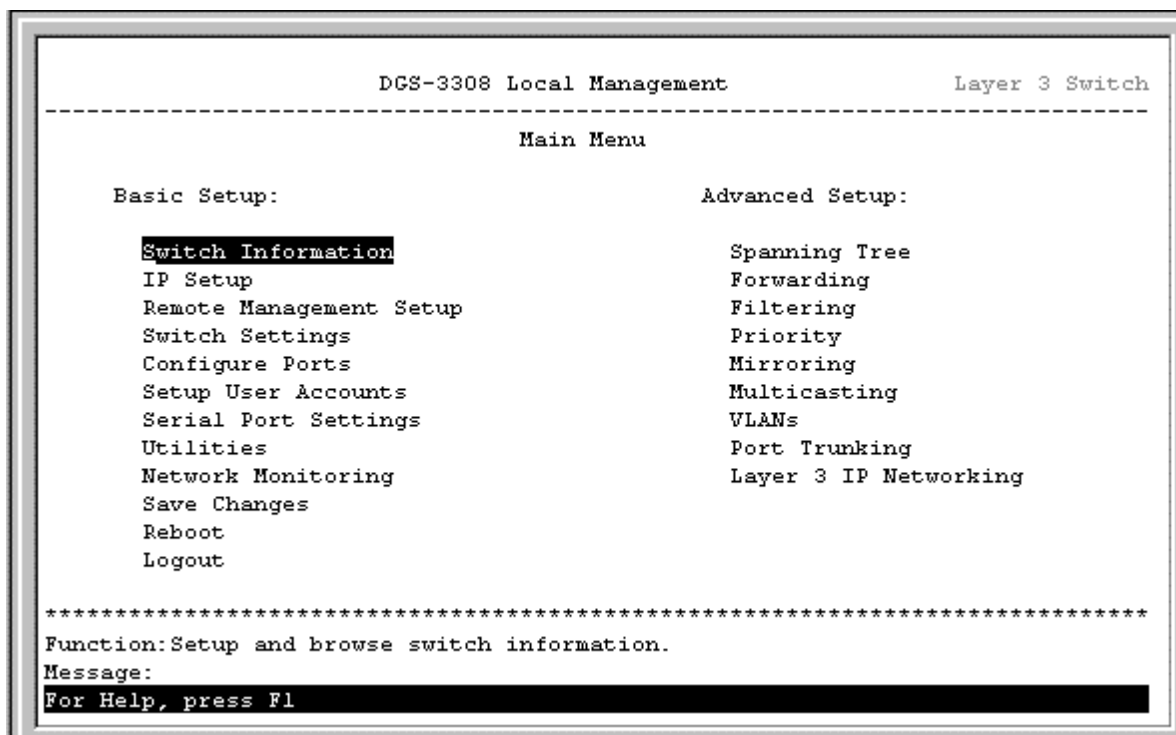


Figure 6-2. Main Menu

Note: The first user automatically gets Root privileges (See Table 6-1). It is recommended to create at least one Root-level user for the Switch.

Setup User Accounts

To create a new user account, highlight **Setup User Accounts** from the **Main Menu** and press **Enter**:

```
DGS-3308 Local Management                               Layer 3 Switch
-----
Main Menu

Basic Setup:                                           Advanced Setup:

Switch Information                                     Spanning Tree
IP Setup                                               Forwarding
Remote Management Setup                               Filtering
Switch Settings                                       Priority
Configure Ports                                       Mirroring
Setup User Accounts                                Multicasting
Serial Port Settings                                  VLANs
Utilities                                              Port Trunking
Network Monitoring                                    Layer 3 IP Networking
Save Changes
Reboot
Logout

*****
Function: Setup user account and password.
Message:
For Help, press F1
```

Figure 6-3. Main Menu

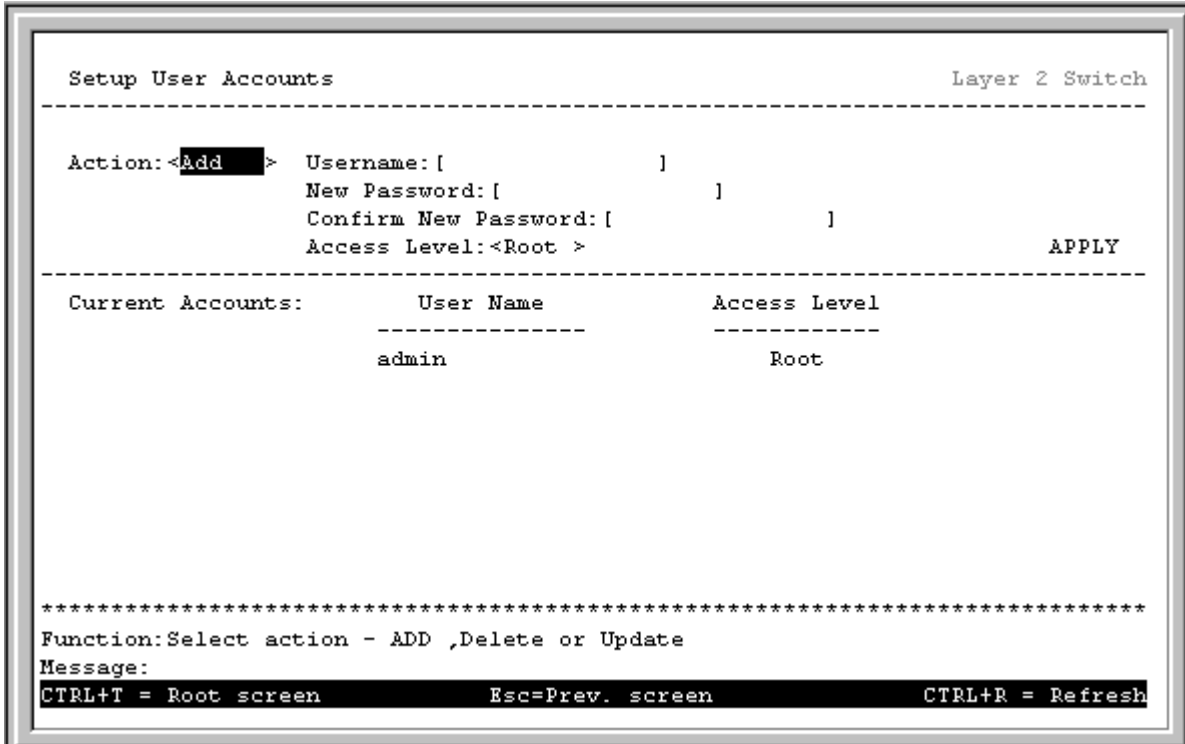


Figure 6-4. Setup User Accounts screen

User Accounts Management

From the **Main Menu**, highlight **Setup User Accounts** and press **Enter**, then the **Setup User Accounts** menu appears.

1. Toggle the **Action:**< > field to <Add> using the space bar. This will allow the addition of a new user. The other options are <Delete> - this allows the deletion of a user entry, and <Update> - this allows for changes to be made to an existing user entry.
2. Enter the new user name, assign an initial password, and then confirm the new password. Determine whether the new user should have <Root>, <User+>, or <User> privileges. The space bar toggles between the three options.
3. Highlight **APPLY** and press enter to make the user addition effective.
4. Press **Esc.** to return to the previous screen or Ctrl+T to go to the root screen.
5. A listing of all user accounts and access levels is shown below the user setup menu. This list is updated when **APPLY** is executed.
6. Please remember that **APPLY** makes changes to the switch configuration for the **current session only**. All changes (including User additions or updates) must be entered into non-volatile ram using the **Save Changes** command on the **Main Menu** - if you want these changes to be permanent.

Root, User+ and Normal User Privileges

There are three levels of user privileges: *Root* and *User+*, and *User*. Some menu selections available to users with *Root* privileges may not be available to those with *User+* and *User* privileges.

The following table summarizes the *Root*, *User+* and *User* privileges:

Switch Configuration Management	Privilege		
	Root	User+	User

Configuration	Yes	Read Only	Read Only
Network Monitoring	Yes	Read Only	Read Only
Community Strings and Trap Stations	Yes	Read Only	Read Only
Update Firmware and Configuration Files	Yes	No	No
System Utilities	Yes	Ping Only	Ping Only
Factory Reset	Yes	No	No
Reboot Switch	Yes	Yes	No
<i>User Accounts Management</i>			
Add/Update/Delete User Accounts	Yes	No	No
View User Accounts	Yes	No	No

Table 6-1. Root, User+, and User Privileges

After establishing a User Account with **Root**-level privileges, press **Esc**. Then highlight **Save Changes** and press **Enter** (see below). The Switch will save any changes to its non-volatile ram and reboot. You can logon again and are now ready to continue configuring the Switch.

Save Changes

The DGS-3308 has two levels of memory; normal RAM and non-volatile or NV-RAM. Configuration changes are made effective by highlighting **Apply** and pressing **Enter**. When this is done, the settings will be immediately applied to the switching software in RAM, and will immediately take effect.

Some settings, though, require you to restart the switch before they will take effect. Restarting the Switch erases all settings in RAM and reloads the stored settings from the NV-RAM. Thus, it is necessary to save all setting changes to NV-RAM before rebooting the Switch.

To retain any configuration changes permanently, highlight **Save Changes** from the **Main Menu**. The following screen will appear to verify that your new settings have been saved to NV-RAM:

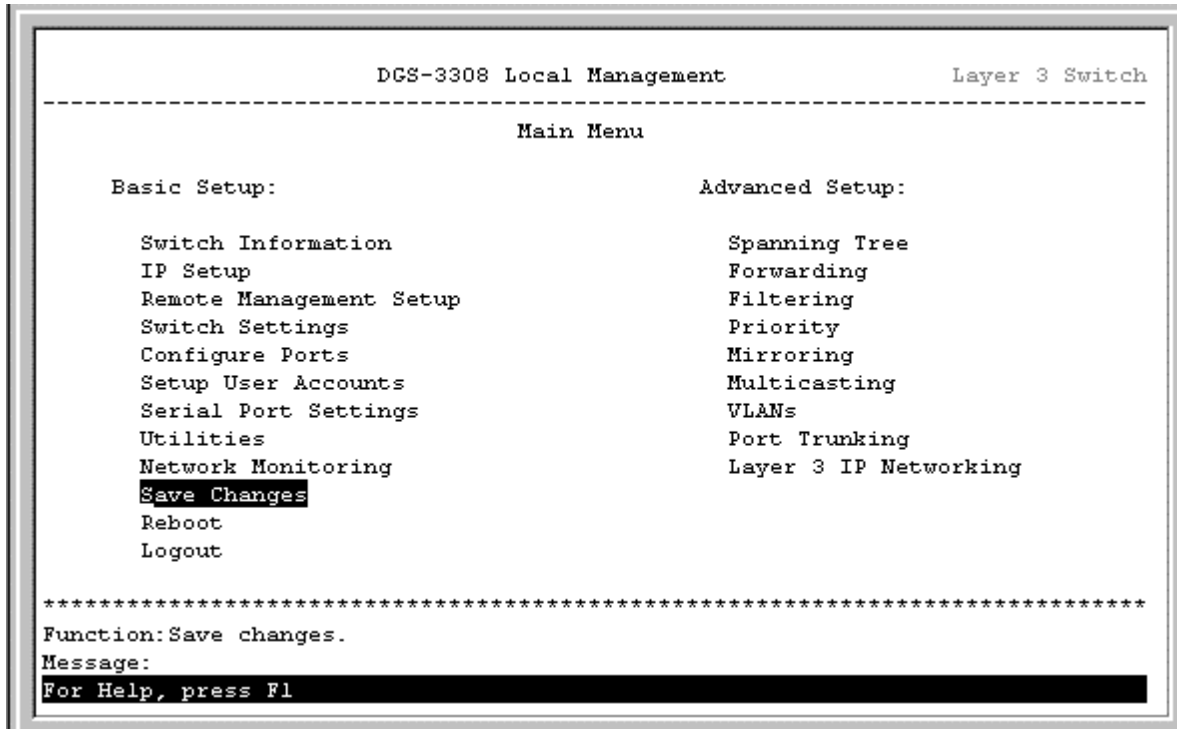


Figure 6-5. Main Menu

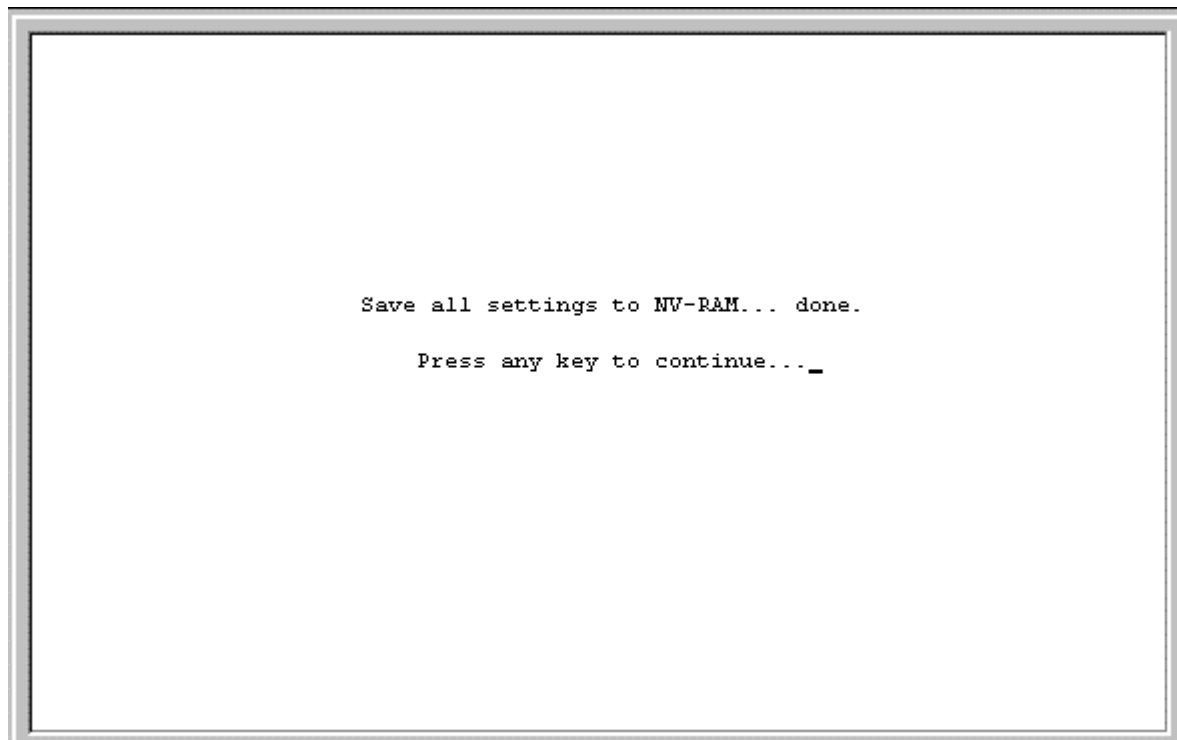
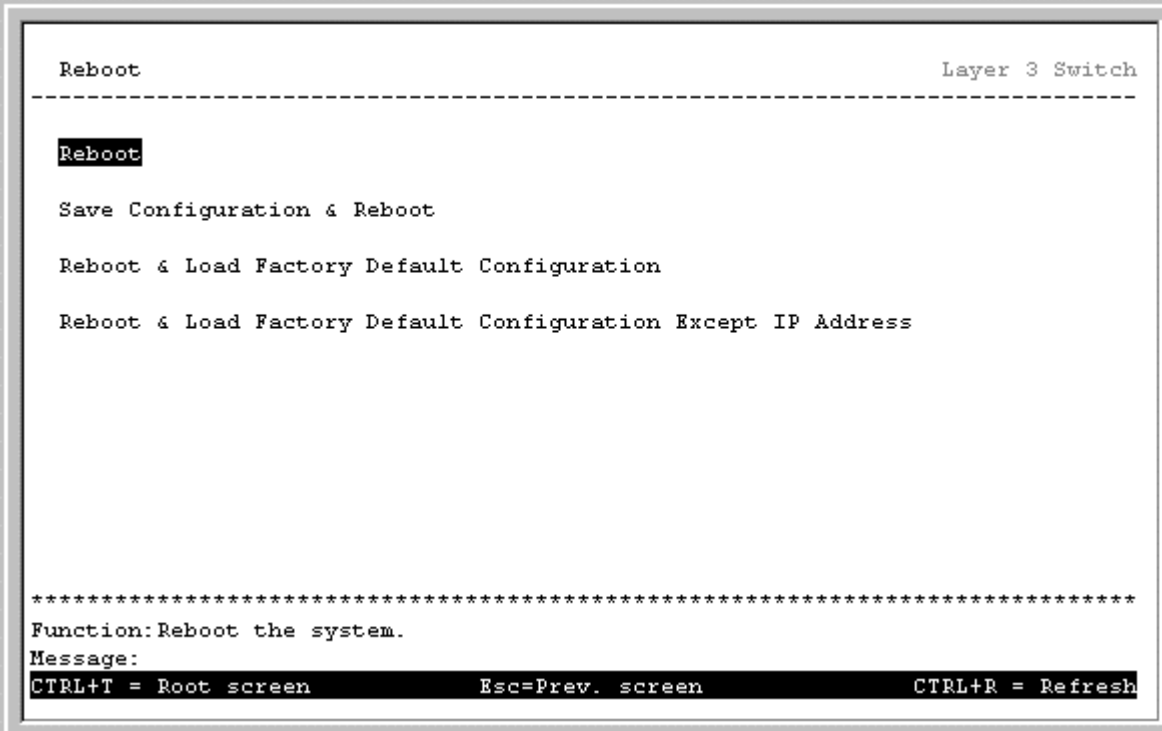


Figure 6-6. Save Changes screen

Once the Switch configuration settings have been saved to NV-RAM, they become the default settings for the switch. These settings will be used every time the Switch is rebooted.

Reboot

The only way to change the configuration stored in NV-RAM is to save a new configuration using **Save Changes** from the **Main Menu** or to execute a factory reset from the **System Reboot** menu (click **Reboot** on the **Main Menu**). This will clear all settings and restore them to their initial values listed in the Appendix. These are the configuration settings entered at the factory and are the same settings present when the Switch was purchased.



```
RebootLayer 3 Switch
-----
Reboot
Save Configuration & Reboot
Reboot & Load Factory Default Configuration
Reboot & Load Factory Default Configuration Except IP Address

*****
Function: Reboot the system.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh
```

Figure 6-7. Reboot menu

Highlight the desired option on the menu above and press **Enter**.

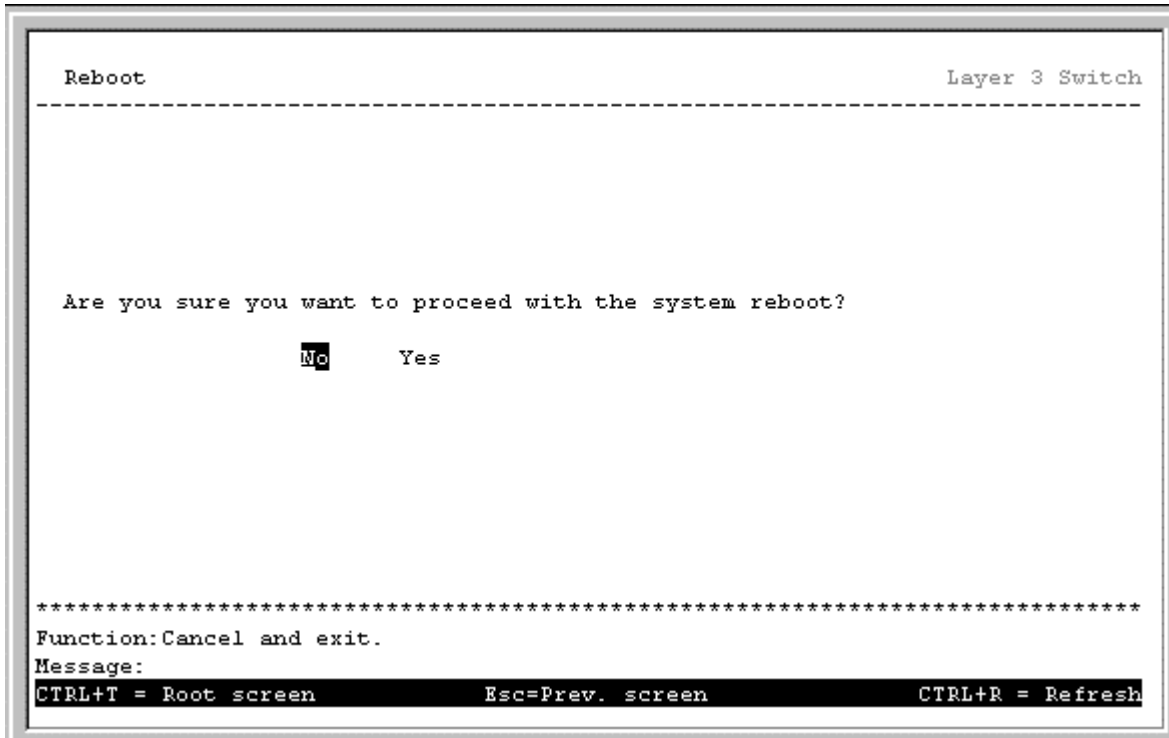


Figure 6-8. Reboot screen

Highlight **Yes** and press **Enter** to complete the desired option from the **System Reboot** screen. Please note that if either the third or fourth choice is selected, all User Accounts (and other configuration settings) you may have entered will be erased and the Switch will return to the state it was in when it was purchased.

Logging Onto The Switch Console

To log in once you have created a registered user, from the login screen:

1. Type in your **username** and press **Enter**.
2. Type in your **password** and press **Enter**.
3. The **Main Menu** screen will be displayed based on your access level or privilege.

Updating or Deleting User Accounts

To update or delete a user password:

Choose **Setup User Accounts** from the **Main Menu**. The following **Setup User Accounts** screen appears:

```

Setup User Accounts                                     Layer 2 Switch
-----
Action: <Add >   Username: [           ]
                New Password: [         ]
                Confirm New Password: [       ]
                Access Level: <Root >                APPLY
-----
Current Accounts:   User Name       Access Level
                   -----
                   admin           Root
-----

*****
Function: Select action - ADD ,Delete or Update
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-9. Setup Users Accounts screen

1. Toggle the **Action:**<Add> field using the space bar to choose *Add*, *Update*, or *Delete*.
2. Type in the **Username** for the user account you wish to change and enter the **Old Password** for that user account.
3. You can now modify the password or the privilege level for this user account.
4. If the password is to be changed, type in the **New Password** you have chosen, and press **Enter**. Type in the same new password in the following field to verify that you have not mistyped it.
5. If the privilege level is to be changed, toggle the **Access Level:**<Root> field until the appropriate level is displayed – *Root*, *User+* or *User*.
6. Highlight **APPLY** and press **Enter** to make the change effective.
7. You must enter the configuration changes into the non-volatile ram (NV-RAM) using **Save Changes** from the **Main Menu** if you want the configuration to be used after a switch reboot.

Only a user with **Root** privileges can make changes to user accounts.

Viewing Current User Accounts

Access to the console, whether using the console port or via Telnet, is controlled using a user name and password. Up to eight user accounts can be created. The console interface will not let you delete the current logged-in user, to prevent accidentally deleting all of the users with *Root* privilege.

Only users with the **Root** privilege can delete users.

To view the current user accounts:

Highlight **Setup User Accounts** from the **Main Menu**. The current user accounts can be read from the **Setup User Accounts** screen that is displayed.

Deleting a User Account

To delete a user account:

1. Toggle the **Action:<Add>** field to *Delete*.
2. Enter the **Username** for the account you want to delete.
3. Highlight **APPLY** and press **Enter** to make the deletion of the selected user take effect.
4. You must enter the configuration changes into the non-volatile RAM (NV-RAM) using **Save Changes** from the **Main Menu** if you want the configuration to be used after a switch reboot.

Only users with **Root** privileges can delete user accounts.

Setting Up The Switch

Basic Setup

This section will help prepare the Switch user by describing the **Switch Information**, **Remote Management Setup**, **Configure Ports**, **Serial Port Settings** and **Switch Settings** menus.

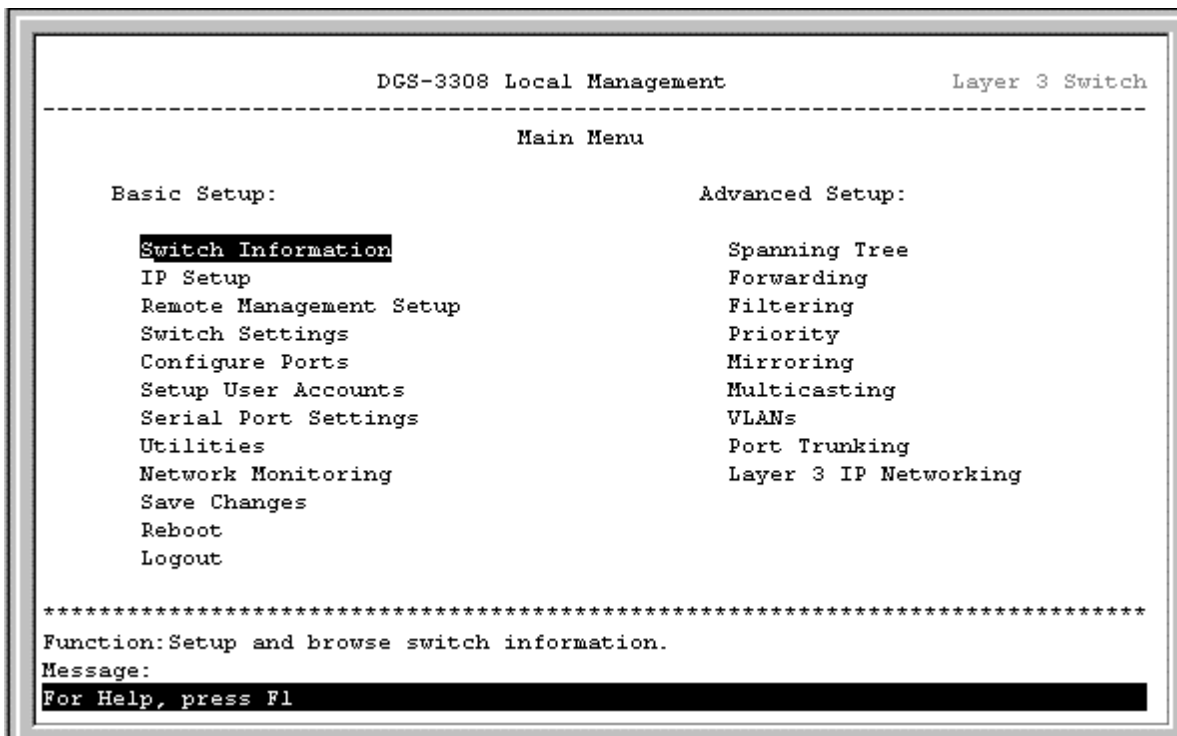


Figure 6-10. Main Menu

Switch Information

Highlight **Switch Information** from the **Main Menu** and press **Enter**:

```

Switch Information                                     Layer 2 Switch
-----
Device Type      : DGS-3308 Layer 3 Gigabit Ethernet Switch
MAC Address      : 00-01-F4-DB-06-C0
Boot PROM Version: 0.2
Firmware Version : 0.62
Hardware Version : v1.00
Device S/N       : 12345678

System Name      : [Gigabit Ethernet L2/L3 Switch ]
System Location  : [53 Discovery Dr, Irvine CA 92620 ]
System Contact   : [D-Link Systems Inc.           ]

Power Supply and Cooling Fan Status

APPLY

*****
Function: Sets a name for identification purposes.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-11. Switch Information screen

The **Switch Information** shows the type of switch (Layer 3), which (if any) external modules are installed, and the Switch's **MAC Address** (assigned by the factory and unchangeable). In addition, the **Boot PROM** and **Firmware Version** numbers are shown. This information is helpful to keep track of PROM and Firmware updates and to obtain the Switch's MAC address for entry into another network device's address table – if necessary.

You can also enter the name of the **System**, its location, and the name and telephone number of the System Administrator. It is recommended that the person responsible for the maintenance of the network system that this Layer 3 switch is installed on be listed here.

Power Supply and Cooling Fan Status

Highlight **Power Supply and Cooling Fan Status** on the **Switch Information** screen and press **Enter** to display the current status of the primary and secondary power supplies and the four cooling fans. The following screen appears:

```
Power Supply and Cooling Fan Status                                Layer 3 Switch
-----

Power Supply Status:
  Primary Power Supply   : Running
  Secondary Power Supply : None

Cooling Fans Status:
  Cooling Fan 1: Down
  Cooling Fan 2: Down
  Cooling Fan 3: Down
  Cooling Fan 4: Down

*****
Function:Current Power Supply and Cooling Fan Status
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh
```

Figure 6-12. Power Supply and Cooling Fan Status screen

IP Setup

Some settings must be entered to allow the Switch to be managed from an SNMP-based Network Management System such as SNMP v1 or to be able to access the Switch using the Telnet protocol or the Web-based Manager. Please see the next chapter for Web-based network management information.

The **IP Setup** menu lets you specify how the Switch will be assigned an IP address to allow it to be identified on the network.

To setup the Switch for remote management:

Highlight **IP Setup** from the **Main Menu**. The following screen appears:

```

IP Setup                                                    Layer 3 Switch
-----
Current Switch IP Settings:

  Get IP From:      Manual
  IP Address:       10.24.22.9
  Subnet Mask:      255.0.0.0
  Default Gateway: 10.254.254.251
  Management VID:   1

New Switch IP Settings:

  Get IP From:      Manual
  IP Address:       [10.24.22.9 ]
  Subnet Mask:      [255.0.0.0  ]
  Default Gateway: [10.254.254.251 ]
  Management VID:   [1   ]

                                                    APPLY

*****
Function: Sets the IP address.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-13. IP Setup screen

Configuring the Switch's IP Address

The Switch needs to have an IP address assigned to it so that an In-Band network management system (e.g. Web-based Manager or Telnet) client can find it on the network. The **IP Setup** screen allows you to change the settings for this management interface used on the Switch.

The fields listed under the Current Switch IP Settings heading are those that are currently being used by the Switch. The fields listed under the New Switch IP Settings heading are those that will be used after the Switch has been Rebooted.

In Layer 2 mode, toggle the **Get IP From:** < > field using the space bar to choose from *Manual*, *BOOTP*, or *DHCP*. This selects how the Switch will be assigned an IP address on the next reboot (or startup). If the Switch is in Layer 3 mode, *Manual* is automatically assigned.

The **Get IP From:** < > options are:

- **BOOTP** – The Switch will send out a BOOTP broadcast request when it is powered up. The BOOTP protocol allows IP addresses, network masks, and default gateways to be assigned by a central BOOTP server. If this option is set, the Switch will first look for a BOOTP server to provide it with this information before using the default or previously entered settings.
- **DHCP** – The Switch will send out a DHCP broadcast request when it is powered up. The DHCP protocol allows IP addresses, network masks, and default gateways to be assigned by a DHCP server. If this option is set, the Switch will first look for a DHCP server to provide it with this information before using the default or previously entered settings.
- **Manual** – Allows the entry of an IP address, Subnet Mask, and a Default Gateway for the Switch. These fields should be of the form *xxx.xxx.xxx.xxx*, where each *xxx* is a number (represented in decimal form) between 0 and 255. This address should be a unique address on the network assigned for use by the Network Administrator. The fields which require entries under this option are as follows:

- **Subnet Mask** – A Bitmask that determines the extent of the subnet that the Switch is on. Should be of the form *xxx.xxx.xxx.xxx*, where each *xxx* is a number (represented in decimal) between 0 and 255. The value should be 255.0.0.0 for a Class A network, 255.255.0.0 for a Class B network, and 255.255.255.0 for a Class C network, but custom subnet masks are allowed.
- **Default Gateway** – IP address that determines where packets with a destination address outside the current subnet should be sent. This is usually the address of a router or a host acting as an IP gateway. If your network is not part of an intranet, or you do not want the Switch to be accessible outside your local network, you can leave this field unchanged.
- **Management VID** – Allows the input of a VLAN VID to restrict access to the management module on the Switch to a single VLAN.

Remote Management Setup

This allows the Switch to send traps (messages about errors, etc.) to management stations on the network. Highlight **Remote Management Setup** on the **Main Menu** and press **Enter**. The trap recipients can be setup from the following screen:

```

Remote Management Setup                                     Layer 3 Switch
-----
Management Station IP Settings:

IP Address: [0.0.0.0 ]
IP Address: [0.0.0.0 ]
IP Address: [0.0.0.0 ]

SNMP Community Settings:

Community String      Rights      Status
[public                ] <Read>    <Enabled >
[private              ] <R/W >   <Enabled >
[                      ] <Read>   <Disabled>
[                      ] <Read>   <Disabled>

SETUP TRAP RECEIVERS                                     APPLY
*****
Function:Create a list of IP addresses that can access the switch.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-14. Remote Management Setup screen

The **IP Address** field is the IP address of a management station (usually a computer) that is configured to receive the SNMP traps from the Switch.

The **SNMP Community String** is similar to a password in that stations that do not know the correct string cannot receive or request SNMP information from the Switch.

The **Status** field can be toggled between *Enabled* and *Disabled* to enable or disable the receipt of SNMP traps by the listed management stations.

Note: Up to four SNMP trap recipients can be entered.

Setup Trap Recipients

```

Setup Trap Recipients                                     Layer 3 Switch
-----
SNMP Trap Recipients:

  IP Address      SNMP Community String      Status
  [          ]    [          ]    <Disabled>
  [          ]    [          ]    <Disabled>
  [          ]    [          ]    <Disabled>
  [          ]    [          ]    <Disabled>

                                           APPLY

*****
Function:Edit SNMP Trap Receivers.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-15. Setup Trap Recipients screen

Configure Ports

Highlight **Configure Ports** from the **Main Menu** and press **Enter**:

```

Configure Ports                                         Layer 3 Switch
-----
View Ports:< 1 to 8 >   Configure Port from [ 1 ] to [ 1 ]
State:<Enabled > Speed/Duplex:<Auto > Flow Control:<Enabled > APPLY

Port      State      Settings      Connection      port type
-----
1         Enabled   Auto/Enabled  Link Down       1000SX
2         Enabled   Auto/Enabled  Link Down       1000SX
3         Enabled   Auto/Enabled  Link Down       1000SX
4         Enabled   Auto/Enabled  Link Down       1000SX
5         Enabled   Auto/Enabled  Link Down       1000SX
6         Enabled   Auto/Enabled  Link Down       1000SX
7         Enabled   Auto/Enabled  Link Down       GBIC_EMPTY
8         Enabled   Auto/Enabled  Link Down       GBIC_EMPTY

*****
Function:Select the scope of ports for display and configuration.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```


Figure 6-16. Configure Ports screen

To configure a specific port, toggle the **Configure Port from** [] to [] field until the appropriate port numbers appear.

Toggle the **State**:< > field to either enable or disable a given port.

Toggle the **Speed/Duplex**:< > field to select the speed and duplex state of the port. There are two choices: *Auto* and *1000M/Full*. *Auto* allows the port to automatically determine the fastest settings the device the port is connected to can handle, and then to use those settings. There is no automatic adjustment of port settings with any option other than *Auto*.

Serial Port Settings

The **Serial Port Settings** screen allows the configuration of the Switch's serial port through either the console port or through use of the Telnet protocol.

Highlight **Serial Port Settings** and press **Enter**.

```

Serial Port Settings                                     Layer 3 Switch
-----
Serial port setting: Console

  Console Settings:          Telnet Settings:

  Baud Rate: <9600 >       Telnet Time Out(min): <10 mins>
  Data Bits: 8              Telnet Sessions(1..4): [1]
  Stop Bits: 1
  Auto-Logout: <10 mins>

                                                                    APPLY

*****
Function:Select baud rate.
Message:
CTRL+T = Root screen          Esc=Prev. screen          CTRL+R = Refresh

```

Figure 6-17. Serial Port Settings screen

The following fields can then be set:

- **Baud Rate** – Sets the serial bit rate that will be used to communicate the next time the Switch is restarted. Applies only when the serial port is being used for out-of-band (SLIP) management; it does not apply when the port is used for the console port. Available speeds are *4800*, *9600*, *19200*, *38400* and *57600* bits per second. The default setting is *9600*.
- **Auto-Logout** – This sets the time the interface can be idle before the Switch automatically logs-out the user. The options are *2 mins*, *5 mins*, *10 mins*, *15 mins*, or *Never*.
- **Telnet Time Out**<*min*> – Select the desired Telnet age-out time in this field.
- **Telnet Sessions**<*1..4*> – Select between 1 and 4 Telnet sessions in this field.

Switch Operation Mode

Note: The Switch will retain the configuration entered for **IP Routing** when in **Layer 2 Only** mode (if the configuration is saved to NV-RAM), but the **IP Routing** configuration will not be active. The **IP Routing** configuration will become active when the Switch is again put in **IP Routing** mode.

Note: Putting the Switch in **IP Routing** mode does not – by itself – enable IP routing. The Switch must be configured to use IP interfaces before it is capable of IP routing. (See the section titled **Setting up IP Interfaces** below.)

The Switch can operate in one of two modes:

1. **Layer 2 Only with IEEE 802.1Q VLAN support:** the switching process is based upon the source and destination MAC addresses only. 802.1Q VLANs are supported and the Switch is considered as a VLAN-tag aware device.
2. **IP Routing with IEEE 802.1Q VLAN support:** the switching process is based upon the IP source and destination addresses, if present. If the IP addresses are not present, the switching process is based upon the MAC addresses (as in Layer 2 above). 802.1Q VLANs are supported and the Switch is considered as a VLAN-tag aware device.

The Switch must be rebooted when changing the operation mode before the new operation mode can take effect.

Changing the Switch Operation Mode

To change the Switch's operating mode:

Highlight **Switch Settings** on the **Main Menu** and press **Enter**.

```

Switch Settings                                     Layer 3 Switch
-----
Switch Operation Mode
Layer 2 Switch Settings

*****
Function:Select switch operation mode.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refres

```

Figure 6-18. Switch Settings screen

Highlight **Switch Operation Mode** on the **Switch Settings** menu and press **Enter**.

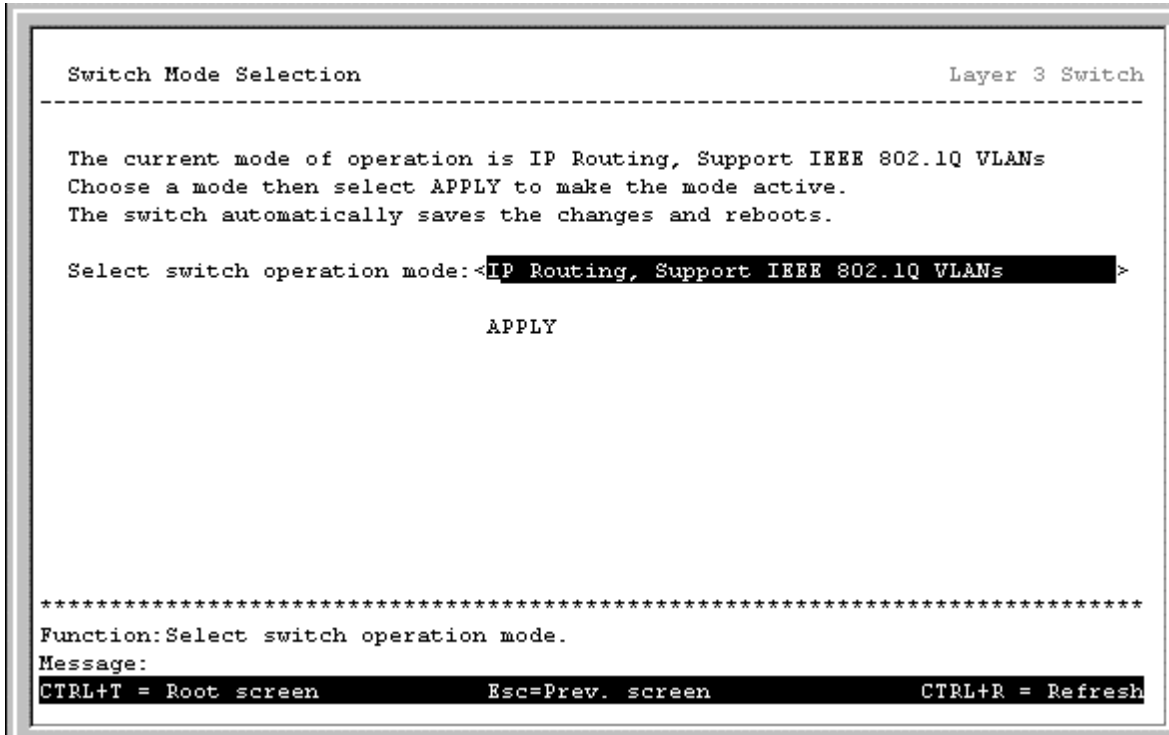


Figure 6-19. Switch Mode Selection screen

The field **Select switch operation mode:< >** can be toggled using the space bar to one of the two switch operation modes: **Layer 2 Only, Support IEEE 802.1Q VLANs** and **IP Routing, Support IEEE 802.1Q VLANs**.

To make a change in the operation mode of the Switch effective, highlight **APPLY** and press **Enter**.

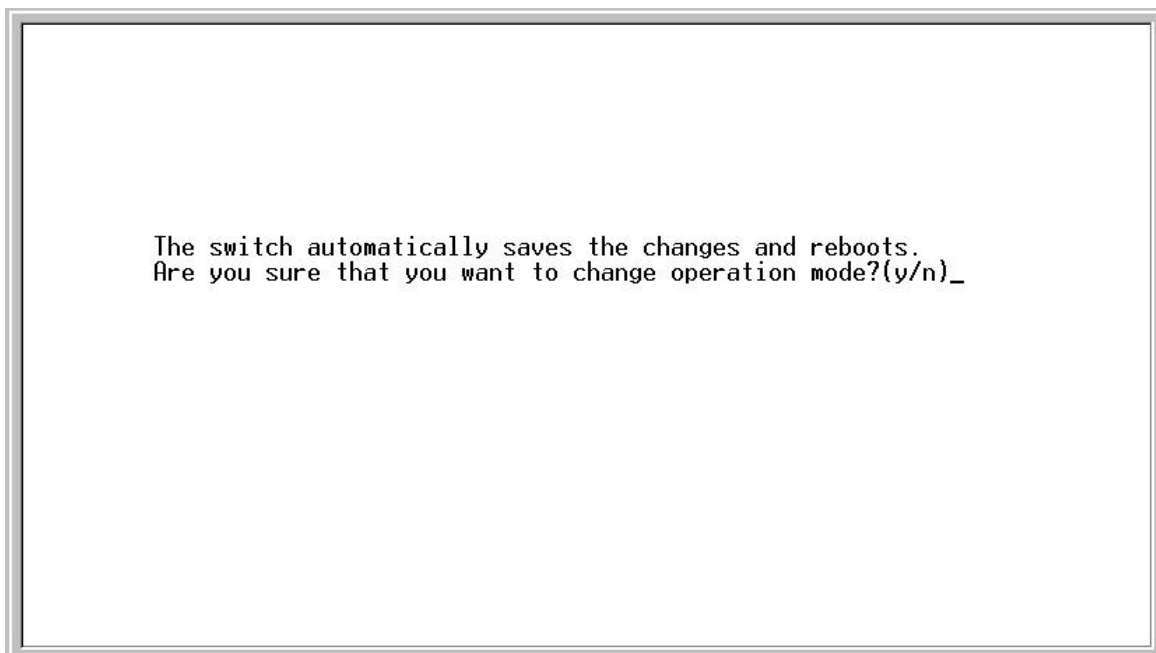


Figure 6-20. Change Mode Confirmation screen

Type **y** and press **Enter**. The Switch will then save the changes made during the current session and reboot. The Switch must be rebooted to change the operation mode.

Switch Settings – IP Routing Mode

Once the Switch is configured for IP Routing (Layer 3 Switching), and rebooted, the **Main Menu** adds some functions compared to the Layer 2 Only mode.

```
DGS-3308 Local Management                               Layer 3 Switch
-----
Main Menu

Basic Setup:                                           Advanced Setup:

Switch Information                                     Spanning Tree
IP Setup                                               Forwarding
Remote Management Setup                               Filtering
Switch Settings                                       Priority
Configure Ports                                       Mirroring
Setup User Accounts                                  Multicasting
Serial Port Settings                                  VLANs
Utilities                                             Port Trunking
Network Monitoring                                    Layer 3 IP Networking
Save Changes
Reboot
Logout

*****
Function:Setup and browse switch information.
Message:
For Help, press F1
```

Figure 6-21. Main Menu – Layer 3 IP Routing Mode

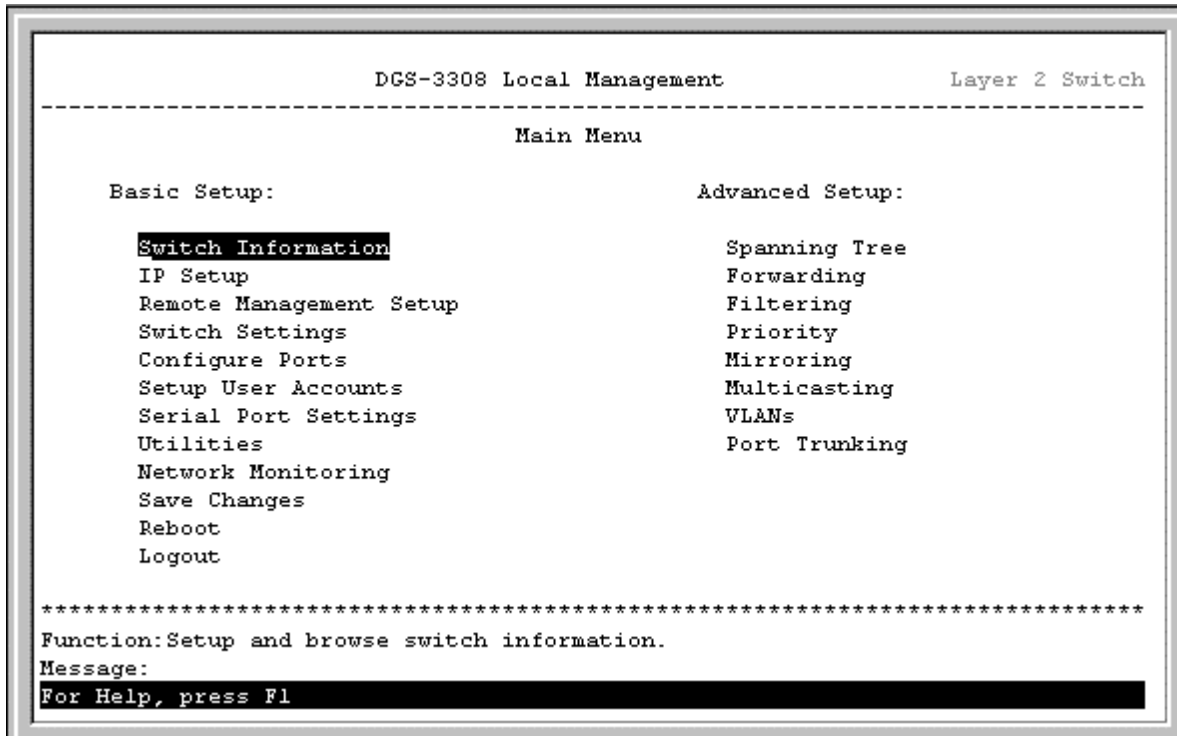


Figure 6-22. Main Menu – Layer 2 Switching Mode

Layer 2 Switch Settings

Note: Layer 2 Switch functions and settings are also available when the Switch is configured to operate in the IP Routing (Layer 3) mode.

To access the **Layer 2 Switch Settings** menu, highlight **Layer 2 Switch Settings** on the **Switch Settings** menu and press **Enter**:

```

Layer 2 Switch Settings                                     Layer 2 Switch
-----
Layer 2 Switch Settings:

Switch GVRP: <Disabled>
Switch GMRP: Disabled

Broadcast/Multicast Storm Control:

Upper Threshold: [128] Kpps

Broadcast Storm Mode: <Disabled>
Multicast Storm Mode: <Disabled>                                APPLY
*****
Function:Set GVRP status.
Message:
CTRL+T = Root screen           Esc=Prev. screen           CTRL+R = Refresh

```

Figure 6-23. Layer 2 Switch Settings screen

The following fields can then be set:

- **Switch GVRP:** <Disabled> – Group VLAN Registration Protocol is a protocol that allows members to dynamically join VLANs.
- **Switch GMRP:** Disabled – Group Multicast Registration Protocol is a protocol that allows members to dynamically join Multicast groups. **This function is not supported in the current version of the Switch software.**

Broadcast/Multicast Storm Control:

- **Upper Threshold:** [255]Kpps – This is the number of thousands Broadcast/Multicast packets per second received by the Switch – on one of the base ports – that will trigger the Switch's reaction to a Broadcast/Multicast storm.
- **Broadcast Storm Mode:**<Disabled> – This field can be toggled between *Enabled* and *Disabled* using the space bar. This enables or disables, globally, the Switch's reaction to Broadcast storms, triggered at the threshold set above.
- **Multicast Storm Mode:**<Disabled> – This field can be toggled between *Enabled* and *Disabled* using the space bar. This enables or disables, globally, the Switch's reaction to Multicast storms, triggered at the threshold set above.

Layer 3 Switch Mode - Setup RIP

The Routing Information Protocol (RIP) is a distance-vector protocol that uses the hop count as its criteria for making routing decisions. RIP is an Interior Gateway Protocol (IGP), which means that it performs routing within a single autonomous system.

To setup RIP, click **Layer 3 IP Networking** on the **Main Menu**. The following menu appears:

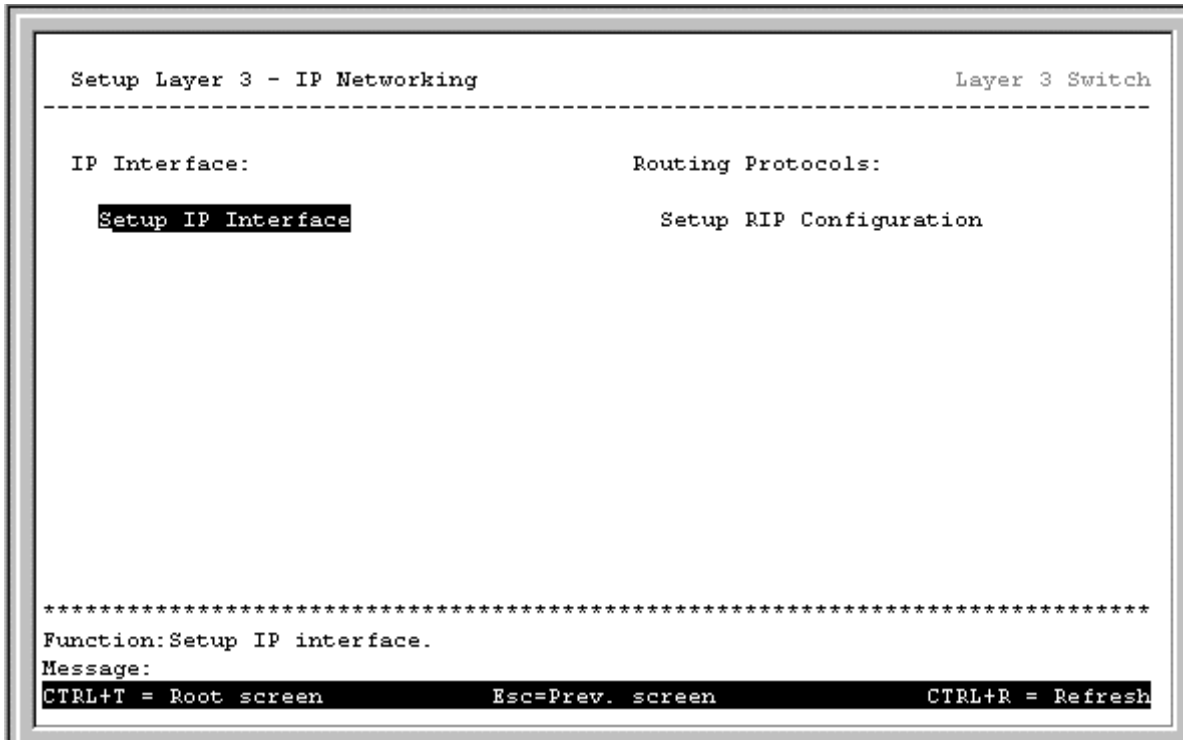


Figure 6-24. Setup Layer 3 – IP Networking menu

Now highlight **Setup RIP Configuration** from the **Setup Layer 3 IP Networking** menu above and press **Enter** to access the following screen:

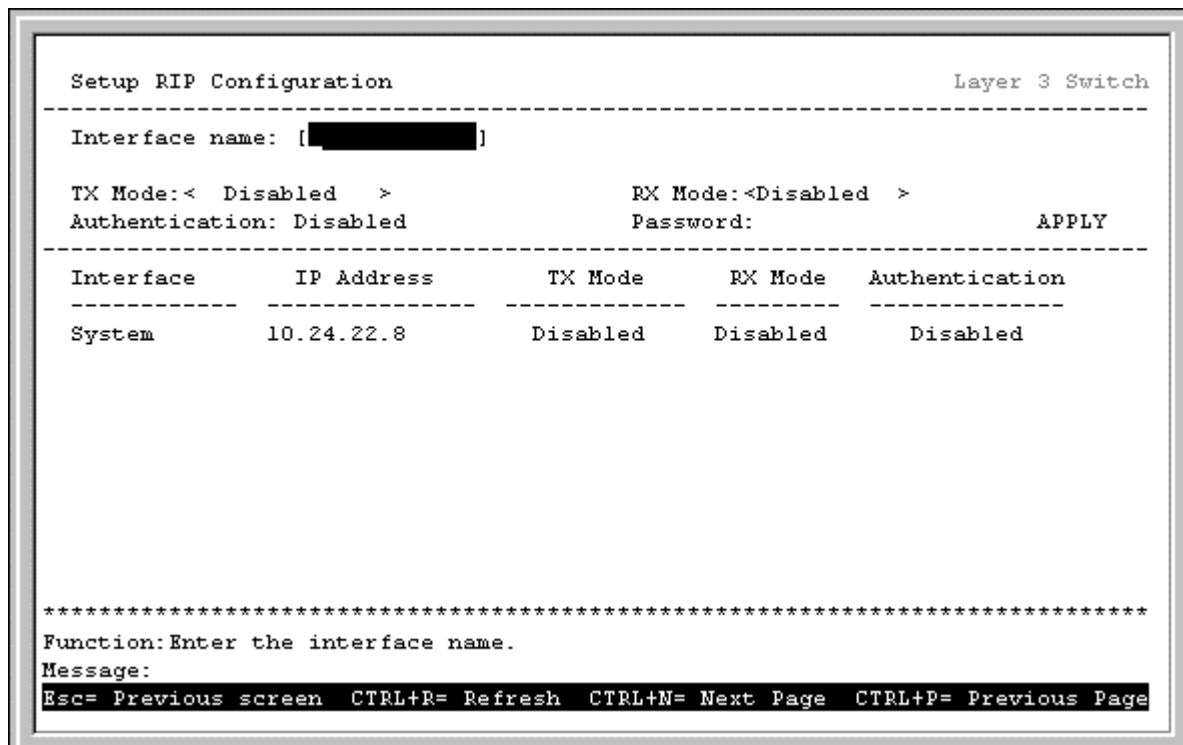


Figure 6-25. Setup RIP Configuration screen

- **Interface name:**[] – The name of the IP interface on which RIP is to be setup. This interface must be previously configured on the Switch.
- **TX Mode:**<V2 Only> – Toggle among *Disabled*, *V1 Only*, *V1 Compatible*, and *V2 Only*. This entry specifies which version of the RIP protocol will be used to transmit RIP packets. *Disabled* prevents the transmission of RIP packets.
- **RX Mode:**<V2 Only> – Toggle among *Disabled*, *V1 Only*, *V2 Only*, and *V1 and V2*. This entry specifies which version of the RIP protocol will be used to interpret received RIP packets. *Disabled* prevents the reception of RIP packets.
- **Authentication:**<Enabled> – Toggle between *Enabled* and *Disabled*. When authentication is enabled, a password is used to authenticate communication between routers on the network. Authentication is only supported when RIP is in *V1 Compatible* or *V2 only* mode.
- **Password:**[] – A password to be used to authenticate communication between routers on the network.

Advanced Setup

The switch operation mode setting changes the menus and configuration options for the Advanced Setup of the Switch. This section of the manual is therefore divided into two sections for each Advanced Setup menu item to reflect the two switch operation modes – **Layer 2 with IEEE 802.1Q VLAN support** and **IP Routing with IEEE 802.1Q VLAN support**. Where there is no difference in the setup between the two switch operation modes, only one section will be presented.

Configuring VLANs

Note: The Switch allows the assignment of an IP interface to each VLAN, in **IP Routing** mode. The VLANs must be configured before setting up the IP interfaces. VLANs in Layer 2 Only Mode

The Switch reserves one VLAN, VID = 1, called the DEFAULT_VLAN for internal use. The factory default setting assigns all ports on the Switch to the DEFAULT_VLAN. As new VLANs are configured, their respective member ports are removed from the DEFAULT_VLAN. If the DEFAULT_VLAN is reconfigured, all ports are again assigned to it. Ports that are not desired to be part of the DEFAULT_VLAN are removed during the configuration.

Packets cannot cross layer 2 VLANs. If a member of one layer 2 VLAN wants to connect to another layer 2 VLAN, it must be through a router.

VLANs by Switch Operating Mode – Layer 2 Only and IP Routing

Note: The Switch's default - in both **Layer 2 Only** mode and **IP Routing** mode - is to assign all ports to a single 802.1Q VLAN named DEFAULT_VLAN. As new VLANs are created, the member ports assigned to the new VLAN will be removed from the default VLAN port member list.

Note: The DEFAULT_VLAN has a VID = 1. An IP interface called System in the IP interface entry menu also has a VID = 1, and therefore corresponds to the DEFAULT_VLAN.

To create a new 802.1Q VLAN:

The VLAN menu adds an entry to edit the VLAN definitions and to configure the port settings for IEEE 802.1Q VLAN support. Highlight **VLANs** from the **Main Menu** and press **Enter**.

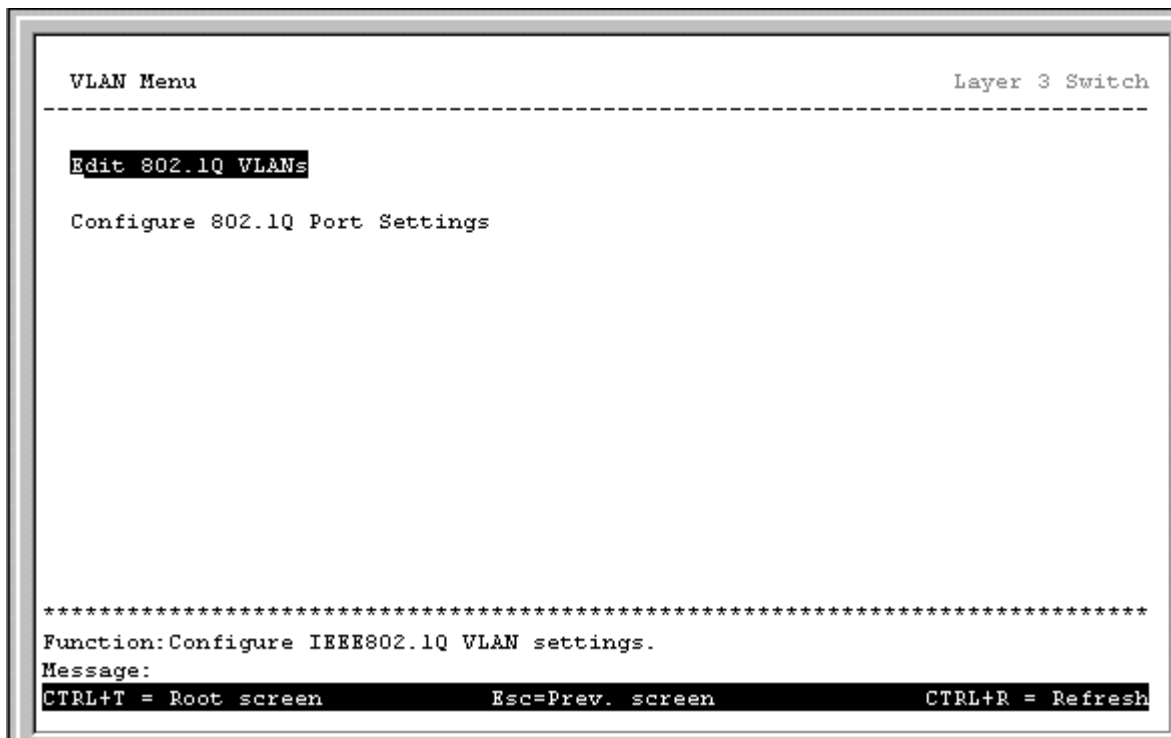


Figure 6-26. VLAN Menu

To create an 802.1Q VLAN, highlight **Edit 802.1Q VLANs** and press **Enter**:

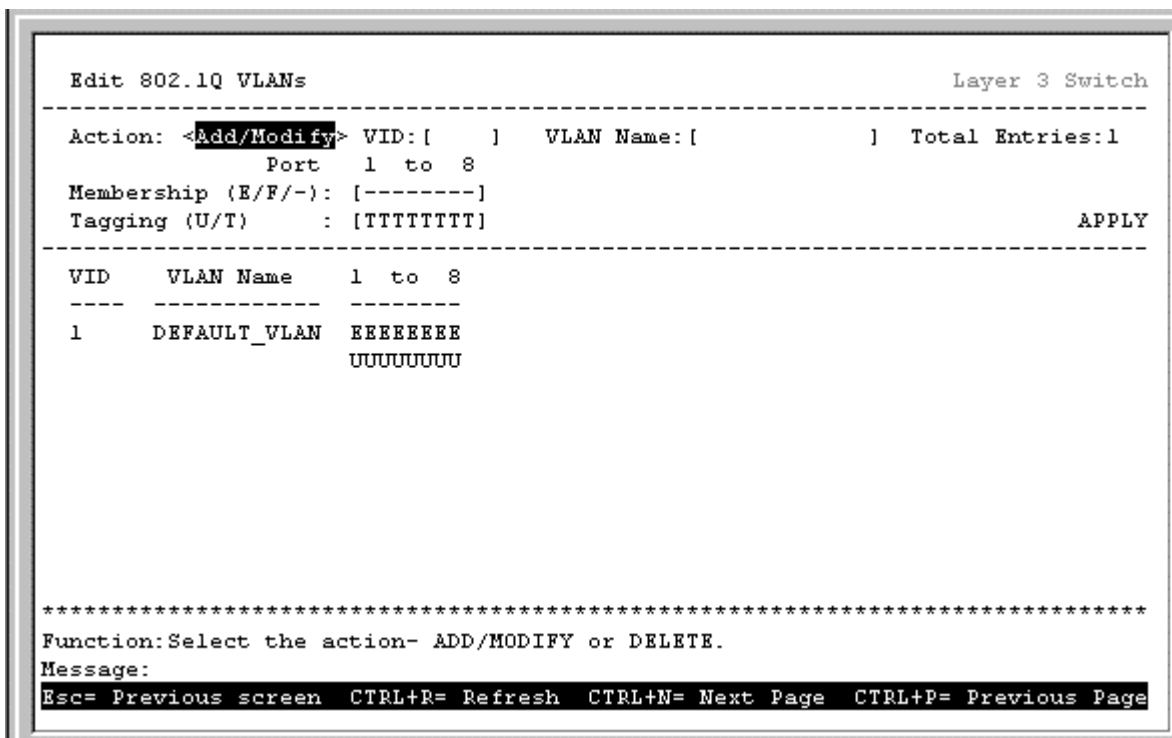


Figure 6-27. Edit 802.1Q VLANs menu

To create an 802.1Q VLAN, toggle the **Action:** *<Add/Modify>* field to *Add/Modify* using the space bar. Enter a VLAN ID number in the **VID:**[] field and a name for the new VLAN in the **VLAN Name:**[] field.

Choose which ports will be members of the new VLAN and enter their membership status in the **Membership (E/F/-):** [II II] field. The status indicators of the individual ports can be entered directly from the keyboard or toggled using the space bar. Moving between the status indicators of the individual ports is accomplished using the arrow keys.

To set the 802.1Q VLAN membership status of a port:

To enter the 802.1Q VLAN status for a port, highlight the first field of **Membership (E/F/-):** [II II]. Each port's 802.1Q VLAN membership can be set individually by highlighting the port's entry using the arrow keys, and then toggling between *E*, *F*, or – using the space bar.

- *E* - (Egress Member) specifies the port as being a static member of the VLAN. Egress Member Ports are ports that will be transmitting traffic for the VLAN. These ports can be either tagged or untagged.
- *F* - (Forbidden Non-Member) specifies the port as not being a member of the VLAN and that the port is forbidden from becoming a member of the VLAN dynamically.
- (Non-Member) specifies the port as not being a member of the VLAN, but the port can become a member of the VLAN dynamically.

Next, determine which of the ports that are members of the new VLAN will be Tagged or Untagged ports.

To set a port as either a Tagged or an Untagged port:

Highlight the first field of **Tagging (U/T):**[II II] field. Each port's state can be set by highlighting the port's entry using the arrow keys and then toggling between U or T using the space bar.

- *U* - specifies the port as an Untagged member of the VLAN. When an untagged packet is transmitted by the port, the packet header remains unchanged. When a tagged packet exits the port, the tag is stripped and the packet is changed to an untagged packet.
- *T* - specifies the port as a Tagged member of the VLAN. When an untagged packet is transmitted by the port, the packet header is changed to include the 32-bit tag associated with the PVID (Port VLAN Identifier – see below). When a tagged packet exits the port, the packet header is unchanged.

If the port is attached to a device that is not IEEE 802.1Q VLAN compliant (VLAN-tag unaware), then the port should be set to *U* – Untagged.

If the port is attached to a device that is IEEE 802.1Q VLAN compliant, (VLAN-tag aware), then the port should be set to *T* – Tagged.

Press **APPLY** to make the additions/deletions effective for the current session. To make enter the IP Interfaces into Non-volatile RAM, highlight **Save Changes** from the **Main Menu** and press **Enter**.

In the following example screen, the VLAN “Accounting” - VID# 2 – has been added. Ports 7 and 8 are Egress ports (static members of “Accounting”). Ports 5 and 6 are Forbidden ports (non-members and are not allowed to join the VLAN “Accounting” dynamically).

Example 802.1Q VLAN add screen:

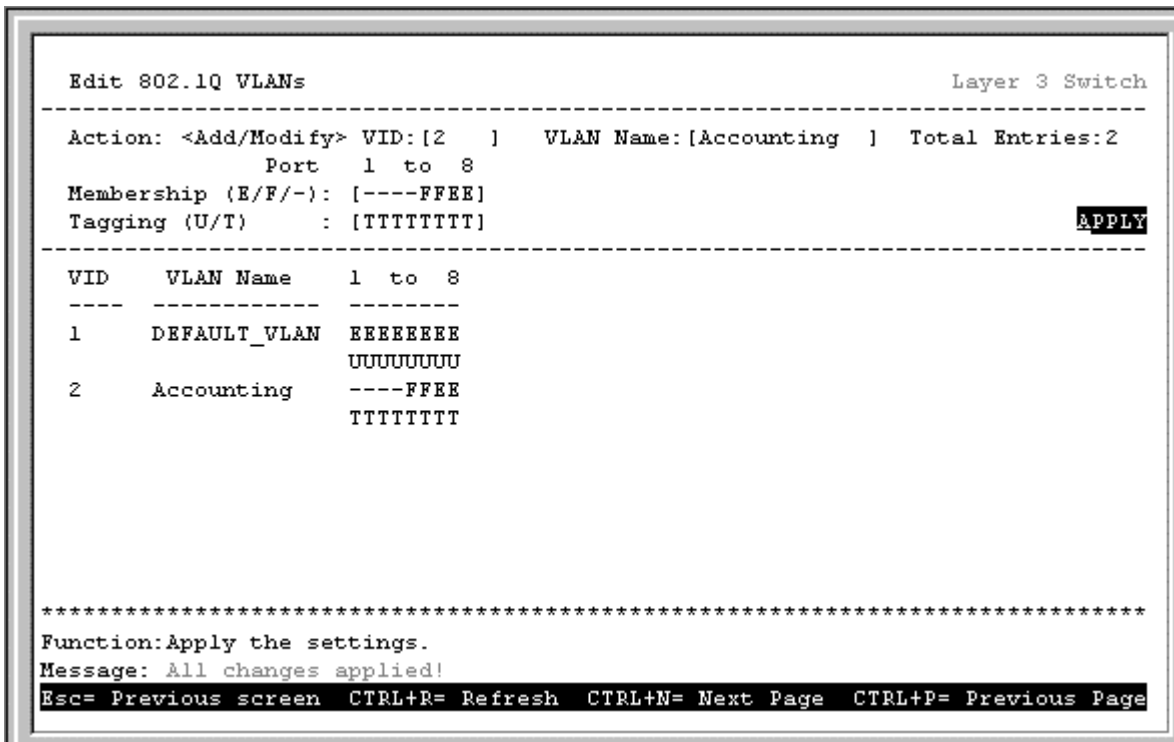


Figure 6-28. Edit 802.1Q VLANs menu

Note: The default VLAN includes all of the ports on the Switch at first boot. As new VLANs are added, the member ports of the new VLAN are deleted from the default VLAN.

To configure the member ports of an 802.1Q VLAN:

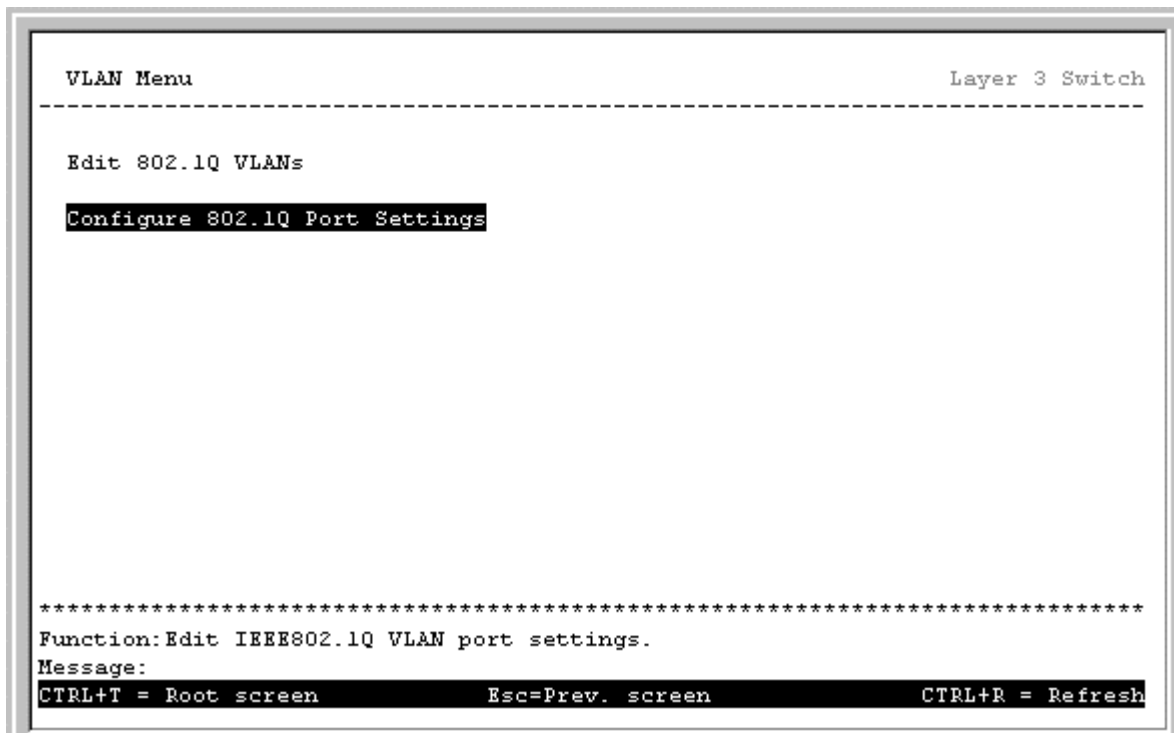


Figure 6-29. VLAN Menu

To configure the port settings of an 802.1Q VLAN, highlight **Configure 802.1Q Port Settings** and press **Enter**:

```

Configure 802.1Q Port Settings                                     Layer 3 Switch
-----
Configure Port from [1 ] to [1 ]
PVID [1 ] Ingress Filter:<Disabled> GVRP:<Disabled> GMRP: Disabled  APPLY
-----
Port          1    2    3    4    5    6    7    8
-----
PVID          1    1    1    1    1    1    1    1
Ingress      DIS DIS DIS DIS DIS DIS DIS DIS
GVRP         DIS DIS DIS DIS DIS DIS DIS DIS
GMRP         DIS DIS DIS DIS DIS DIS DIS DIS

*****
Function:Input port number.
Message:
CTRL+T = Root screen          Esc=Prev. screen          CTRL+R = Refresh

```

Figure 6-30. Configure 802.1Q Port Settings screen

Each port can be configured to use an Ingress Filter. The ports to be configured in a given session can be identified by either entering a range of port numbers or by entering the PVID#.

Ingress filtering is toggled between *On* and *Off* using the space bar.

To configure a port's 802.1Q VLAN settings:

Highlight the **Configure Port from [] to []** field and enter the range of port numbers you want to configure. As an alternative you can use the arrow keys to highlight the **PVID[]** field and enter the PVID for the VLAN's member ports you want to configure.

- **PVID** – A Port VLAN Identifier is a classification mechanism that associates a port with a specific VLAN and is used to make forwarding decisions for untagged packets received by the port. For example, if port #2 is assigned a PVID of 3, then all untagged packets received on port #2 will be assigned to VLAN 3. This number is generally the same as the VID# number assigned to the port in the Edit 802.1Q VLANs menu above.

Use the arrow keys to highlight the remaining fields and the space bar to toggle between *On* and *Off*.

- **Ingress Filter** – This enables the port to compare the VID tag of an incoming packet with the PVID number assigned to the port. If the two are different, the port filters (drops) the packet.
- **GVRP** – The Group VLAN Registration Protocol enables the port to dynamically become a member of a VLAN.
- **GMRP** – The Group Multicast Registration Protocol enables the port to dynamically become a member of a multicast group. **This function is not supported in the current version of the Switch software.**

To edit an existing 802.1Q VLAN:

Highlight **VLANs** on the main menu and press **Enter**:

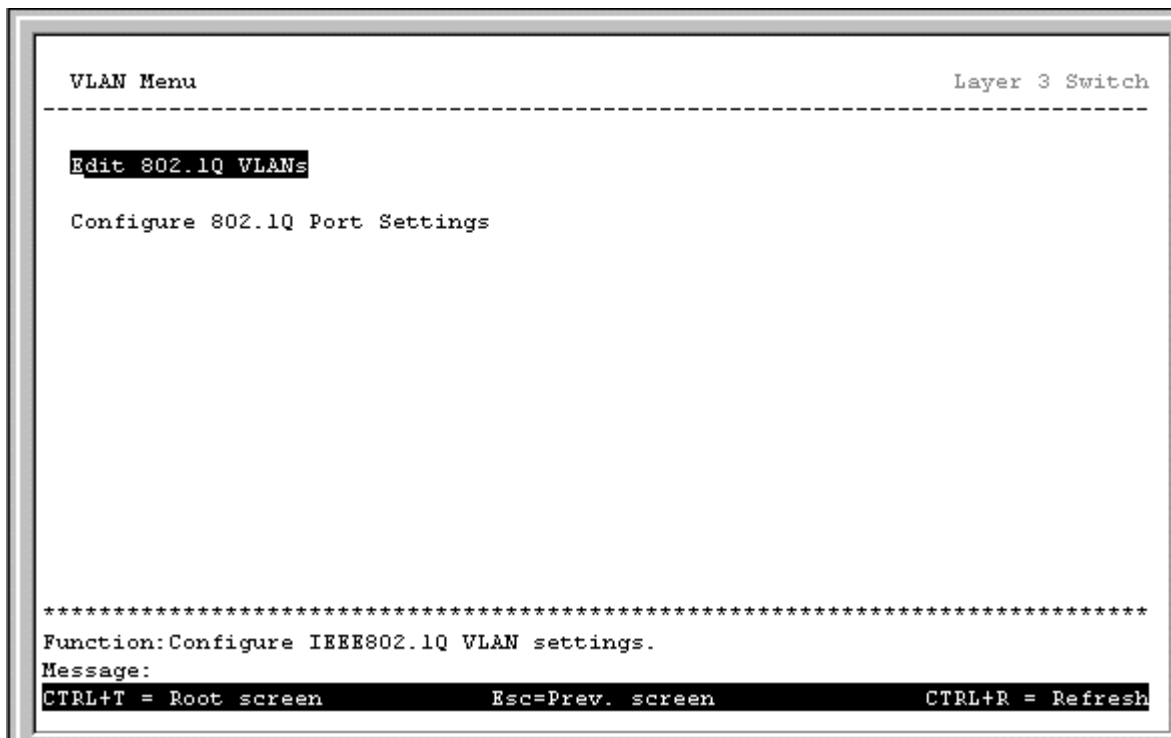


Figure 6-31. VLAN Menu

To edit an existing 802.1Q VLAN, highlight **Edit 802.1Q VLANs** and press **Enter**:

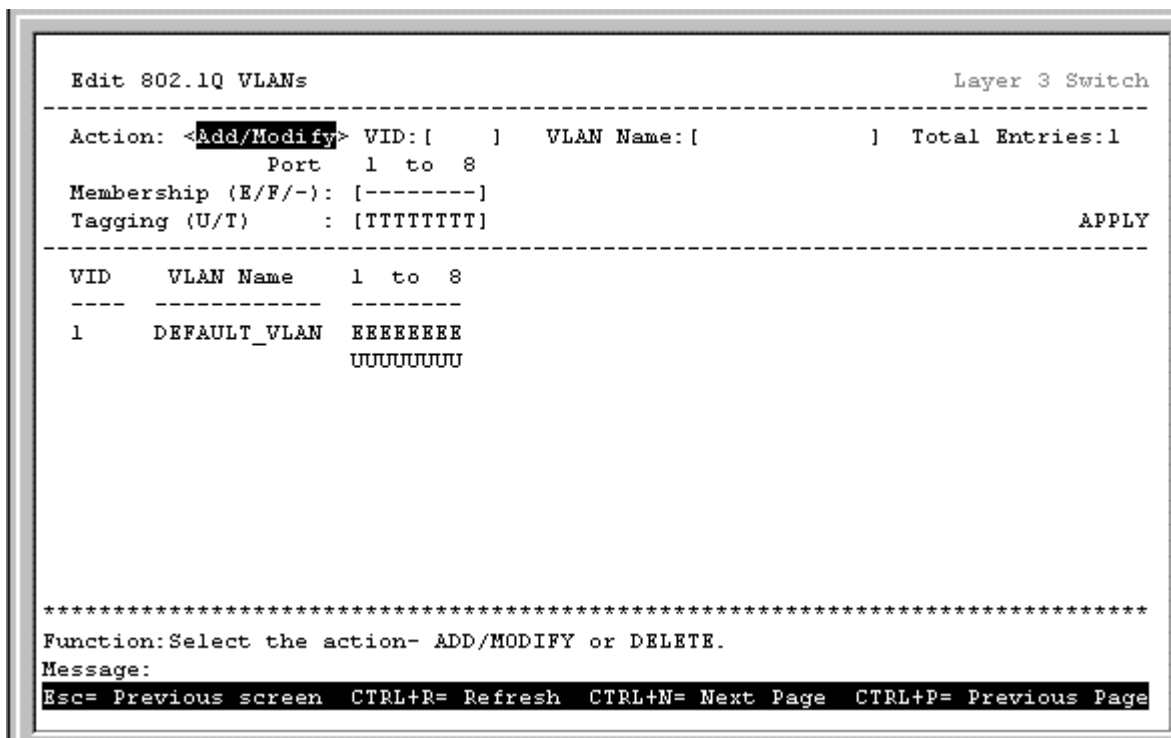


Figure 6-32. Edit 802.1Q VLANs screen

To edit an existing 802.1Q VLAN, highlight the **Action:<Add/Modify>** field and toggle between *Add/Modify* and *Delete*. In the *Add/Modify* mode, both individual entrees to a selected VLAN and entire VLANs can be added. In the

Delete mode, entire VLANs can be deleted. VLANs to be edited can be selected by either the **VID:[]** field or the **VLAN Name:[]** fields. Enter either the VID or the VLAN Name for the 802.1Q VLAN you want to edit and press **Enter**.

Note: To delete an entire VLAN, toggle the **Action:<Add/Modify>** field to Delete, enter either the VID or the VLAN Name in the appropriate field and press **Enter**. Highlight Apply and press **Enter**. The selected VLAN will be deleted. To enter the change into Non-volatile RAM, select **Save Changes** from the **Main Menu**.

The 802.1Q VLANs are edited by specifying which ports will be Egress Members, Forbidden non-members or non-members.

The ports are further set to be either a Tagged or an Untagged port.

To edit the 802.1Q VLAN membership of a port

Highlight the first field of **Membership (E/F/-): [][]**. Each port's 802.1Q VLAN membership can be set individually by highlighting the port's entry using the arrow keys, and then toggling between *E*, *F*, or *-* using the space bar.

- *E* - (Egress Member) specifies the port as being a static member of the VLAN. Egress Member Ports are ports that will be transmitting traffic for the VLAN. These ports can be either tagged or untagged.
- *F* - (Forbidden Non-Member) specifies the port as not being a member of the VLAN and that the port is forbidden from becoming a member of the VLAN dynamically.
- (Non-Member) specifies the port as not being a member of the VLAN, but the port can become a member of the VLAN dynamically.

To edit a port's Tagged or Untagged status:

Highlight the first field of **Tagging (U/T):[][]** field. Each port's state can be set by highlighting the port's entry using the arrow keys and then toggling between *U* or *T* using the space bar.

- *U* - specifies the port as an Untagged member of the VLAN. When an untagged packet is transmitted by the port, the packet header remains unchanged. When a tagged packet exits the port, the tag is stripped and the packet is changed to an untagged packet.
- *T* - specifies the port as a Tagged member of the VLAN. When an untagged packet is transmitted by the port, the packet header is changed to include the 32-bit tag associated with the PVID (Port VLAN Identifier – see below). When a tagged packet exits the port, the packet header is unchanged.

If the port is attached to a device that is not IEEE 802.1Q VLAN compliant (VLAN-tag unaware), then the port should be set to *U* – Untagged.

If the port is attached to a device that is IEEE 802.1Q VLAN compliant, (VLAN-tag aware), then the port should be set to *T* – Tagged.

Each port can be configured to have a PVID or to use an Ingress Filter.

To configure a port's 802.1Q VLAN settings:

Highlight the **Configure Port#[]** field and enter the port number of the port you want to configure. Use the arrow keys to highlight the **PVID#[]** field and enter the PVID for the port.

- **PVID** – A Port VLAN Identifier is a classification mechanism that associates a port with a specific VLAN and is used to make forwarding decisions for untagged packets received by the port. For example, if port #2 is assigned a PVID of 3, then all untagged packets received on port #2 will be assigned to VLAN 3. This number is generally the same as the VID# number assigned to the port in the **Edit Existing 802.1Q VLANs** menu above.

Use the arrow keys to highlight the remaining fields and the space bar to toggle between *On* and *Off*.

- **Ingress Filter** – This enables the port to compare the VID tag of an incoming packet with the PVID number assigned to the port. If the two are different, the port filters (drops) the packet.
- **GVRP** – Group VLAN Registration Protocol enables the port to dynamically become a member of a VLAN.
- **GMRP** – Group Multicast Registration Protocol enables the port to dynamically become a member of a multicast group. ***This function is not supported in the current version of the Switch software.***

Setting Up IP Interfaces

Note: A VLAN that does not have a corresponding IP interface defined for it, will function as a **Layer 2 Only VLAN** – regardless of the **Switch Operation mode**.

Each VLAN must be configured prior to setting up the corresponding IP interface.

An example is presented below:

VLAN Name	VID	Switch Ports
System (default)	1	7, 8
Engineering	2	1, 2
Marketing	3	5, 6
Shipping	4	3,4

Table 6-2. VLAN Example – Assigned Ports

In this case, 4 IP interfaces are required, so a CIDR notation of 10.32.0.0/10 (or a 10-bit) addressing scheme will work. This addressing scheme will give a subnet mask of 11111111.11000000.00000000.00000000 (binary) or 255.192.0.0 (decimal).

Using a 10.xxx.xxx.xxx IP address notation, the above example would give 4 network addresses and 4 subnets.

Any IP address from the allowed range of IP addresses for each subnet can be chosen as an IP address for an IP interface on the switch.

For this example, we have chosen the next IP address above the network address:

VLAN Name	VID	Network Address	IP Address
System (default)	1	10.0.0.0	10.0.0.1
Engineering	2	10.64.0.0	10.64.0.1
Marketing	3	10.128.0.0	10.128.0.1
Shipping	4	10.192.0.0	10.192.0.1

Table 6-3. VLAN Example – Assigned IP Addresses

The 4 IP interfaces, each with an IP address (listed in the table above), and a subnet mask of 255.192.0.0 can be entered into the **Setup IP Interface** menu.

Note: IP interfaces consist of two parts – a subnet mask and an IP address.

Note: Each IP interface listed above will give a maximum of 2,097,150 unique IP addresses per interface (assuming the 10.xxx.xxx.xxx notation).

To setup IP Interfaces on the switch:

Highlight **Layer 3 IP Networking** from the **Main Menu** and press **Enter**.

```
Setup Layer 3 - IP Networking                                Layer 3 Switch
-----
IP Interface:                                             Routing Protocols:
  Setup IP Interface                                     Setup RIP Configuration

*****
Function: Setup IP interface.
Message:
CTRL+T = Root screen          Esc=Prev. screen          CTRL+R = Refresh
```

Figure 6-33. Setup Layer 3 – IP Networking menu

Highlight **Setup IP Interface** and press **Enter**.


```

Setup IP Interface                                     Layer 3 Switch
-----
Action:<Add/Modify>
Interface Name:[   ]                                VID:[   ]
IP Address :[0.0.0.0   ]                            Active:<Yes>
Subnet Mask:[0.0.0.0   ]

Total IP Interface: 1      APPLY
-----
Interface Name: System                                1 to 8
IP Address : 10.24.22.9                               MMMMMMM
Subnet Mask: 255.0.0.0
VID      : 1
Active   : Yes

Interface Name:                                     1 to 8
IP Address :
Subnet Mask:
VID      :
Active   :
*****
Function:Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-34. Setup IP Interface screen

Toggle the **Action:<Add/Modify>** field to *Add/Modify*. Choose a name for the interface to be added and enter it in the **Interface Name:[]** field. The corresponding VLAN ID must also be entered in the **VID:[]** field. Enter the interface's IP address and subnet mask in the corresponding fields. Toggle the **Active:<Yes>** field to **yes**, highlight **APPLY** and press enter to make the IP interface effective. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

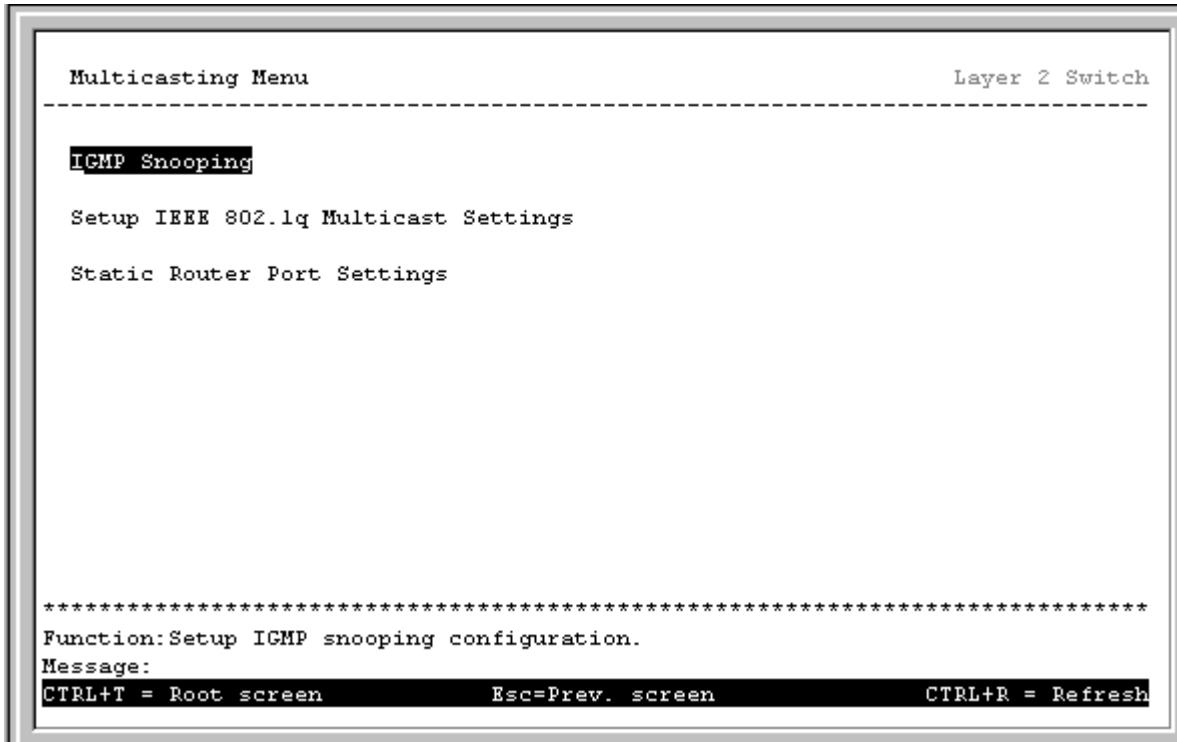
- **Action:<Add/Modify>** – This field can be toggled between *Add/Modify* and *Delete* using the space bar. This enables the addition/modification of a new or existing IP interface entry or the deletion of an existing entry.
- **Interface Name:[]** – Allows the entry of a name for the IP interface. The default IP interface is named “System”.
- **IP Address:[]** – The IP address to be assigned to this subnet.
- **Subnet Mask:[]** – The subnet mask to be applied to this subnet. It has the same form as an IP address.
- **Active:<Yes>** – Toggled between *Yes* and *No*. This entry makes determines whether the interface will be active or not.
- **VID:[]** – Allows the entry of the VLAN ID number for the VLAN the IP interface belongs to. The VLAN must have been previously created.

Press **APPLY** to make the additions/deletions effective for the current session. To make enter the IP Interfaces into NV-RAM, use **Save Changes** from the **Main Menu**.

Multicasting

Layer 2 Multicast Setup

To access the **Multicasting Menu**, highlight **Multicasting** from the **Main Menu** and press **Enter**.



```
Multicasting Menu                                     Layer 2 Switch
-----
IGMP Snooping
Setup IEEE 802.1q Multicast Settings
Static Router Port Settings

*****
Function: Setup IGMP snooping configuration.
Message:
CTRL+T = Root screen          Esc=Prev. screen          CTRL+R = Refresh
```

Figure 6-35. Multicasting Menu

IGMP Snooping Settings – by VLAN

To Enable or Disable IGMP Snooping for a VLAN, highlight **IGMP Snooping Settings**, and press **Enter**.

```

IGMP Snooping                                     Layer 2 Switch
-----
Switch IGMP Snooping: <Disabled>

Querier State:<Non-Querier>
Robustness Variable:[2 ]      Query Interval:[125 ]      Max Response:[10]

                                           APPLY

Age Out = Robustness Variable * Query Interval + Max Response = 260
*****
Function:Set IGMP snooping status.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-36. IGMP Snooping screen

To edit a VLAN's IGMP Snooping Settings:

- **Switch IGMP Snooping:**< > – This field can be toggled between *Enabled* and *Disabled* using the space bar. This enables or disables IGMP snooping for the selected VLAN.
- **Querier State:**< > – This field determines whether the Switch is able to send IGMP snooping queries.
 - *Non-Querier* – This indicates the IGMP interface will never try to become a querier in the VLAN.
 - *V1-Querier* – If there is no querier present in the VLAN or the interface's IP address is smaller than the current querier—whether *V1-Querier* or *V2-Querier*—the IGMP interface will become the querier for the VLAN. An IGMPv1 query packet is sent in this mode. IGMPv2 Group Specific Query and leave packets are not handled.
 - *V2-Querier* – In this mode, if there is one *V1-Querier* present in the VLAN, the IGMP interface will keep silent. If there is no querier present in the VLAN or the interface's IP address is smaller than the current *V2-Querier*, the IGMP interface will become the querier for the VLAN. When receiving an IGMPv2 leave packet, the IGMP interface will issue an IGMPv2 Group Specific Query packet immediately and wait one second to see if any IGMP report is received on the Ethernet port. If not, the Ethernet port will be removed from the IGMP group member list and the group's multicast data will not be forwarded to this port until an IGMP report is received again.
- **Robustness Variable** – A numeric value between 2 and 255 that allows tuning for expected packet losses on a subnet. If a subnet is expected to have high packet losses, the robustness variable maybe increased. The default is 2.
- **Query Interval** – The time in seconds between transmission of IGMP packets.
- **Max Response** – Sets the maximum amount of time allowed before sending an IGMP response report value between 1 and 20 seconds can be entered, with a default of 10 seconds.

Robustness Variable, Query Interval, and Max Response values are combined to produce an IGMP age-out timer value between 10 and 9,999 seconds. This timer determines how long a snooped multicast member's IP and MAC

address remain in the IGMP address table. The default value is 260 seconds. To set the age-out timer for an individual IGMP snooping entry, you must enter values in the **Robustness Variable**, **Query Interval**, and **Max Response** fields as the age-out value is arrived at by multiplying the first two figures and then adding the last value.

IEEE 802.1Q Multicast Forwarding

To edit the IEEE802.1 Multicast Forwarding settings, highlight **IEEE 802.1Q Multicast Settings** from the **Multicasting Menu** and press **Enter**.

```

Setup IEEE 802.1q Multicast Forwarding                               Layer 2 Switch
-----
Action: <Add/Modify>      VID: [1  ]
Multicast MAC Address: [010101010101]
Port    1 to 8
(E/F/-) [-----EE]

Total Entries: 1  APPLY
-----
MAC Address  VID    1 to 8
-----
010101010101  1    -----EE

*****
Function:Apply the settings.
Message: All changes applied!
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-37. Setup IEEE 802.1Q Multicast Forwarding

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. To add a new entry to the multicast forwarding table, select *Add/Modify* and enter the VID of the VLAN that will be receiving the multicast packets. Enter the MAC address of the multicast source, and then enter the member ports.

Each port can be an Egress, Forbidden, or a Non-member of the multicast group, on a per-VLAN basis.

To set a port's multicast group membership status, highlight the first field of **(E/F/-): [][][]**. Each port's multicast group membership can be set individually by highlighting the port's entry using the arrow keys, and then toggling between *E*, *F*, or – using the space bar.

- *E* - (Egress Member) specifies the port as being a static member of the multicast group. Egress Member Ports are ports that will be transmitting traffic for the multicast group.
- *F* - (Forbidden Non-Member) specifies the port as not being a member of the multicast group and that the port is forbidden from becoming a member of the multicast group dynamically.
- (Non-Member) specifies the port as not being a member of the multicast group, but the port can become a member of the multicast group dynamically.

Static Router Port

Note: There is no difference between the setup of a 'router port' in **Layer 2 Only** mode and in **IP Routing** mode.

Note: A router port allows UDP multicast and IGMP packets to be forwarded to a designated port on the switch regardless of VLAN configuration.

Note: A router port functions within layer 2 of the OSI model. This section is repeated in the **Layer 3 Multicasting** section of this manual below because of the possible confusion caused by the term 'router port' when compared to a traditional router.

A static router port is a port that has a router attached to it. Generally, this router would have a connection to a WAN or to the Internet. Establishing a router port will allow multicast packets coming from the router to be propagated through the network, as well as allowing multicast messages coming from the network to be propagated to the router.

The purpose of a router port is to enable UDP multicast packets, and IGMP multicast group membership messages to reach multiple ports of a multicast-enabled router. Routers do not implement IGMP snooping or transmit/forward IGMP report packets. Thus, forwarding all IP UDP multicast packets to a static router port on the DGS-3308 guarantees that all ports of a multicast-enabled router – attached to the DGS-3308– can reach all multicast group members through the attached router's other ports.

To setup a static router port, highlight **Static Router Port Settings** from the **Multicasting Menu** and press **Enter**.

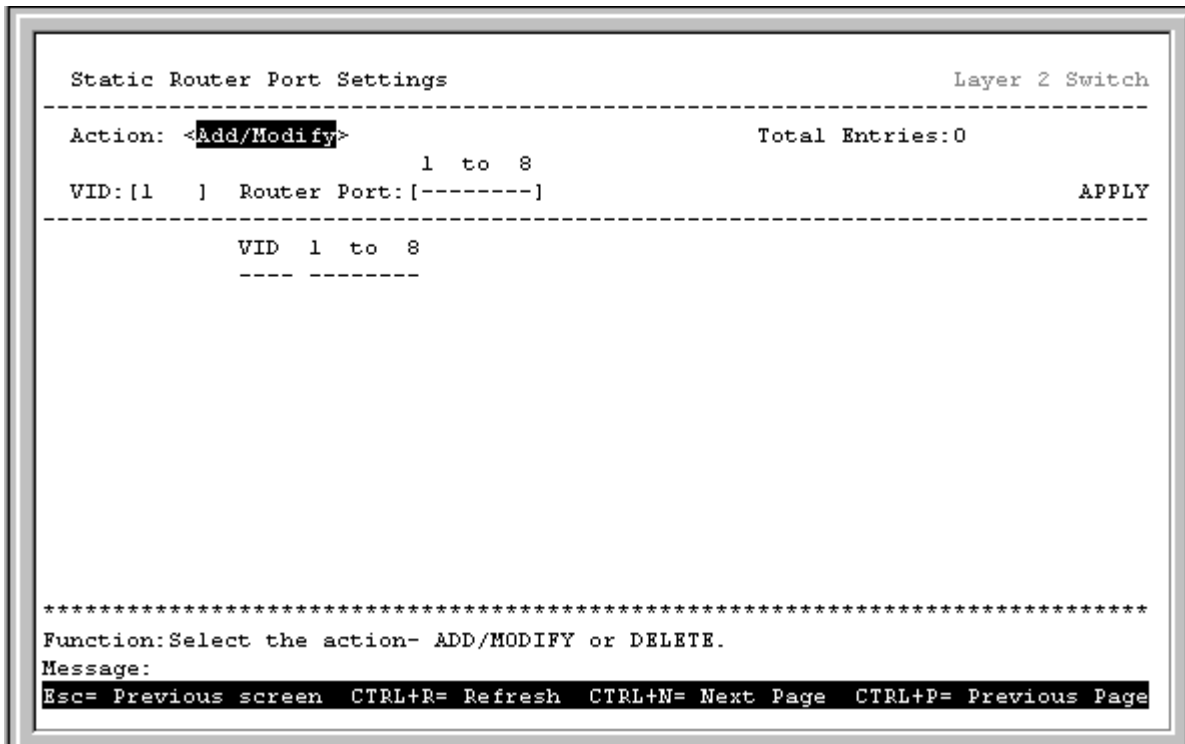


Figure 6-38. Static Router Port Settings screen

Note: All IGMP Report packets will be forwarded to the router port.

Note: IGMP queries (from the router port) will be flooded to all ports.

Note: All UDP multicast packets will be forwarded to the router port. Because routers do not send IGMP reports or implement IGMP snooping, a multicast-enabled router connected to the router

port of the Layer 3 switch would not be able to receive UDP data streams at all of its ports unless the UDP multicast packets were all forwarded to the router port.

Note: A router port will be dynamically configured when IGMP query packets, RIPv2 multicast, DVMRP multicast, PIM-DM multicast packets are detected flowing into a port. It is recommended that router ports be statically configured whenever possible.

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. To add a port to the static router port table, select *Add/Modify* and enter the VID of the VLAN the router port will belong to.

Highlight the first field of **Router Port (M-):**[]. Each port can be set individually as a router port by highlighting the port's entry using the arrow keys, and then toggling between *M* and *-* using the space bar.

Highlight **APPLY** and press enter to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

To delete an entry, select **Delete** and enter the VID of the VLAN for which the router port table entry is to be deleted. Highlight **APPLY** and press **Enter**. The entry for the VLAN will be deleted. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

Layer 3 Multicasting

With the Switch in IP Routing mode, highlight **Multicasting** from the **Main Menu** and press **Enter**.

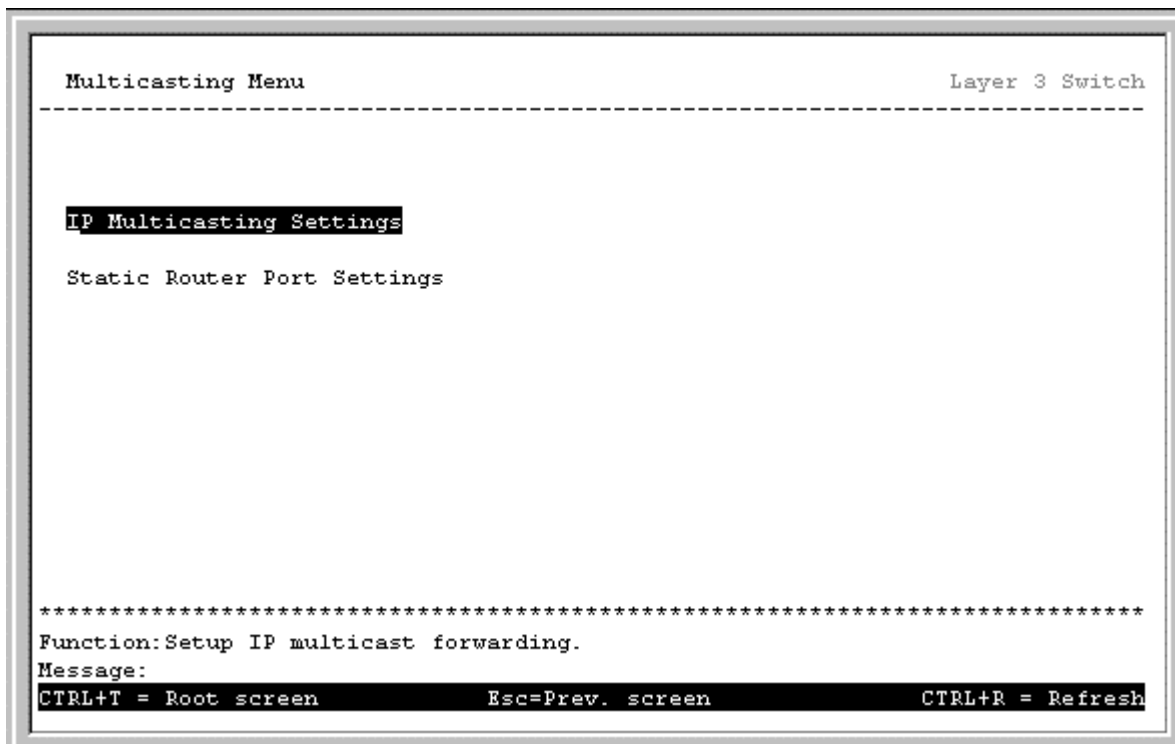


Figure 6-39. Multicasting Menu

To set up IP multicasting on the Switch, highlight **IP Multicast Settings** from the **Multicasting Menu** and press **Enter**.

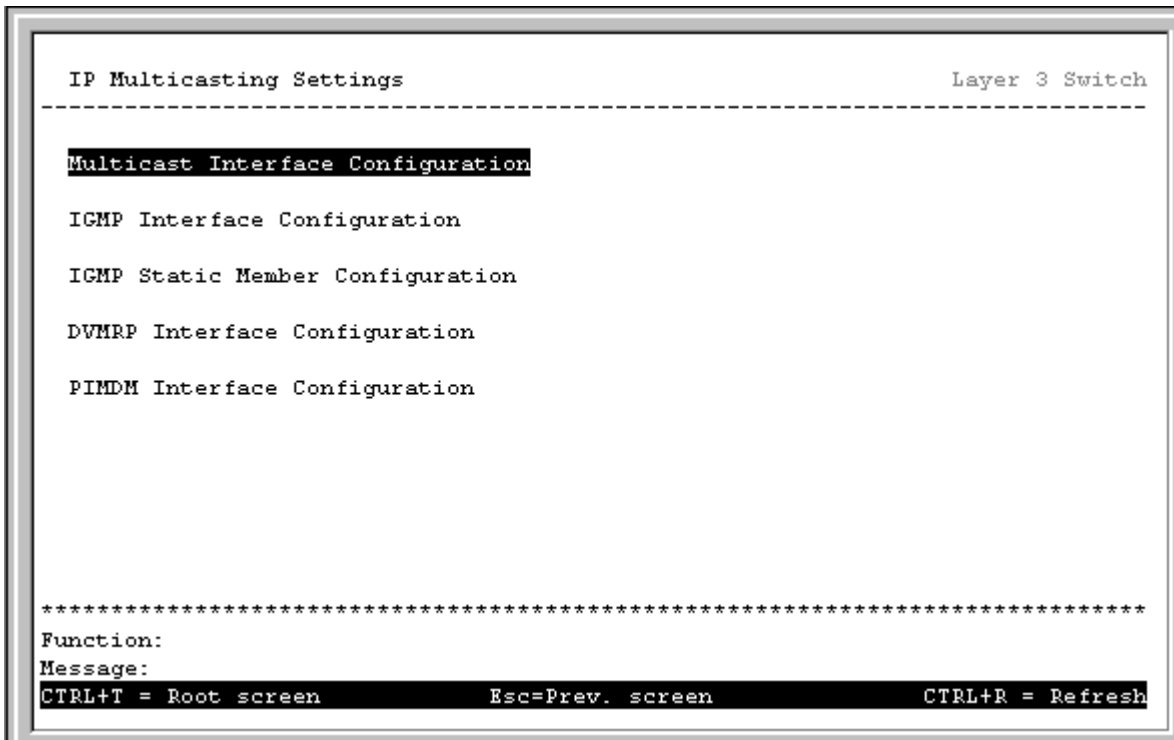


Figure 6-40. IP Multicast Settings menu

Multicast Interface Configuration

To configure the multicast interface, highlight **Multicast Interface Configuration** and press **Enter**.

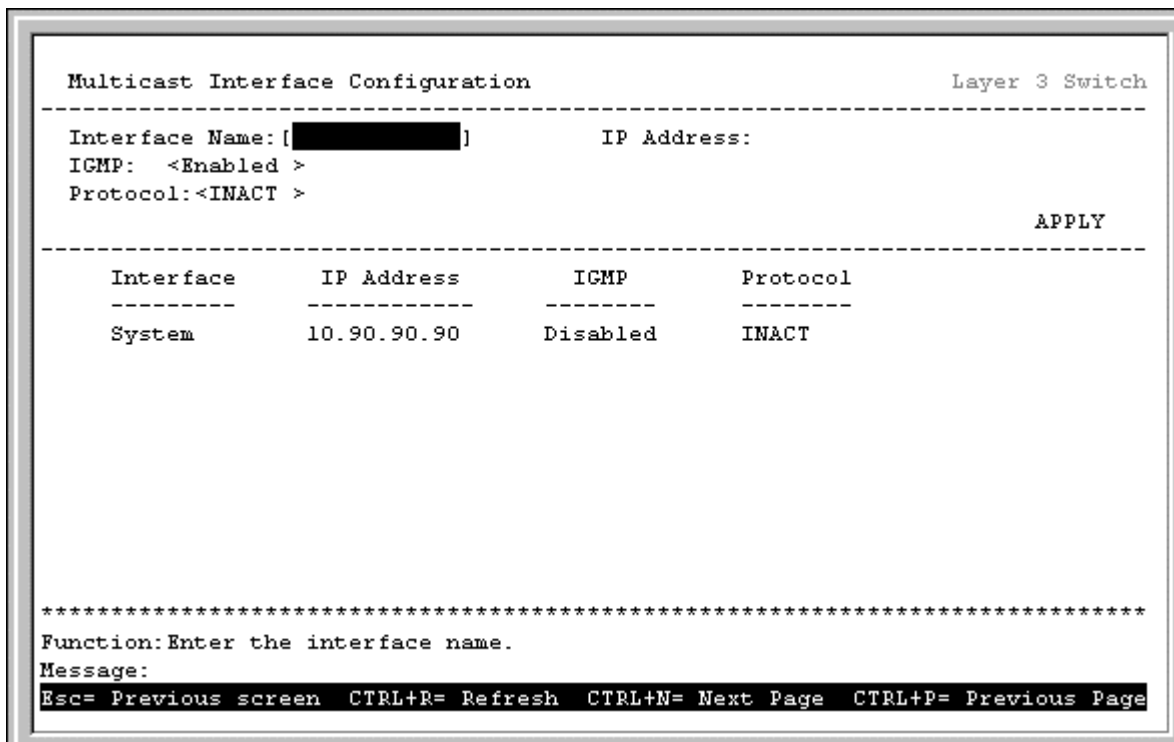


Figure 6-41. Multicast Interface Configuration screen

- **Interface Name:**[] – Enter the name of the IP interface that is to be configured for multicasting in this field. This must be a previously configured IP interface. See *Setting up IP Interfaces* in Chapter 6 of this manual for more information.
- **IGMP:** < > – Toggle between *Enabled* and *Disabled* using the space bar. This will enable or disable IGMP for the IP interface entered above.
- **Protocol:** < > – Toggle among *PIM-DM* (Protocol Independent Multicasting – Dense Mode), *DVMRP* (Distance Vector Multicasting Routing Protocol), and *INACT* (inactive). *INACT* is not a multicast routing protocol. It is used to make a given interface inactive for IP routing.

IGMP Interface Configuration

To configure the IGMP interface, highlight **IGMP Interface Configuration** from the **IP Multicasting Settings** menu and press **Enter**.

```

IGMP Interface Configuration                                     Layer 3 Switch
-----
Interface Name: [      ] IP Address:
Querier State : <V2-Querier> Query: [125 ] Max Response: [10]
Robustness Var: [2 ]
                                                                APPLY
-----
Interface      IP Address      Querier State  Query Max Response Robustness Var
-----
System        10.24.22.9      V2-Querier    125     10           2

*****
Function: Input the interface name.
Message:
Esc= Previous screen CTRL+R= Refresh CTRL+N= Next Page CTRL+P= Previous Page

```

Figure 6-42. IGMP Interface Configuration screen

- **Interface Name:**[] – Enter the name of the interface in this field. This interface must be previously defined.
- **Querier State:**< > – This field can be toggled between *V1-Querier* and *V2-Querier*. This is the version of IGMP that the interface will use (IGMP version 1 or IGMP version 2).
- **Query:**[] – This field allows an entry between *1* and *65,500* seconds and defines the time between transmitting IGMP queries.
- **Max Response:**[] – This field allows an entry between *1* and *25* and defines the maximum time allowed before sending a response report to a query measured in units of 1/10 of a second. This is used to adjust the “leave latency”, the time interval between the moment the last host leaves a group and when the routing protocol is notified there are no more members.

- **Robustness Var:**[] – This is a tuning variable to allow for subnetworks that are expected to lose a large number of packets. A value between 2 and 255 can be entered, with larger values being specified for subnetworks that are expected to lose larger numbers of packets

IGMP Static Member Configuration

To configure IGMP static members, highlight **IGMP Static Member Configuration** on the **IP Multicasting Settings** menu and press **Enter**.

```

IGMP Static Member Configuration                                Layer 3 Switch
-----
Action: <Add/Modify>                                         Total Entries: 0
Interface Name: [      ]                                     IP Address:
IGMP Static Group: [0.0.0.0      ]                          Group MAC Addr:
                   1 to 8
Port (M/-): [-----]                                       State: <Enabled >      APPLY
-----
Interface      IGMP static Group 1 to 8 Status
-----
*****
Function: Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-43. IGMP Static Member Configuration screen

- **Action:**<Add/Modify> – This field can be toggled between *Add/Modify* and *Delete*. *Add/Modify* allows you to enter a new IGMP Static Member into the table, or to modify an existing entry. *Delete* allows you to delete an existing entry.
- **Interface Name:**[] – Enter the IP Interface name the IGMP Static Member belongs to in this field.
- **IGMP Static Group:**[] – Enter the IP address of the IGMP Static Group in this field.
- **Group MAC Addr:** – Displays the MAC address corresponding to the IGMP Static Group IP address entered above.
- **IP Address:** – Displays the IP address corresponding to the IP interface entered above.
- **State:**<Enabled> – Can be toggled between *Enabled* and *Disabled*.
- **Total Entries:** – Displays the total number of entries into the Switch's IGMP Static Member table.

DVMRP Interface Configuration

To configure DVMRP for an IP interface, highlight **DVMRP Interface Configuration** from the **IP Multicasting Settings** menu and press **Enter**.

```

DVMRP Interface Configuration                                     Layer 3 Switch
-----
Interface Name:[System ]          IP Address:10.24.22.9
Neighbor Time-Out Interval:[35   ] Probe Interval:[10   ]
Route Metric:[1   ]              Include Unknown Neighbor Report:<Disabled>
State:<Disabled>                                                         APPLY
-----
IF          IP Address      Neighbor Probe   Route State      Include Unknown
          Time-Out Interval Metric      Neighbor Report
          Interval
-----
System     10.24.22.9       35      10      1   Disabled      Disabled

*****
Function:Input the interface name.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-44. DVMRP Interface Configuration screen

- **Interface Name:** [] – Enter the name of the IP interface for which DVMRP is to be configured in this field. This must be a previously defined IP interface. See *Setting up IP Interfaces* in Chapter 6 of this manual for more information.

Note: *The Distance Vector Multicast Routing Protocol (DVMRP) is a hop-based method of building multicast delivery trees from multicast sources to all nodes of a network. Because the delivery trees are 'pruned' and 'shortest path', DVMRP is relatively efficient. Because multicast group membership information is forwarded by a distance-vector algorithm, propagation is slow. DVMRP is optimized for high delay (high latency) relatively low bandwidth networks, and can be considered as a 'best-effort' multicasting protocol. See Chapter 5, Distance-Vector Multicasting Routing Protocol for more information.*

Note: *DVMRP resembles the Routing Information Protocol (RIP), but is extended for multicast delivery. It relies upon RIP hop counts to calculate 'shortest paths' back to the source of a multicast message, but defines a 'route cost' to calculate which branches of a multicast delivery tree should be 'pruned' – once the delivery tree is established.*

Note: *When a sender initiates a multicast, DVMRP initially assumes that all users on the network will want to receive the multicast message. When an adjacent router receives the message, it checks its unicast routing table to determine the interface that gives the shortest path (lowest cost) back to the source. If the multicast was received over the shortest path, then the adjacent router enters the information into its tables and forwards the message. If the message is not received on the shortest path back to the source, the message is dropped.*

Note: *DVMRP version 3 incorporates the Reverse Path Multicasting algorithm. See Chapter 5, Reverse Path Multicasting, for more information.*

- **Neighbor Time-Out Interval:**[35] – This field allows an entry between 1 and 65,535 seconds and defines the time period for which DVMRP will hold Neighbor Router reports before issuing poison route messages. The default is 35 seconds.

- Route Metric:[1]** – This field allows an entry between 1 and 255 and defines the route cost for the IP interface. The DVMRP route metric is a relative number that represents the real cost of using this route in the construction of a multicast delivery tree. It is similar to, but not defined as, the hop count in RIP. The default cost is 1.

Note: Route metric is a relative number that is used by DVMRP to calculate which branches of a multicast delivery tree should be 'pruned'.

Note: The higher the route cost, the lower the probability that the current route will be chosen to be an active branch of the multicast delivery tree (not 'pruned') – if there is an alternative route.
- Probe Interval:[10]** – This field allows an entry between 0 and 65,535 seconds and defines the interval between 'probes'. The default is 10. DVMRP defines an extension to IGMP that allows routers to query other routers to determine if a multicast group is present on an given IP interface or not.
- State:<Disabled>** – Toggle between *Enabled* and *Disabled* to enable or disable DVMRP for the IP interface. The default is *Disabled*.
- Include Unknown Neighbor Report:<Disabled>** – Allows the Layer 3 switch to accept a DVMRP route report from a non-adjacent neighbor.

PIM-DM Interface Configuration

To configure PIMDM for an IP interface:

Highlight **PIMDM Interface Configuration** from the **IP Multicasting Settings** menu and press **Enter**.

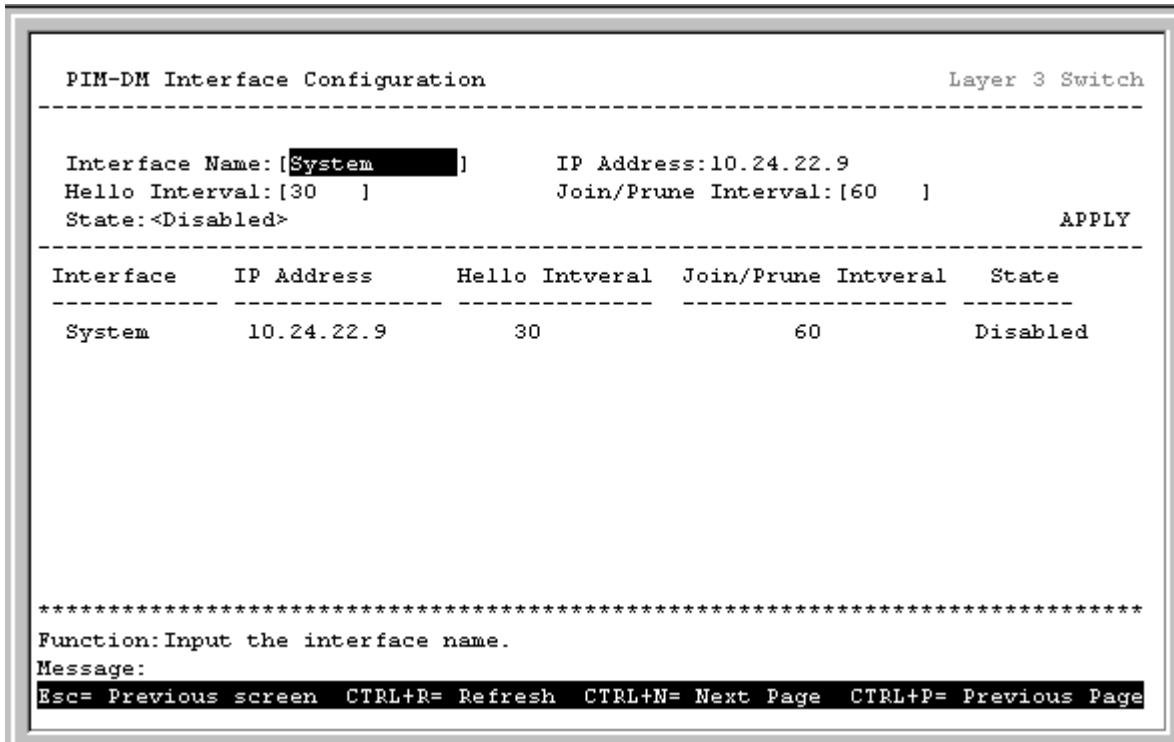


Figure 6-45. PIM-DM Interface Configuration screen

- Interface Name:[]** – Enter the name of the IP interface for which PIM-DM is to be configured in this field. This must be a previously defined IP interface. See *Setting up IP Interfaces* in Chapter 6 of this manual for more information.

Note: *The Protocol Independent Multicast – Dense Mode (PIM-DM) protocol should be used in networks with a low delay (low latency) and high bandwidth as PIM-DM is optimized to guarantee delivery of multicast packets, not to reduce overhead.*

- **Hello Interval:**[30] – This field allows an entry of between 1 and 18,724 seconds and determines the interval between sending Hello packets to other routers on the network. The Hello messages are used by the router to determine if it is the root router on the delivery tree or not. If the router does not receive a Hello message within the Hello Interval, it will begin transmitting Hello messages to advertise its availability to become the root router. The default is 30 seconds.
- **Join/Prune Interval:**[60] – This field allows an entry of between 1 and 18,724 seconds and determines the interval between transmitting (flooding to all interfaces) multicast messages to downstream routers, and automatically 'pruning' a branch from the multicast delivery tree. This interval also determines the time interval the router uses to automatically remove prune information from a branch of a multicast delivery tree and begin to flood multicast messages to all branches of that delivery tree. These two actions are equivalent. The default is 60 seconds.

Note: *The PIM-DM multicast routing protocol assumes that all downstream routers want to receive multicast messages and relies upon explicit prune messages from downstream routers to remove branches from the multicast delivery tree that do not contain multicast group members.*

Note: *PIM-DM has no explicit 'join' messages. It relies upon periodic flooding of multicast messages to all interfaces and then either waiting for a timer to expire (the **Join/Prune Interval**) or for the downstream routers to transmit explicit 'prune' messages indicating that there are no multicast members on their respective branches. PIM-DM then removes these branches ('prunes' them) from the multicast delivery tree.*

Note: *Because a member of a pruned branch of a multicast delivery tree may want to join a multicast delivery group (at some point in the future), the protocol periodically removes the 'prune' information from its database and floods multicast messages to all interfaces on that branch. The interval for removing 'prune' information is the **Join/Prune Interval**.*

- **State:**<Enabled> – Toggle between *Enabled* and *Disabled* using the space bar to enable or disable PIM-DM for the IP interface. The default is *Disabled*.

Static Router Port

Note: *There is no difference between the setup of a 'router port' in **Layer 2 Only** mode and in **IP Routing** mode.*

Note: *A router port allows UDP multicast and IGMP packets to be forwarded to a designated port regardless of VLAN configuration.*

Note: *A router port functions within layer 2 of the OSI model. This section is repeated in the **Layer 2 Multicasting** section of this manual above because of the possible confusion caused by the term 'router port' when compared to a traditional router.*

A static router port is a port that has a router attached to it. Generally, this router would have a connection to a WAN or to the Internet. Establishing a router port will allow multicast packets coming from the router to be propagated through the network, as well as allowing multicast messages coming from the network to be propagated to the router.

The purpose of a router port is to enable UDP multicast packets, and IGMP multicast group membership messages, to reach multiple ports of a multicast-enabled router. Routers do not implement IGMP snooping or transmit/forward IGMP report packets. Thus, forwarding all IP UDP multicast packets to a static router port on the DGS-3308 guarantees that all ports of a multicast-enabled router – attached to the DGS-3308 – can reach all multicast group members through the attached router's other ports.

To setup a static router port

Highlight **Static Router Port Settings** from the **Multicasting Menu** and press **Enter**.

```

Static Router Port Settings                                     Layer 3 Switch
-----
Action: <Add/Modify>                                         Total Entries:0
                               1 to 8
VID: [1 ] Router Port: [-----]                            APPLY
-----
                               VID 1 to 8
                               -----

*****
Function:Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-46. Static Router Port Setup screen

Note: All IGMP Report packets will be forwarded to the router port.

Note: IGMP queries (from the router port) will be flooded to all ports.

Note: All UDP multicast packets will be forwarded to the router port. Because routers do not send IGMP reports or implement IGMP snooping, a multi-port router connected to the router port of the Layer 3 switch would not be able to receive UDP data streams at all of its ports unless the UDP multicast packets were all forwarded to the router port.

Note: A router port will be dynamically configured when IGMP query packets, RIPv2 multicast, DVMRP multicast, PIM-DM multicast packets are detected flowing into a port.

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. To add a port to the static router port table, select *Add/Modify* and enter the VID of the VLAN the router port will belong to.

Highlight the first field of **Router Port** (:[]). Each port can be set individually as a router port by highlighting the port's entry using the arrow keys, and then toggling between *M* and *-* using the space bar.

Highlight **APPLY** and press **Enter** to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

To delete an entry, select *Delete* and enter the VID of the VLAN for which the router port table entry is to be deleted. Highlight **APPLY** and press **Enter**. The entry for the VLAN will be deleted. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

Mirroring

To configure a port for port mirroring, highlight **Mirroring** from the **Main Menu** and press **Enter**.



Figure 6-47. Mirroring Menu

To select the target port, highlight **Target Port Selection** and press **Enter**.

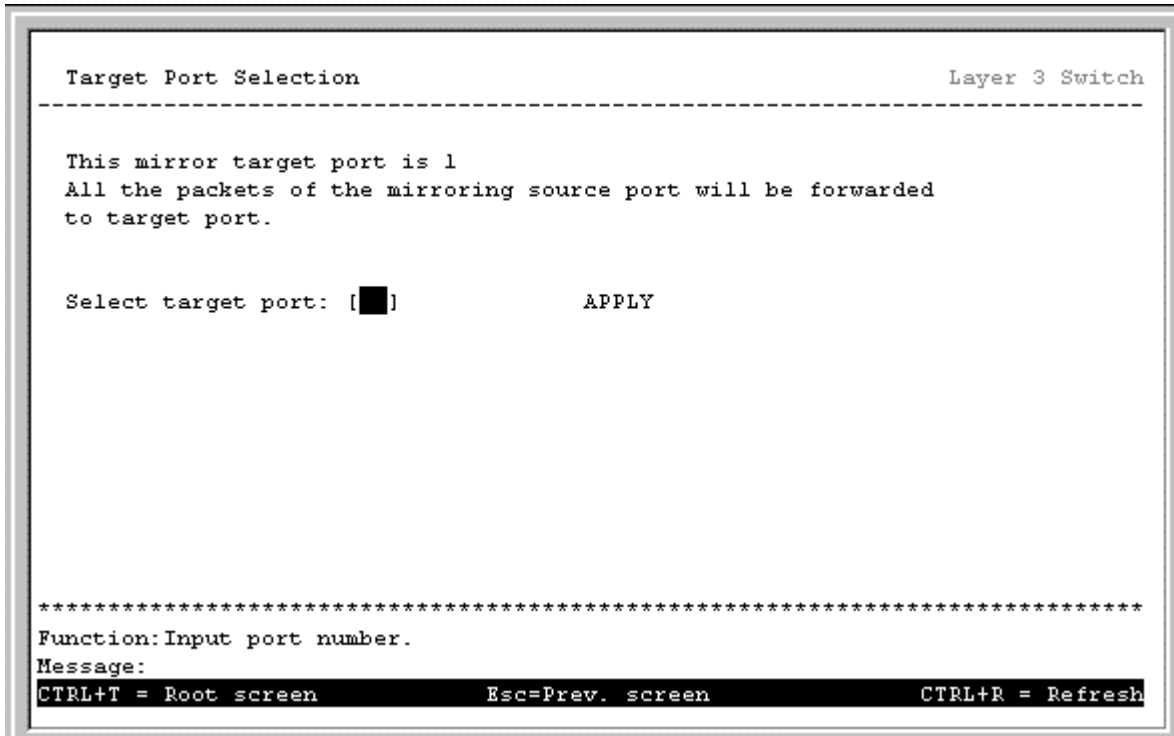


Figure 6-48. Target Port Selection screen

The target port is the port where information will be duplicated and sent for capture and network analysis. This is the port where a network analyzer would be attached to capture packets duplicated from the source port.

To select the source port(s) for mirroring, highlight **Port Mirroring Settings** and press **Enter**.

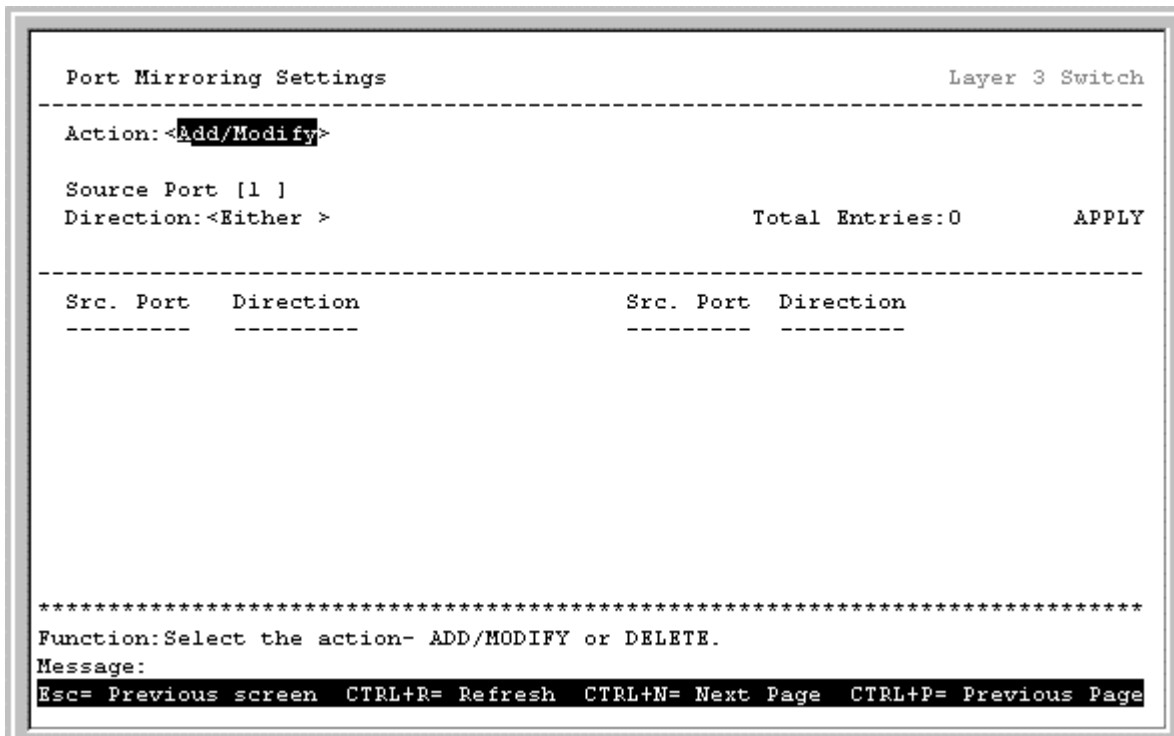


Figure 6-49. Port Mirroring Settings screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. Entries can be added, modified or deleted based upon the port number entered in the Source Port [] field.

The **Direction:**< > field can be toggled between *Either*, *Ingress*, and *Egress*. *Either* mirrors both received and transmitted packets at the given port. *Ingress* mirrors only received packets, while *Egress* mirrors only transmitted packets.

Up to 25 entries can be made to the port mirroring table, but it should be noted that a faster port (a 1000 Mbps Gigabit Ethernet port, for example) should not be mirrored to a slower port, because many packets will be dropped.

Priority

To configure a forwarding priority for a given MAC address, highlight **Priority** from the **Main Menu** and press **Enter**.

```

Setup MAC Address Priority                                     Layer 3 Switch
-----
Action: <Add/Modify>
VID: [1  ]
MAC Address: [000000000000]
Priority Level: <Low >
Source/Destination: <Src. >

                                                    Total Entries: 0      APPLY
-----
VID      MAC Address      Priority      Src/Dst
----      -
*****
Function: Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-50. Setup MAC Address Priority screen

- **Action:**< > - Toggle between *Add/Modify* and *Delete* using the space bar.
- **VID:**[] - Enter the VID (VLAN ID) in this field
- **MAC Address:**[] - Enter the MAC address for which the priority queue is required this field.
- **Priority Level:**< > - This field can be toggled among *Low*, *Med-L* (Medium Low), *Med-H* (Medium High), and *High*, corresponding to the priority of packets sent to or transmitted from the MAC address entered above.
- **Source/Destination:**< > - This field can be toggled among *Src.* (Source), *Dst.* (Destination), and *Either*, corresponding to whether the MAC address entered above will be transmitting packets (a source), receiving packets (a destination) or both (either).

Filtering

Layer 2 Filtering

Layer 2 Only switch operation mode.

To enter a MAC address into the filtering table:

Highlight **Filtering** from the **Main Menu** and press **Enter**.

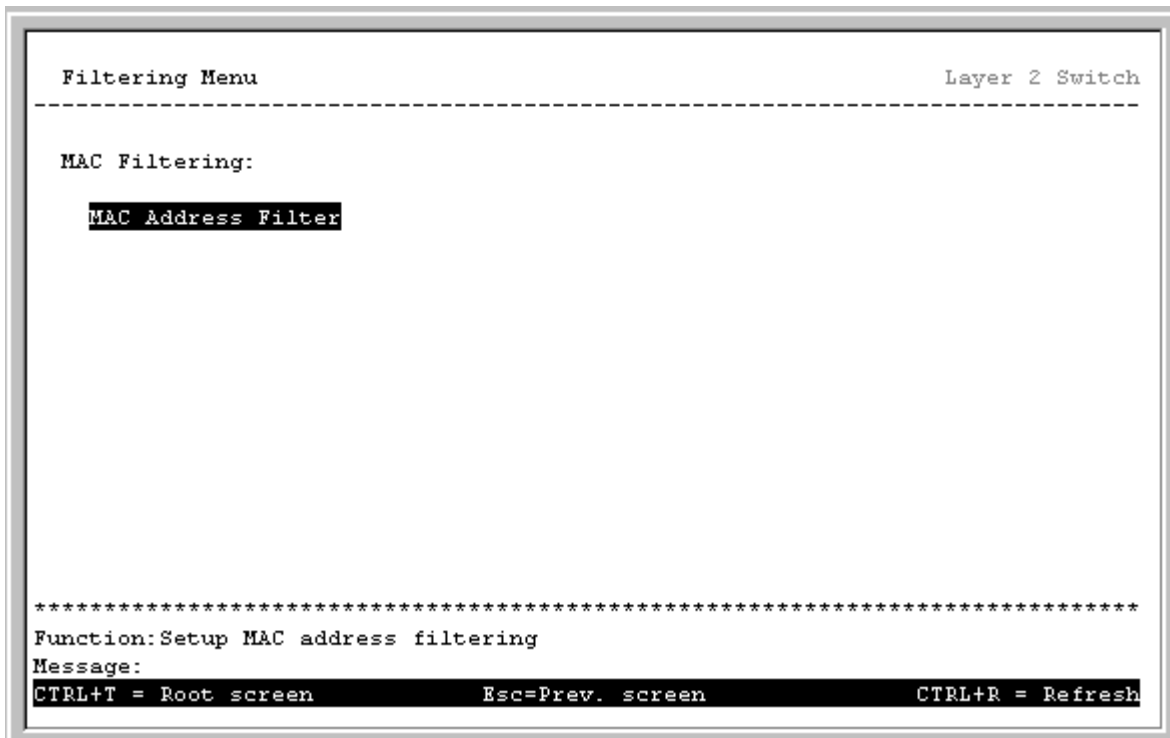


Figure 6-51. Filtering Menu

Highlight **MAC Address Filter** and press **Enter**.

```

Setup MAC Address Filter                                     Layer 2 Switch
-----
Action: <Add/Modify>   VID: [1  ]
MAC Address: [000000000000]
Source/Destination: <Src.  >                               Total Entries: 0      APPLY
-----
VID   MAC Address   Src/Dst           VID   MAC Address   Src/Dst
----   -
*****
Function: Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-52. Setup MAC Address Filter screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar.

Enter the VLAN ID in the **VID:** [] field and the MAC address to be filtered in the **MAC Address:**[] field. This address must be a unicast MAC address.

The **Source/Destination:**< > field can be toggled between *Src.* (source), *Dst.* (destination), and *Either*.

Highlight **APPLY** and press **Enter** to make the changes current. Use **Save Changes** from the **Main Menu** to save the changes to NV-RAM.

Layer 3 (IP Routing) Filtering

The Switch is in IP Routing switch operation mode.

With the Switch configured to Layer 3 Operation mode, both MAC and IP addresses can be entered into the filtering table. To enter an address, highlight **Filtering** from the **Main Menu** and press **Enter**.

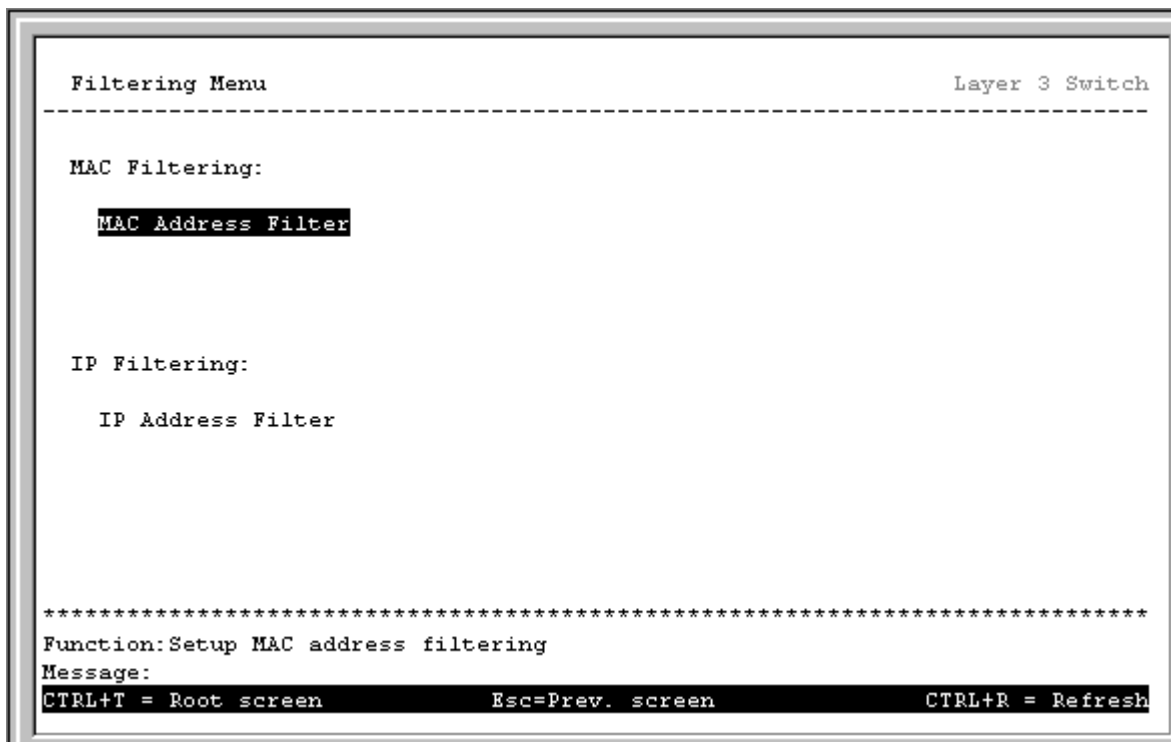


Figure 6-53. Filtering Menu

To enter a MAC address into the filtering table, highlight **MAC Address Filter** and press **Enter**.

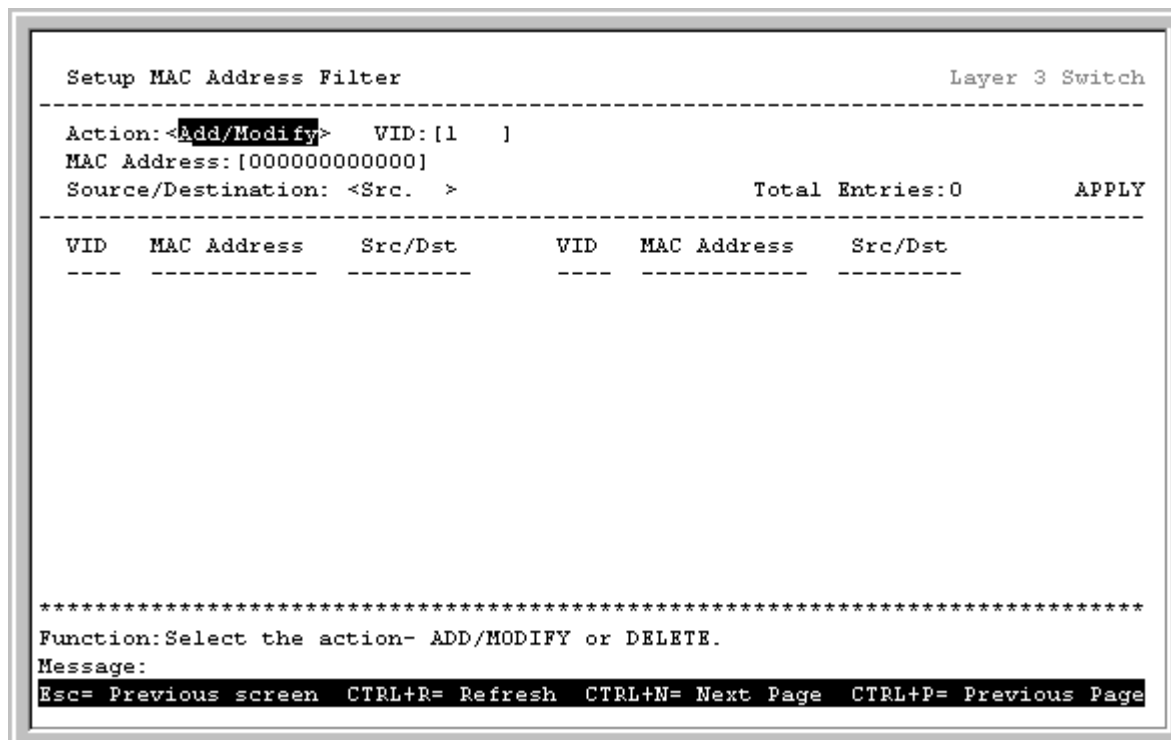


Figure 6-54. Setup MAC Address Filter screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. Enter the VLAN ID in the **VID:**[] field and the MAC address to be filtered in the **MAC Address:**[] field.

The **Source/Destination:** < > field can be toggled between *Src.* (source), *Dst.* (destination), and *Either*. The MAC address entered into the filtering table can be filtered as a source (packets will not be received from the MAC address), as a destination (packets will not be transmitted to the MAC address), or as either a source or destination (packets will not be received from or transmitted to the MAC address).

Highlight **APPLY** and press **Enter** to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

To enter an IP address into the filtering table, highlight **IP Address Filter** from the **Filtering Menu** and press **Enter**.

```

IP Address Filter                                     Layer 3 Switch
-----
Action: <Add/Modify>
IP Address: [0.0.0.0 ]
Source/Destination: <Src. >                          Total Entries: 0      APPLY
-----
      IP Address      Src/Dst                IP Address      Src/Dst
      -----
*****
Function: Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-55. IP Address Filter screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. Enter the IP address to be filtered in the **IP Address:**[] field.

The **Source/Destination:** < > field can be toggled between *Src.* (source), *Dst.* (destination), and *Either*. The IP address entered into the filtering table can be filtered as a source (packets will not be received from the IP address), as a destination (packets will not be transmitted to the IP address), or as either a source or destination (packets will not be received from or transmitted to the IP address).

Highlight **APPLY** and press **Enter** to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

Forwarding

Layer 2 Forwarding

Layer 2 Only switch operation mode

To enter a MAC address into the switch's forwarding table, highlight **Forwarding** from the **Main Menu** and press **Enter**.

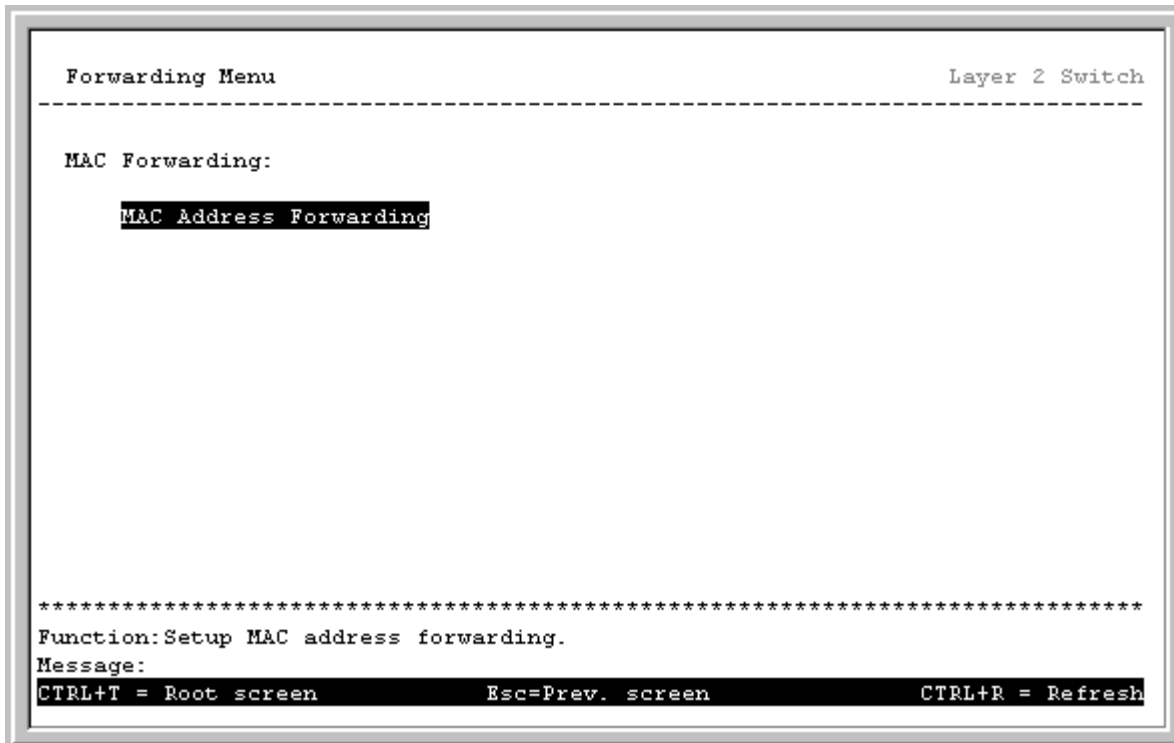


Figure 6-56. Forwarding Menu

Highlight **MAC Address Forwarding** from the **Forwarding Menu** and press **Enter**.

```

MAC Address Forwarding                                     Layer 2 Switch
-----
Action: <Add/Modify>      VID: [1  ]
MAC Address: [000000000000]
Port: [1  ]                                           Total Entries: 0
                                                                APPLY
-----
MAC Address      VID      Port      MAC Address      VID      Port
-----
*****
Function:Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-57. MAC Address Forwarding screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. Enter the VLAN ID in the **VID:**[] field and the MAC address to be statically entered in the forwarding table in the **MAC Address:**[] field. Enter the port number in the **Port:** [] field.

Highlight **APPLY** and press **Enter** to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

IP Routing Forwarding

IP routing Switch Operation Mode

With the Switch in Layer 3 Operation mode, entries into the Switch's forwarding table can be made using both MAC addresses and IP addresses. Static IP forwarding is accomplished by the entry of a Static IP Route.

Static Address Resolution Protocol (ARP) entries can also be made from the **Forwarding Menu**.

MAC Address Forwarding

To enter a MAC address into the Switch's forwarding table, highlight **Forwarding** from the **Main Menu** and press **Enter**.

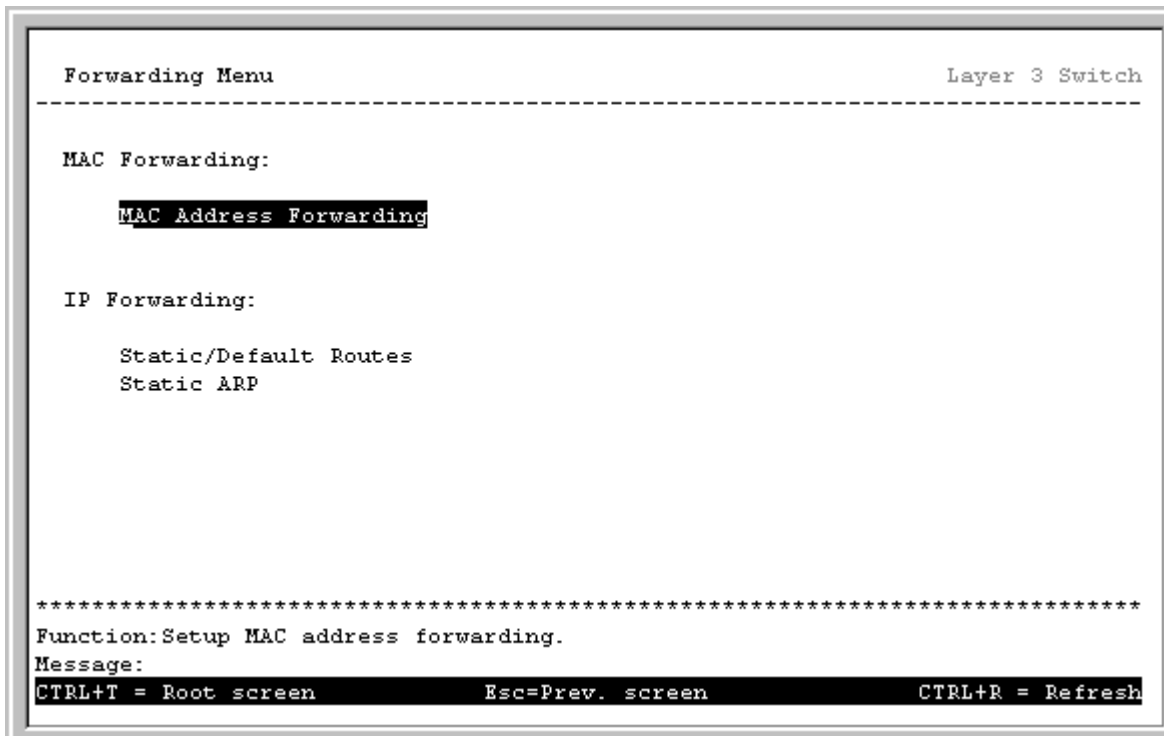


Figure 6-58. Forwarding Menu

Highlight **MAC Address Forwarding** and press **Enter**.

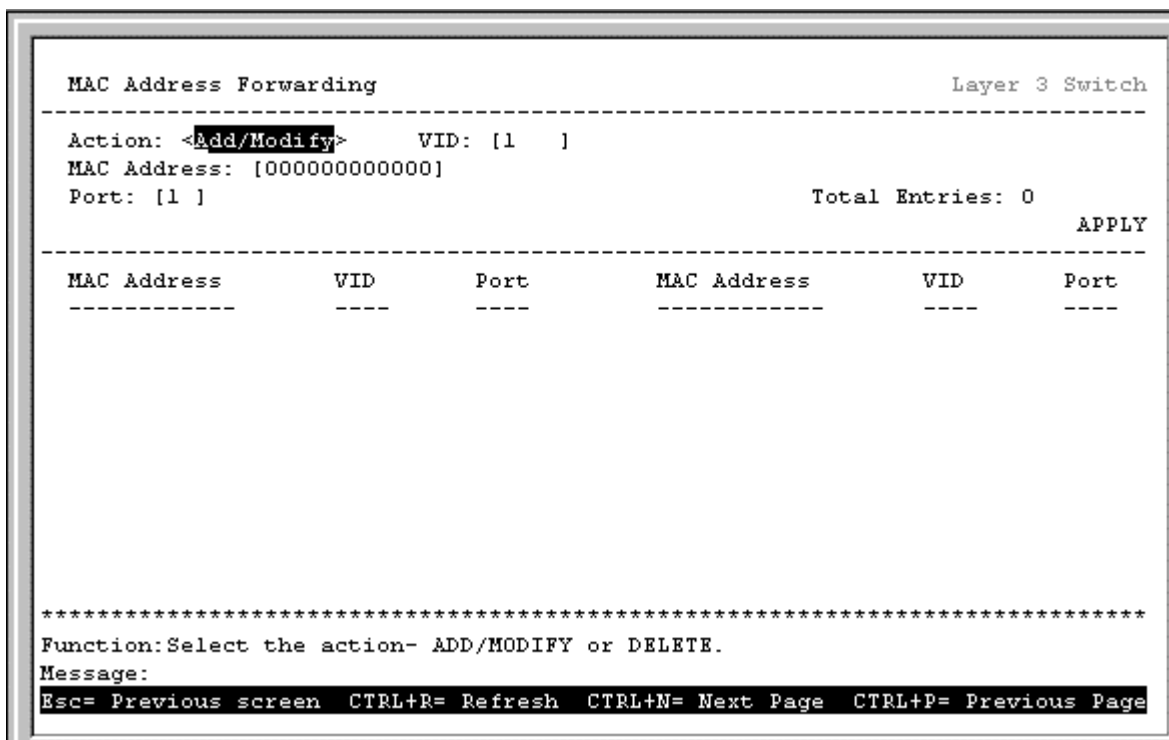


Figure 6-59. MAC Address Forwarding screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. Enter the VLAN ID in the **VID:**[] field and the MAC address to be statically entered in the forwarding table in the **MAC Address:**[] field. Enter the port number in the **Port:** [] field.

Highlight **APPLY** and press enter to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

IP Static Routes

To enter a static IP route into the Switch's forwarding table, highlight **Static/Default Routes** from the **Forwarding Menu** and press **Enter**.

```

Setup Static IP Routes                                     Layer 3 Switch
-----
Action: <Add      >
IP Address : [0.0.0.0      ]      Gateway IP: [0.0.0.0      ]
Subnet Mask: [0.0.0.0      ]      Metric: [1 ]      APPLY
-----
   IP Address      Subnet Mask      Gateway IP      Metric
   -----
0.0.0.0           0.0.0.0           10.254.254.251      1

*****
Function: Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-60. Setup Static IP Routes screen

The **Action:**< > field can be toggled between *Add* and *Delete* using the space bar. Enter the IP address in the **IP Address:**[] field and subnet mask in the **Subnet Mask:**[] field. The IP address of the gateway (usually a router with a connection to a WAN or the Internet) is entered in the **Gateway IP:**[] field and a corresponding metric (a number representing the distance the gateway is from the IP interface in “hops” – or the number of routers between the IP interface and the gateway) is entered in the **Metric:**[] field.

Highlight **APPLY** and press **Enter** to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

Static ARP

To make a static ARP entry, highlight **Static ARP** from the **Forwarding** menu and press **Enter**.


```

Setup Static ARP Entries                                     Layer 3 Switch
-----
Action: <Add/Modify>
Interface Name[      ]
IP Address:[0.0.0.0      ]      MAC Address:[000000000000]      APPLY
-----

Interface      Interface IP      IP Address      MAC Address
-----

*****
Function:Select the action- ADD/MODIFY or DELETE.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-61. Setup Static ARP Entries screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. Enter the IP interface name in the **Interface:**[] field, the corresponding IP address in the **IP Address:**[] field, and the MAC address in the last field.

Highlight **APPLY** and press **Enter** to make the changes current. Use **Save Changes** from the **Main Menu** to enter the changes into NV-RAM.

Spanning Tree

Switch Spanning Tree Settings

To globally configure STP on the Switch, highlight **Spanning Tree** on the **Main Menu** and press **Enter**.

```

Configure Spanning Tree                                     Layer 3 Switch
-----
Switch Settings:
  STP Group: <Default >
    Status: <Enabled >
    Max Age: [20]
    Hello Time: [2 ]
    Forward Delay: [15]
    Priority: [32768]
              APPLY
  Designated Root Bridge: 0080C2666666
  Root Priority: 1
  Cost to Root: 29
  Root Port: 1
  Last Topology Change: 77 secs
  Topology Changes Count: 1

Group Configuration:
  STP Group Configuration
  STP Port Settings

*****
Function:Select Spanning tree group.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-62. Configure Spanning Tree screen

Note: The Spanning Tree Protocol (STP) operates on two levels: on the switch level, the settings are globally implemented. On the port level, the settings are implemented on a per user-defined Group basis.

Note: The factory default setting should cover the majority of installations. However, it is advisable to keep the default settings as set at the factory; unless, it is absolutely necessary.

The user-changeable parameters in the Switch are as follows:

- **Max Age:** [] – The Maximum Age can be set from 6 to 40 seconds. At the end of the Max. Age, if a BPDU has still not been received from the Root Bridge, your Switch will start sending its own BPDU to all other Switches for permission to become the Root Bridge. If it turns out that your Switch has the lowest Bridge Identifier, it will become the Root Bridge.
- **Hello Time:**[] – The Hello Time can be set from 1 to 10 seconds. This is the interval between two transmissions of BPDU packets sent by the Root Bridge to tell all other Switches that it is indeed the Root Bridge. If you set a Hello Time for your Switch, and it is not the Root Bridge, the set Hello Time will be used if and when your Switch becomes the Root Bridge.

Note: The Hello Time cannot be longer than the Max. Age. Otherwise, a configuration error will occur.

- **Forward Delay:**[] – The Forward Delay can be from 4 to 30 seconds. This is the time any port on the Switch spends in the listening state while moving from the blocking state to the forwarding state.
- **Priority:**[] – A Priority for the switch can be set from 0 to 65535. 0 is equal to the highest Priority. This number is used in the voting process between switches on the network to determine which switch will be the root switch. A low number indicates a high priority, and a high probability that this switch will be elected as the root switch.

Note: Observe the following formulas when setting the above parameters:

$$\text{Max. Age} = 2 \times (\text{Forward Delay} - 1 \text{ second})$$

Max. Age 2 x (Hello Time + 1 second)

Port Group Spanning Tree Settings

In addition to setting Spanning Tree parameters for use on the switch level, the DGS-3308 allows for the configuration of groups of ports, each port-group of which will have its own spanning tree, and will require some of its own configuration settings. An STP Group will use the switch-level parameters entered above, with the addition of Port Priority and Port Cost.

Note: An STP Group spanning tree works in the same way as the switch-level spanning tree, but the root bridge concept is replaced with a root port concept. A root port is a port of the group that is elected on the basis of port priority and port cost, to be the connection to the network for the group. Redundant links will be blocked, just as redundant links are blocked on the switch level.

Note: The STP on the switch level blocks redundant links between switches (and similar network devices). The port level STP will block redundant links within an STP Group.

Note: It is advisable to define an STP Group to correspond to a VLAN group of ports.

To define which ports will be members of an STP Group, highlight **STP Group Configuration** and press **Enter**.

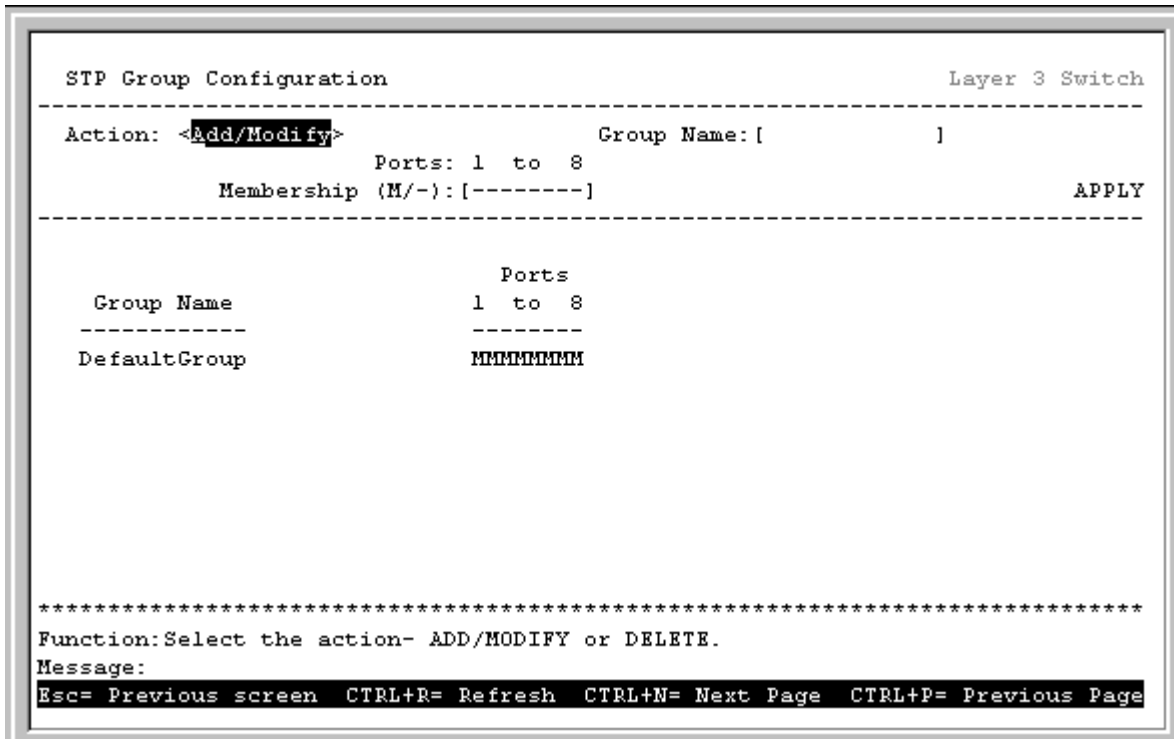


Figure 6-63. STP Group Configuration screen

Toggle the **Action:<Add/Modify>** field to **Add/Modify**. Choose a name for the group and enter it in the **Group Name:[]** field. The group name does not necessarily have to correspond to any name that has been previously entered in the Switch's configuration. Set the membership of the group by pressing the letter M for each desired port in the **Membership (M): []** field.

Now highlight **STP Port Settings** on the **Configure Spanning Tree** screen and press **Enter**. The following screen is displayed:

```

STP Port Settings                                     Layer 3 Switch
-----
View Ports: < 1 to 8 >      Configure Port from [ 1 ] to [ 1 ]
Port Cost: [ 10 ]          Priority: [ 128 ]          Fast STP: < Normal >          APPLY
-----
Port      Connection      Cost  Priority  Status      Group Name  Fast STP
-----
 1      1000M/Full/802.3x    10    128      Forwarding  DefaultGroup  Normal
 2      Link Down            10    128      Forwarding  DefaultGroup  Normal
 3      Link Down            10    128      Forwarding  DefaultGroup  Normal
 4      Link Down            10    128      Forwarding  DefaultGroup  Normal
 5      Link Down            10    128      Forwarding  DefaultGroup  Normal
 6      Link Down            10    128      Forwarding  DefaultGroup  Normal
 7      Link Down            10    128      Forwarding  DefaultGroup  Normal
 8      Link Down            10    128      Forwarding  DefaultGroup  Normal

*****
Function: Select the scope of ports for display and configuration.
Message:
CTRL+T = Root screen      Esc=Prev. screen          CTRL+R = Refresh

```

Figure 6-64. STP Port Settings screen

The STP port settings that can be configured are:

- **Configure Port from [] to []** – Enter the desired ports in the two fields offered.
- **Port Cost** – A Port Cost can be set from 1 to 65535. The lower the number, the greater the probability the port will be chosen to forward packets.
- **Priority** – A Port Priority can be from 0 to 255. The lower the number, the greater the probability the port will be chosen as the Root Port.
- **Fast STP** – Toggle between *Normal* and *Fast*.

Port Trunking

Port trunking allows several ports to be grouped together and to act as a single link. This gives a bandwidth that is a multiple of a single link's bandwidth.

Trunking, also known as link aggregation, is most commonly used to link a bandwidth intensive network device or devices – such as a server or server farm – to the backbone of a network.

Note: *The DGS-3308 allows the creation of up to 4 port trunk groups, each consisting of up to 4 links (ports). The aggregated links must be contiguous (they must have sequential port numbers) and all of the ports in the group must be members of the same VLAN. Further, the linked ports must all be of the same speed and should be configured as full duplex.*

The configuration of the lowest numbered port in the group becomes the configuration for all of the ports in the aggregation group. This port is called the base port of the group, and all configuration options – including the VLAN configuration – that can be applied to the base port are applied to the entire link aggregation group.

Load balancing is automatically applied to the links in the port trunk group, and a link failure within the group causes the network traffic to be directed to the remaining links in the group.

Note: *The Spanning Tree Protocol will treat a port trunk group as a single link, on the switch level. On the port level, the STP will use the port parameters of the base port in the calculation of port cost and in determining the state of the link aggregation group. If two redundant port trunk groups are configured on the Switch, STP will block one entire group – in the same way STP will block a single port that has a redundant link.*

To configure a port trunk group, highlight **Port Trunking** on the **Main Menu** and press **Enter**.

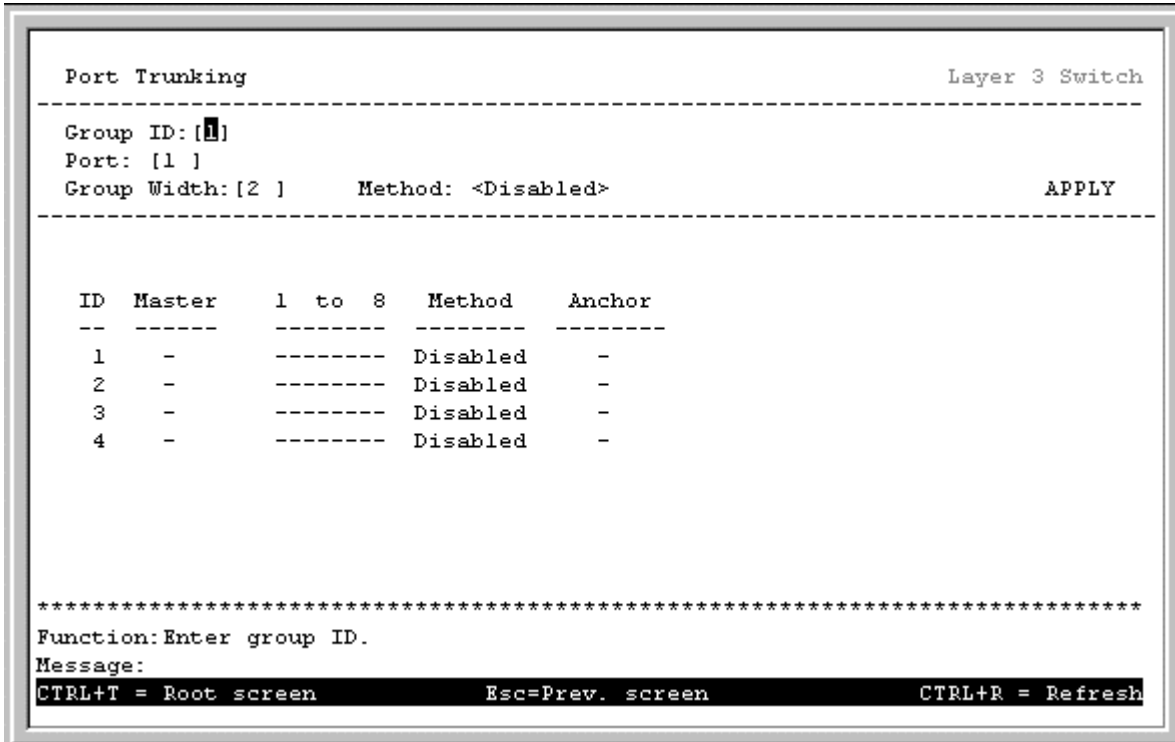


Figure 6-65. Port Trunking screen

Enter the group ID of one of the six possible port trunk groups configurable on the switch in the **Group ID:[1]** field. Enter the desired port number in the second field and specify the **Group Width:[2]**. This is the number of ports, in sequential order from the base port that will be included in the port trunk group.

The **Method:<Disabled>** field can be toggled between *TRUNK* and *Disabled* – and is used to turn a port trunk group on or off. This is useful for diagnostics, to quickly isolate a bandwidth intensive network device or to have an absolute backup port trunk group that is not under automatic control.

Highlight **Apply** and press **Enter** to make the port trunk group configuration active. The **Anchor** column displays what port is receiving BPDUs, SNMP packets, etc. This is usually the same as the **Master** port. However, if the link is down for the master port, the closest port with a valid link will become the new anchor port.

Use **Save Changes** from the **Main Menu** to enter the configuration into NV-RAM.

Switch Utilities

Layer 2 Switch Utilities

To access the Switch Utilities menu, highlight **Utilities** from the **Main Menu** and press **Enter**.

```

Switch Utilities                                     Layer 2 Switch
-----
Switch Settings:

Server IP Address: 0.0.0.0
Switch IP Address: 10.24.22.9
Subnet Mask: 255.0.0.0
Gateway Router: 10.254.254.251

TFTP Services:                                     Others:
Upgrade Firmware from TFTP Server                 Ping Test
Download Configuration File from TFTP Server
Upload Configuration File to TFTP Server
Save Log to TFTP Server

*****
Function:Upgrade firmware.
Message:
CTRL+T = Root screen          Esc=Prev. screen          CTRL+R = Refresh

```

Figure 6-66. Switch Utilities menu

Note: Trivial File Transfer Protocol (TFTP) services allow the switch firmware to be upgraded by transferring a new firmware file from a TFTP server to the switch. A configuration file can also be loaded into the switch from a TFTP server, switch settings can be saved to the TFTP server, and a history log can be uploaded from the switch to the TFTP server.

Upgrade Firmware from TFTP Server

To update the Switch's firmware, highlight **Upgrade Firmware from TFTP Server** on the **Switch Utilities** menu and press **Enter**.

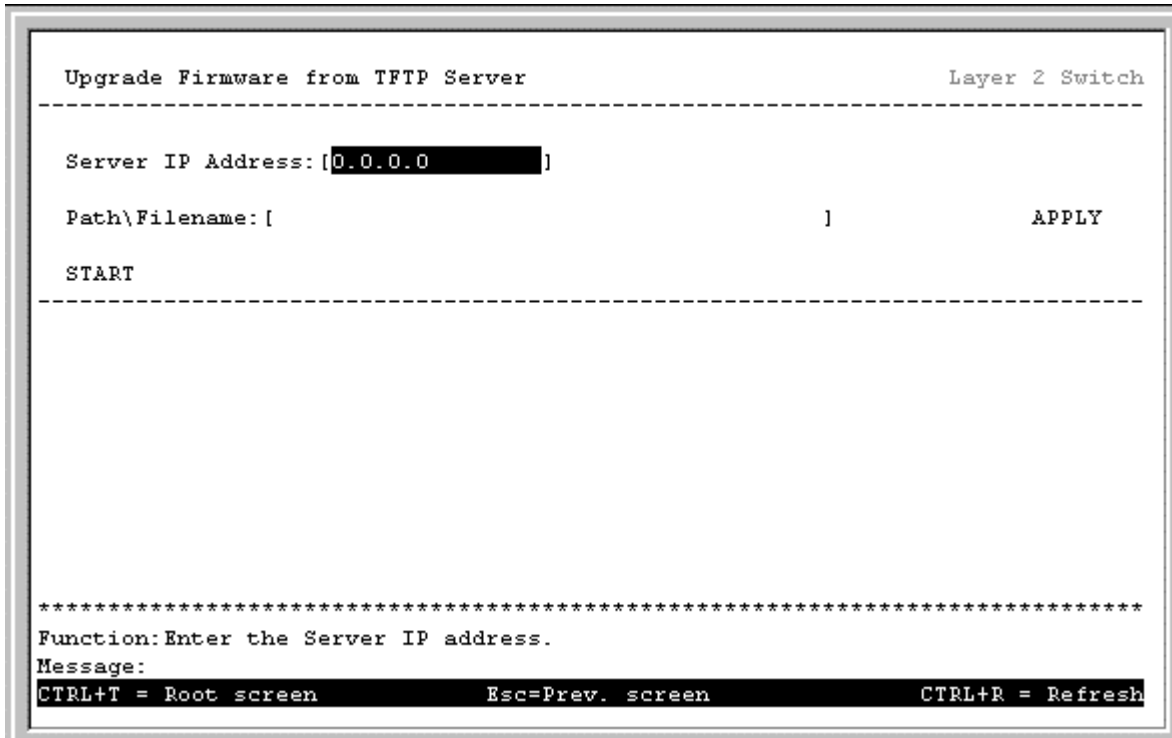


Figure 6-67. Upgrade Firmware from TFTP Server screen

Enter the server IP address and the path and filename of the firmware file on the server. Note that in many instances the firmware file is in the root directory of the C drive of the server.

Note: The TFTP server must be running TFTP server software to perform the file transfer. TFTP server software is a part of many network management software packages, or can be obtained as a separate program.

Highlight **APPLY** and press **Enter** record the IP address of the TFTP server. Use **Save Changes** from the **Main Menu** to enter the address into NV-RAM

Highlight **START** and press **Enter** to initiate the file transfer.

Download Configuration File from TFTP Server

To download a switch configuration file from a TFTP server, highlight **Download Configuration File from TFTP Server** on the **Switch Utilities** menu and press **Enter**.

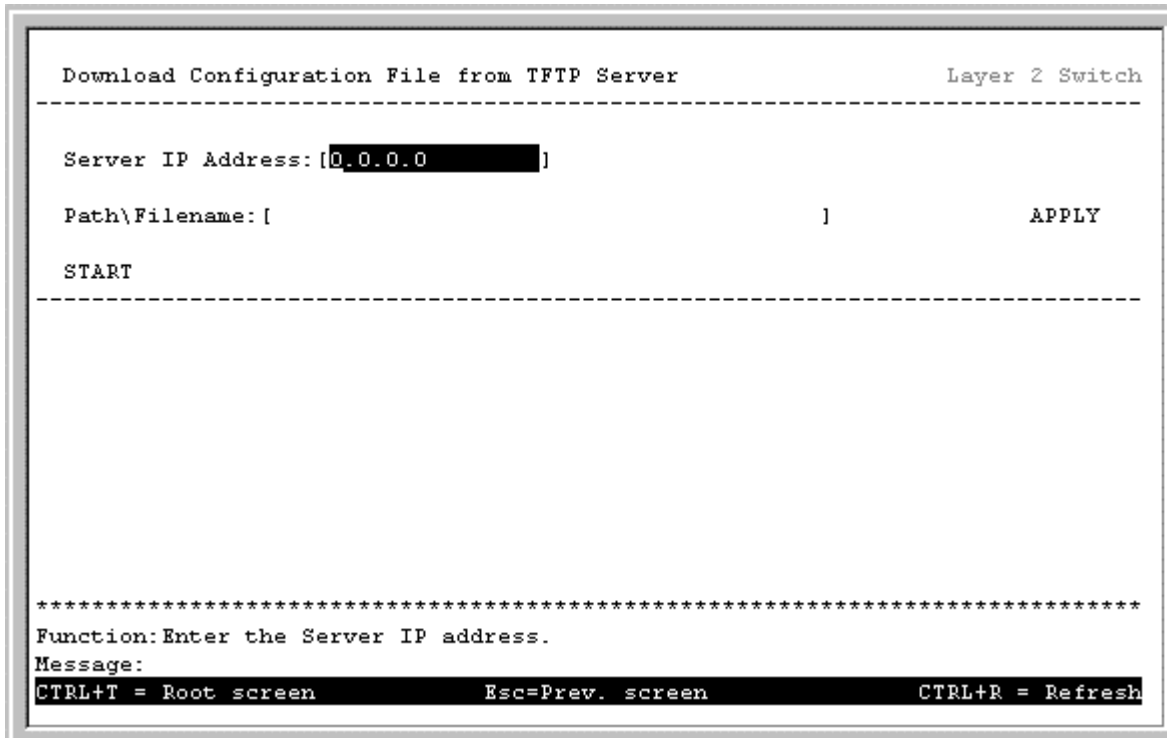


Figure 6-68. Download Configuration File from TFTP Server screen

Enter the IP address of the server and specify the location of the switch configuration file on the server.

Highlight **APPLY** and press **Enter** record the IP address of the server. Use **Save Changes** from the **Main Menu** to enter the address into NV-RAM

Highlight **START** and press **Enter** to initiate the file transfer.

Upload Configuration File to TFTP Server

To upload a settings file to the TFTP server, highlight **Upload Configuration File to TFTP Server** and press **Enter**.


```
Upload Configuration File to TFTP Server                                Layer 2 Switch
-----
Server IP Address: [0.0.0.0 ]
Path\Filename: [ ] APPLY
START
-----

*****
Function:Enter the Server IP address.
Message:
CTRL+T = Root screen          Esc=Prev. screen          CTRL+R = Refresh
```

Figure 6-69. Upload Configuration File to TFTP Server screen

Enter the IP address of the server and the path and filename of the settings file on the server and press **APPLY**.

Save Log to TFTP Server

To save a history log to a TFTP server, highlight **Save Log to TFTP Server** on the **Switch Utilities** menu and press **Enter**.

```
Save Log to TFTP Server                                            Layer 2 Switch
-----
Server IP Address: [0.0.0.0 ]
Path\Filename: [ ] APPLY
START
-----

*****
Function:Enter the Server IP address.
Message:
CTRL+T = Root screen          Esc=Prev. screen          CTRL+R = Refresh
```

Figure 6-70. Save Log to TFTP Server screen

Enter the IP address of the server and the path and filename for the history log on the server. Highlight **APPLY** and press **Enter** to make the changes current.

Ping

To test the connection with another network device using Ping, highlight **Ping Test** on the **Switch Utilities** menu and press **Enter**.

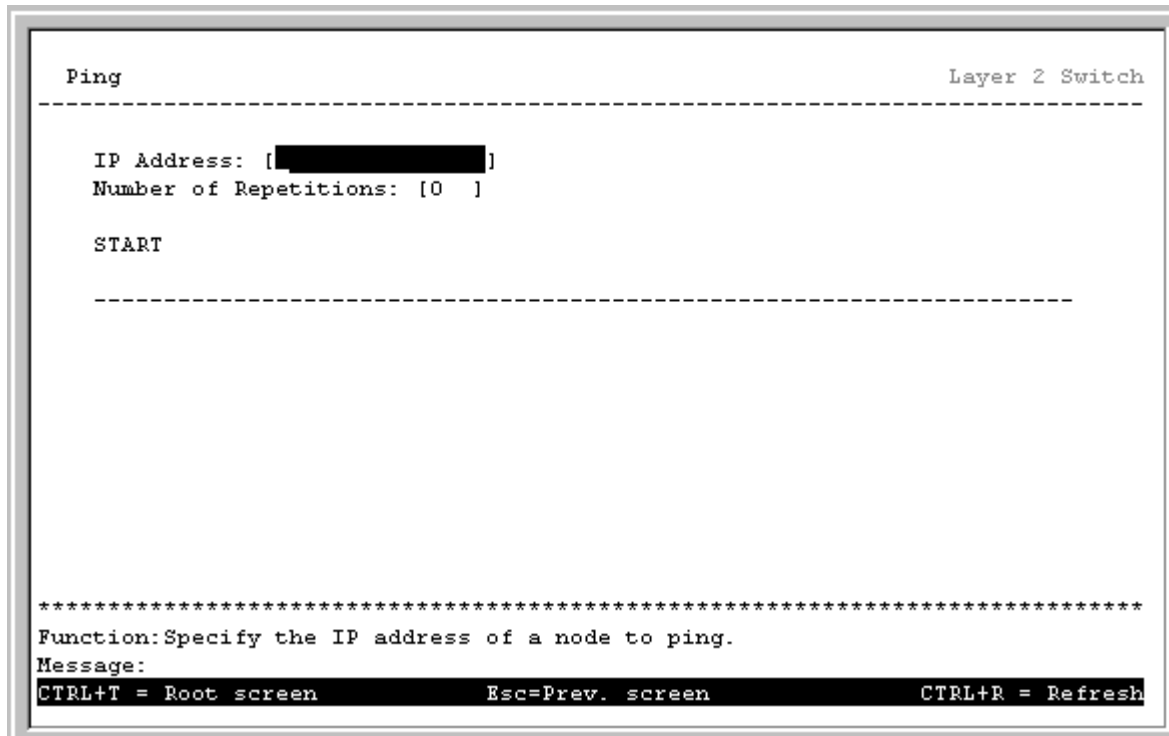


Figure 6-71. Ping screen

Enter the IP address of the network device to be Pinged and the number of test packets to be sent (3 is usually enough). Highlight **START** and press **Enter** to initiate the Ping program.

Layer 3 Utilities

Layer 3 (IP Routing) switch operation mode adds BOOTP/DHCP Relay and DNS Relay to the utilities available on the Switch.

BOOTP/DHCP Relay

To enter the IP addresses of BOOTP/DHCP Relay servers, highlight **Utilities** on the **Main Menu** and press **Enter**.

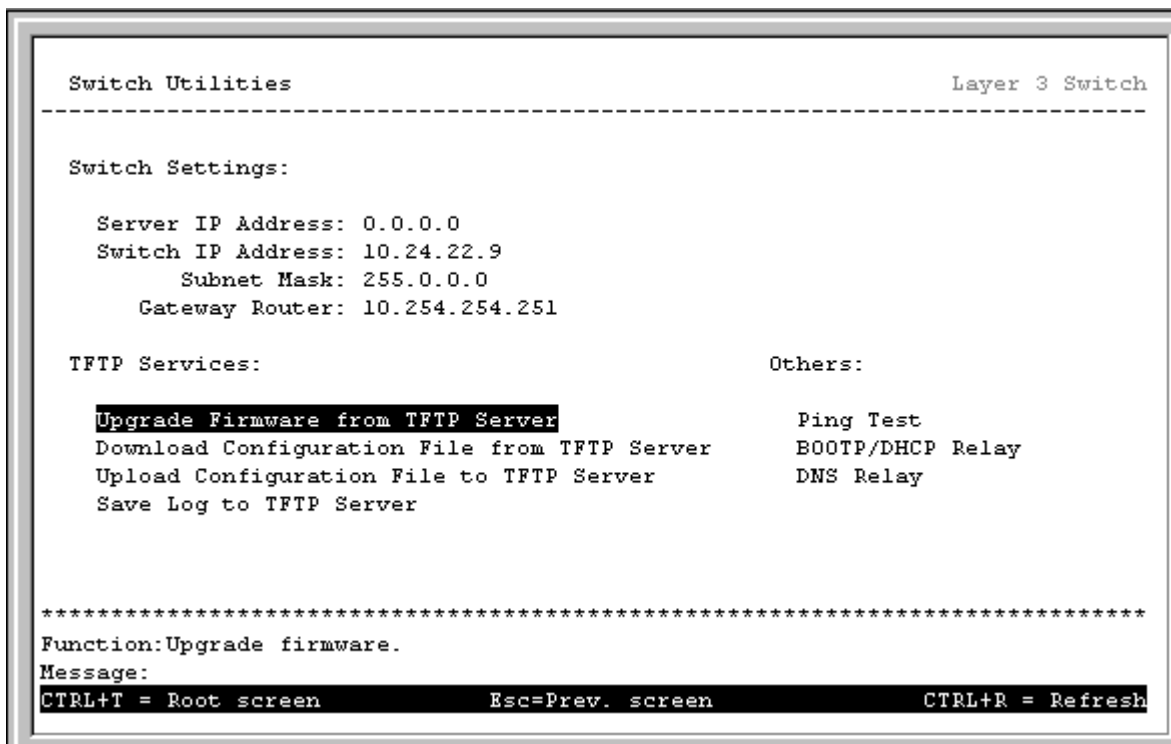


Figure 6-72. Switch Utilities menu

Highlight **BOOTP/DHCP Relay** on the **Switch Utilities** menu and press **Enter**.

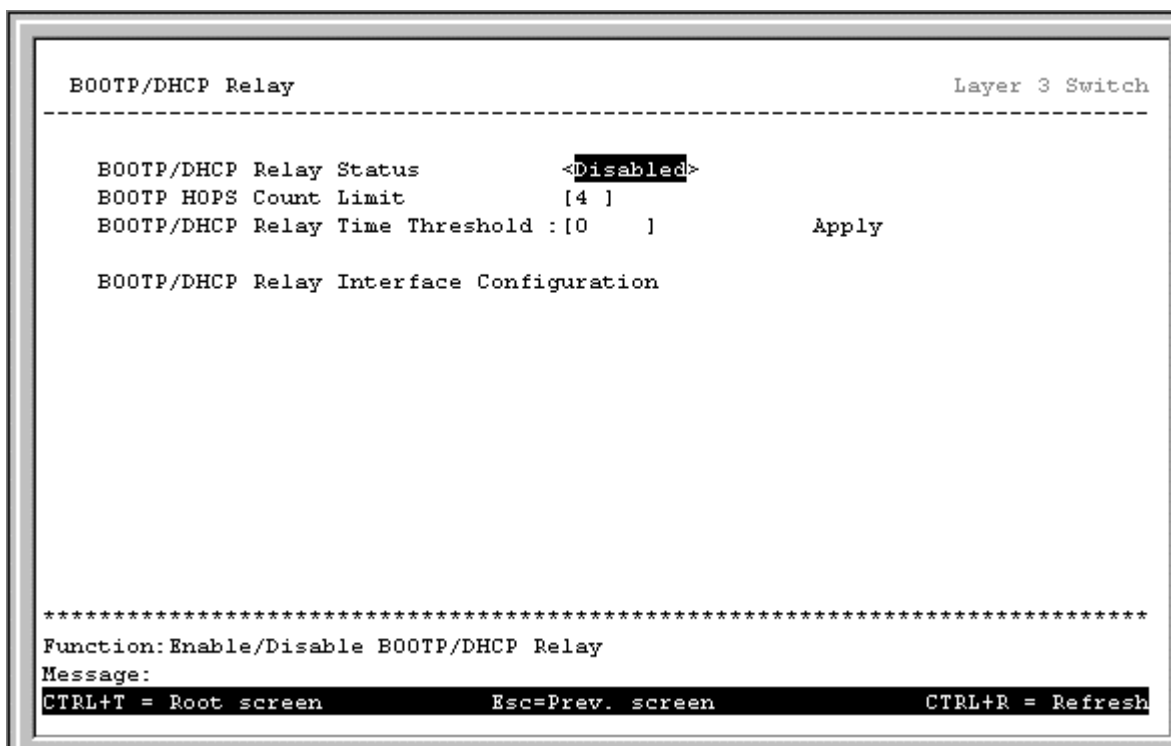


Figure 6-73. BOOTP/DHCP Relay screen

Toggle between *Enabled* and *Disabled* in the first field. The BootP hops count limit allows the number of hops (routers) that the BootP messages can be relayed through to be set while the relay time threshold sets the minimum time (in

seconds) that the Switch will wait before forwarding a BOOTREQUEST packet. If the value in the seconds field of the packet is less than the relay time threshold, the packet will be dropped. The range is between 0 and 9999 seconds, with a default value of 0 seconds.

Highlight **BOOTP/DHCP Relay Interface Configuration** on the **Switch Utilities** menu and press **Enter**.

```

BOOTP/DHCP Relay Interface Configuration                               Layer 3 Switch
-----
Action: <Add > Interface Name: [          ] IP Addr:
BOOTP/DHCP Server: [          ]
                                                                    Apply
-----
Interface  Server 1      Server 2      Server 3      Server 4
-----

*****
Function: Add or Delete an BOOTP Relay.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-74. BOOTP/DHCP Relay Interface Configuration screen

The **Action:**< > field can be toggled between *Add/Modify* and *Delete* using the space bar. Toggle to *Add/Modify* and enter the subnet name for which BOOTP Relay will be active. The subnet's network IP address will be displayed in the **IP Addr** field. Enter the IP address of the BOOTP/DHCP server (or servers, as the case may be) in the last field, highlight **APPLY** and press **Enter** to enter the information into the BOOTP/DHCP Relay table. Use **Save Changes** from the **Main Menu** to enter the information into NV-RAM.

DNS Relay

To enter the IP addresses of DNS Relay servers, highlight **DNS Relay** on the **Switch Utilities** menu and press **Enter**.

```
DNS Relay Layer 3 Switch
-----
DNSR Status: <Disabled>
Name Server: [1] [0.0.0.0      ]
              [2] [0.0.0.0      ]
DNSR Cache Status: <Disabled>
DNSR Static Table Lookup Status: <Disabled>
Apply

Static Table Configuration

*****
Function: Enable/Disable DNS Relay
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh
```

Figure 6-75. DNS Relay screen

The **DNSR Status** <Disabled> can be toggled between *Disabled* and *Enabled* using the space bar. Toggle the field to *Enabled*, enter the IP address of Name Server 1 and Name Server 2, if so desired.

The **DNSR Cache Status**:<Disabled> can be toggled between *Disabled* and *Enabled*. This determines if a DNS cache will be enabled on the switch.

The **DNSR Static Table Lookup Status**:<Disabled> can be toggled between *Disabled* and *Enabled*. This determines if the static DNS table (entered on the **DNS Relay - Static table configuration screen** below) will be used or not.

To make a static DNS table entry, highlight **Static Table Configuration** on the **DNS Relay** menu and press **Enter**.

```

DNS Relay - Static Table Configuration                                Layer 3 Switch
-----
Action: <Add/Modify>
Domain Name                IP Address                Status
[                          ] [0.0.0.0                ] <Enabled >  APPLY
                                                                Total Entries: 0
-----
Domain Name                IP Address                Status
-----

*****
Function: Add/Modify/Delete the entry.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-76. DNS Relay – Static table configuration screen

The **Action:**<Add/Modify> field can be toggled between *Add/Modify* and *Delete*. Enter the Domain name and its corresponding IP address. Highlight **APPLY** and press **Enter** to make the change current. Use **Save Changes** to enter the table into NV-RAM.

Network Monitoring

The DGS-3308 provides extensive network monitoring capabilities.

Layer 2 Network Monitoring

To display the network data compiled by the Switch, highlight **Network Monitoring** on the **Main Menu** and press **Enter**.

```

Network Monitoring Menu                                     Layer 2 Switch
-----
Statistics:                                             Applications:

  Port Utilization                                     GVRP
  Port Error Packets                                 Browse Router Port
  Port Packet Analysis                               IGMP Snooping
                                                    Switch History

Address Table:

  Browse MAC Address Table

*****
Function:Switch port utilization overview.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh
    
```

Figure 6-77. Network Monitoring Menu

Port Utilization

To view the port utilization, highlight **Port Utilization** on the **Network Monitoring Menu** and press **Enter**.

```

Port Utilization                                         Layer 3 Switch
-----
                                CLEAR COUNTER          Interval:< 2 sec >

Port      TX/sec      RX/sec      %Util.
-----
  1         0          137         0
  2         0           0           0
  3         0           0           0
  4         0           0           0
  5         0           0           0
  6         0           0           0
  7         0           0           0
  8         0           0           0

*****
Function:Clear counter.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh
    
```

Figure 6-78. Port Utilization screen

The **Port Utilization** screen shows the number of packets transmitted and received per second and calculates the percentage of the total available bandwidth being used on the port (displayed under %Util.). The **Interval:<2 sec>** field can be toggled from 2 seconds to 1 minute, or *Suspend*.

Port Error Packets

To view the error statistics for a port, highlight **Port Error Packets** on the **Network Monitoring Menu** and press **Enter**.

```

Port Error Packets                                     Layer 3 Switch
-----
Port: [1]                                           CLEAR COUNTER                               Interval:< 2 sec >

          RX Frames                                TX Frames
          -----                                -----
CRC Error          0                               ExDefer          0
Undersize          0                               CRC Error        0
Oversize          0                               Late Coll.       N/A
Fragment          0                               Ex. Coll.        N/A
Jabber            0                               Single Coll.     N/A
Drop Pkts        62653                             Coll.            N/A

*****
Function:Input port number.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-79. Port Error Packets screen

Enter the port number of the port to be viewed. The **Interval:<2 sec>** field can be toggled from 2 seconds to 1 minute, or *Suspend*. This sets the interval at which the error statistics are updated.

Port Packet Analysis Table

To view an analysis of the size of packets received or transmitted by a port, highlight **Port Packet Analysis** on the **Network Monitoring Menu** and press **Enter**.

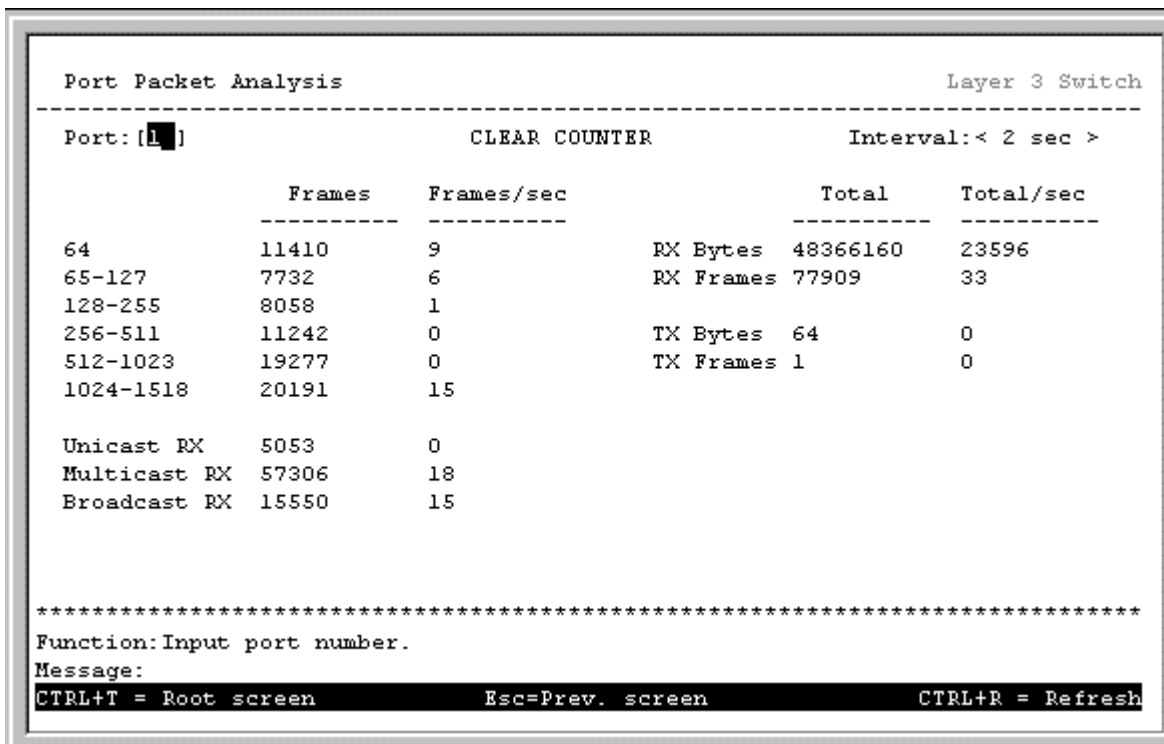


Figure 6-80. Port Packet Analysis screen

In addition to the size of packets received or transmitted by the selected port, statistics on the number of unicast, multicast, and broadcast packets are displayed. Enter the port number of the port to be viewed. The **Interval:<2 sec>** field can be toggled from 2 seconds to 1 minute, or *Suspend*.

MAC Address Forwarding Table

To view the MAC address forwarding table, highlight **Browse MAC Address Table** on the **Network Monitoring Menu** and press **Enter**.

```

Browse MAC Address Table                                     Layer 2 Switch
-----
MAC Address Aging Time(sec): [300]                        APPLY
Browse By: <ALL >                                         Total Addresses in Table: 75
                                                           BROWSE          CLEAR ALL
-----
VID  MAC Address  Port  Learned  VID  MAC Address  Port  Learned
----  -
1    0000819AF2F4  1     Dynamic  1    003326440800  1     Dynamic
1    000102030400  1     Dynamic  1    004005000028  1     Dynamic
1    000130FA5F00  1     Dynamic  1    004005400C85  1     Dynamic
1    0001969C0600  1     Dynamic  1    00400586AD32  1     Dynamic
1    0001F4DB06C0  CPU   Self     1    00485456EF32  1     Dynamic
1    00036D1E7679  1     Dynamic  1    00485456FB04  1     Dynamic
1    00055DF93616  1     Dynamic  1    0050737D0E60  1     Dynamic
1    00055DF9361E  1     Dynamic  1    00508B5C14FB  1     Dynamic
1    00106F030FB1  1     Dynamic  1    0050BA0000FF  1     Dynamic
1    001083CFA85E  1     Dynamic  1    0050BA000523  1     Dynamic
1    001896550A01  1     Dynamic  1    0050BA000778  1     Dynamic
*****
Function: Set the aging time(10-1000000) of MAC address entries.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-81. Browse MAC Address Table screen

The **Browse By:**<ALL > field can be toggled between *ALL*, *MAC address*, *Port*, and *VLAN*. This sets a filter to determine which MAC addresses from the forwarding table are displayed. *ALL* specifies no filter.

To search for a particular MAC address, toggle the **Browse By:**<ALL > field to **MAC Address**. A **MAC Address:**[000000000000] field will appear. Enter the MAC address in the field and press **Enter**.

IGMP Snooping

To view the IGMP snooping table, highlight **IGMP Snooping** from the **Network Monitoring Menu** and press **Enter**.

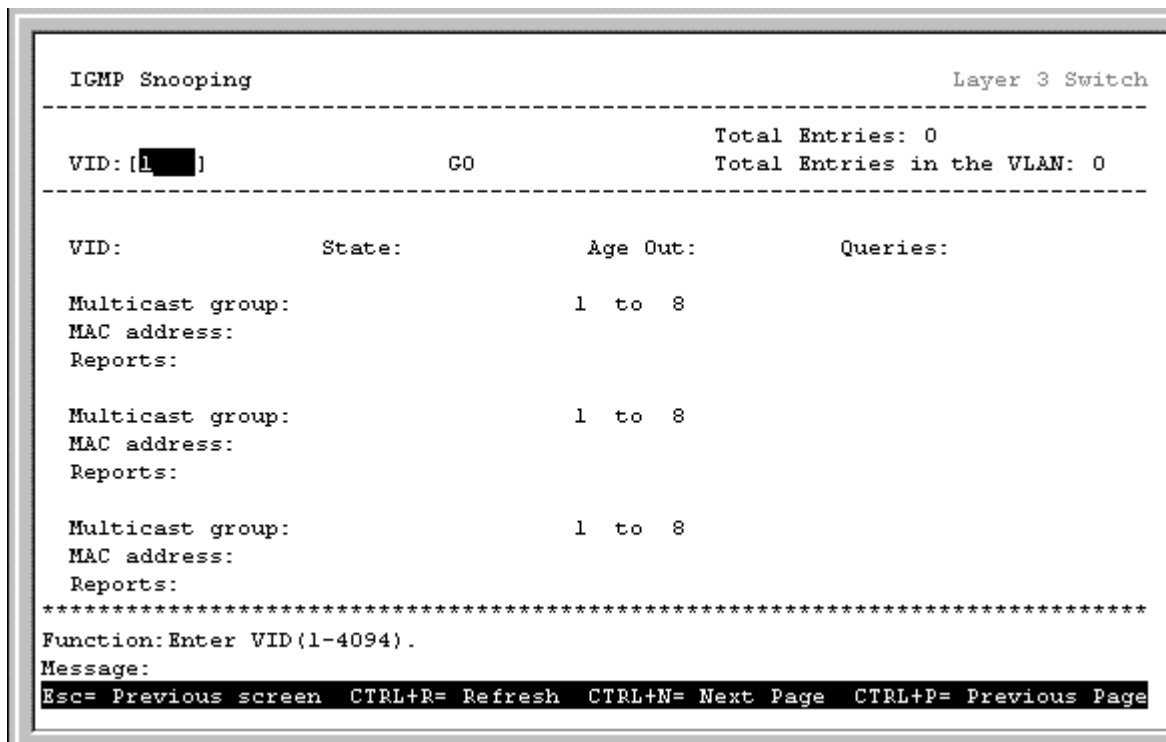


Figure 6-82. IGMP Snooping screen

Switch History

To view the switch history log, highlight **Switch History** from the **Network Monitoring Menu** and press **Enter**.

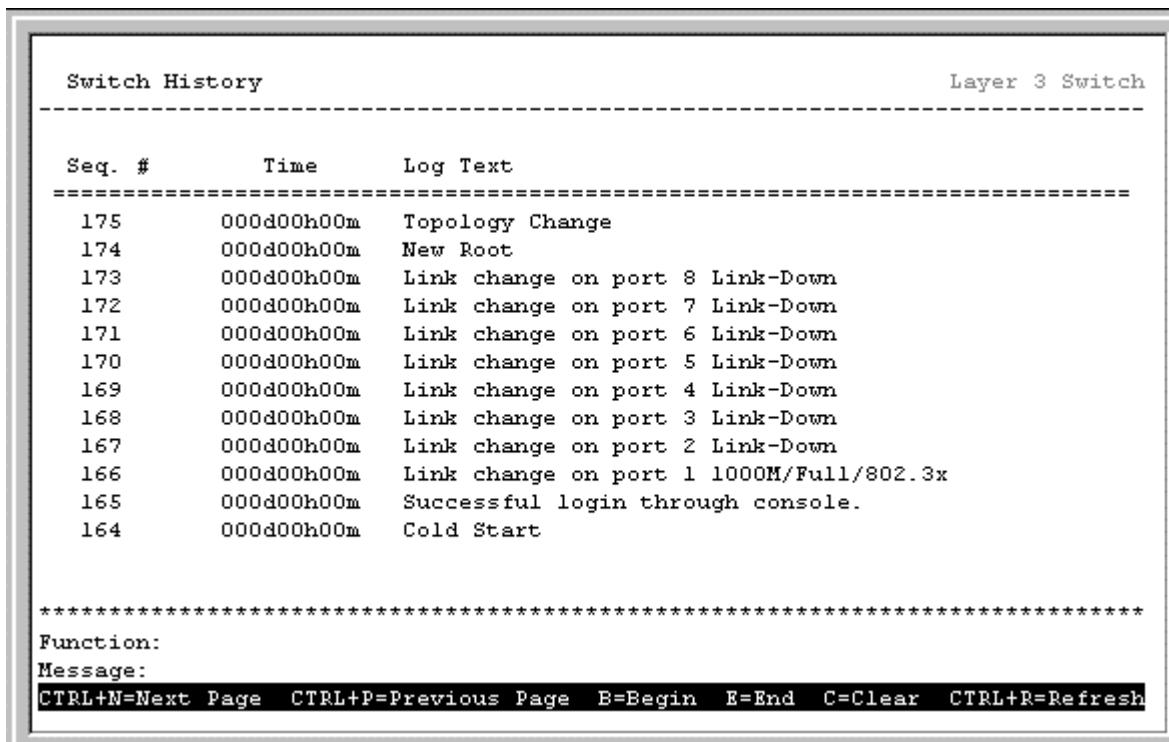


Figure 6-83. Switch History screen

Layer 3 Network Monitoring

When the Switch is in Layer 3 (IP Routing) mode, several items are added to the **Network Monitoring** Menu.

The following items are added to the Network Monitoring Menu when the Switch is in Layer 3 (IP Routing) mode:

- **Browse IP Address**
- **Routing Table**
- **ARP Table**
- **IP Multicast Forwarding Table**
- **IGMP Group Table**
- **DVMRP Routing Table**

```

Network Monitoring Menu                                     Layer 3 Switch
-----
Statistics:                                               Applications:
  Port Utilization                                         GVRP
  Port Error Packets                                       Browse Router Port
  Port Packet Analysis                                     IGMP Snooping
                                                         IP Multicast Forwarding Table
                                                         IGMP Group Table
                                                         DVMRP Routing Table
                                                         Switch History

Address Table:
  Browse MAC Address Table
  Browse IP Address
  Routing Table
  ARP Table

*****
Function: Switch port utilization overview.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh

```

Figure 6-84. Network Monitoring Menu

Browse IP Address

To view the IP address forwarding table, highlight **Browse IP Address** from the **Network Monitoring Menu** and press **Enter**.

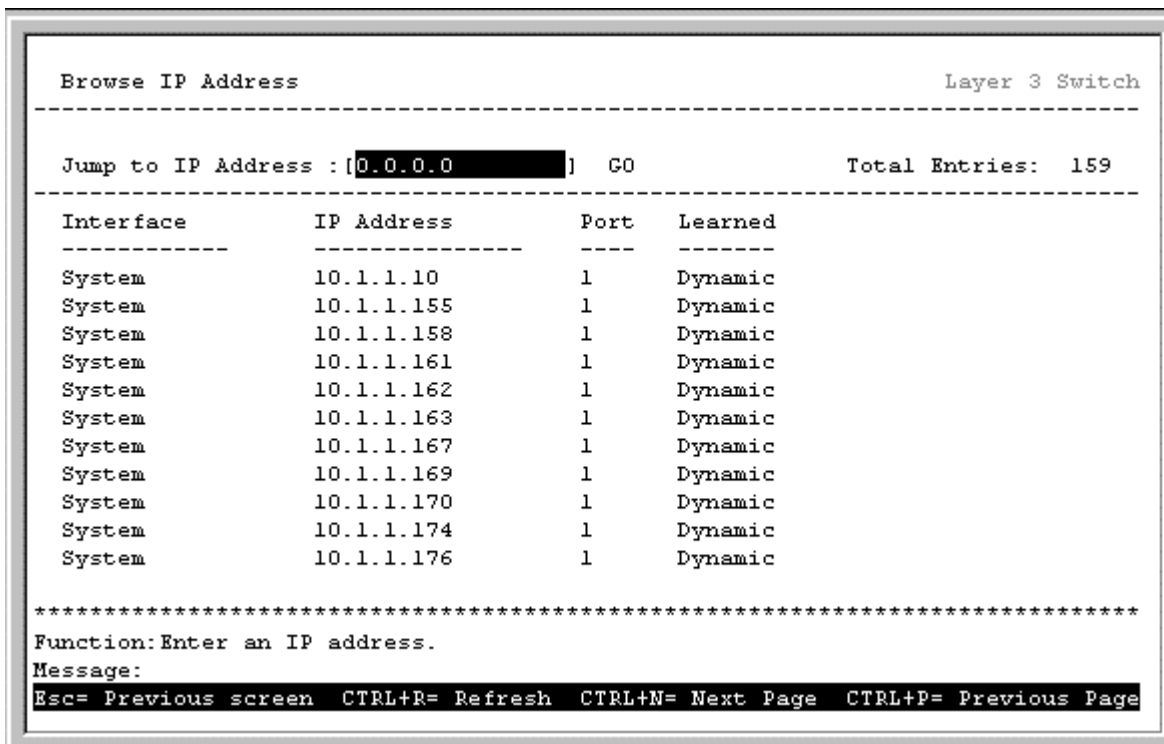


Figure 6-85. Browse IP Address screen

To display a particular IP address, enter the IP address in the **Jump to IP Address:[0.0.0.0]** field, highlight **GO**, and press **Enter**.

IP Routing Table

To view the contents of the routing table, highlight **Routing Table** on the **Network Monitoring Menu** and press **Enter**.

```

Routing Table                                     Layer 3 Switch
-----
Jump to Destination Address: [0.0.0.0]          Mask: [0.0.0.0]
Gateway: [0.0.0.0]          GO      CLEAR TABLE      Total Entries:1
-----
IP Address      Netmask      Gateway      Interface Name  Hops  Protocol
-----
10.0.0.0       255.0.0.0     10.90.90.90  System         1     Local

*****
Function:Enter the IP address.
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-86. Routing Table screen

To display a particular Destination IP address, enter the IP address in the **Jump to Destination Address:[0.0.0.0]** field, the gateway address in the **Gateway:[0.0.0.0]** field, and the subnet mask in the **Mask:[0.0.0.0]** field, highlight **GO**, and press **Enter**. Highlighting CLEAR TABLE and pressing **Enter** will empty the table.

ARP Table

To view the ARP table, highlight **ARP Table** on the **Network Monitoring Menu** and press **Enter**.

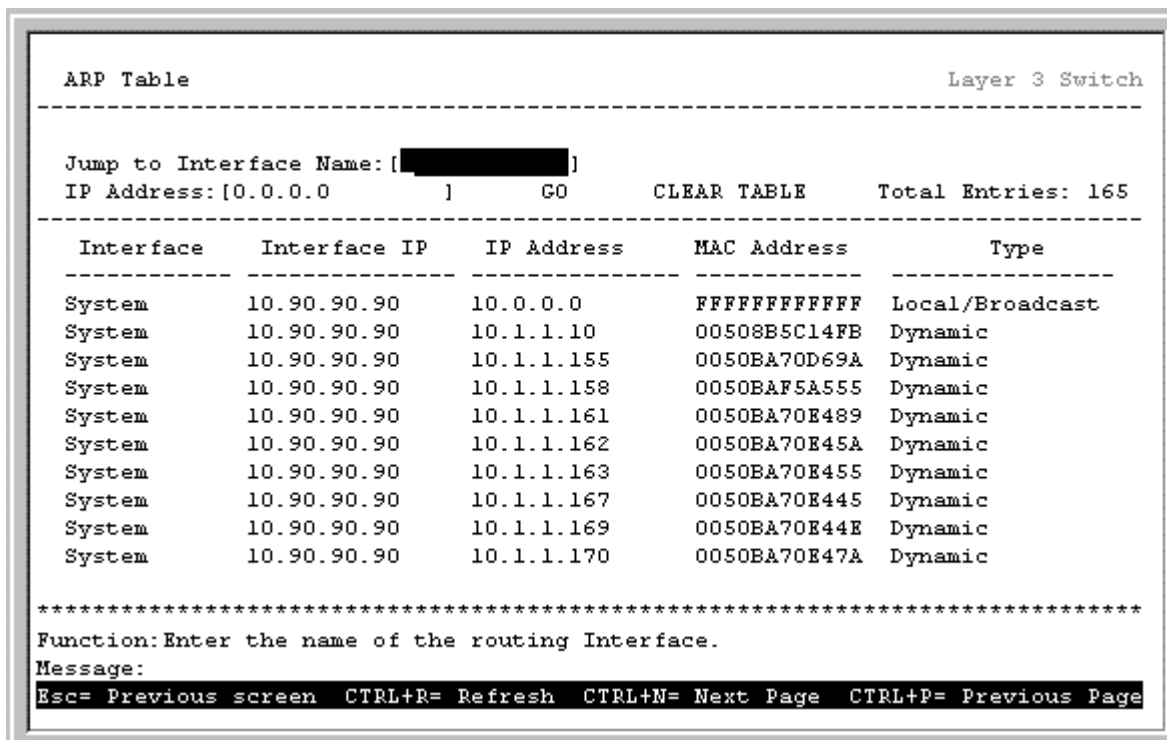


Figure 6-87. ARP Table screen

To display a particular IP interface or an IP address, enter the IP interface name in the **Jump to Interface Name: []** field and the IP address in the **IP Address: [0.0.0.0]** field, highlight **GO**, and press **Enter**. Highlighting **CLEAR TABLE** and pressing **Enter** will empty the table.

Browse Router Port

To view the current router ports, highlight **Browse Router Port** from the **Network Monitoring Menu** and press **Enter**.

```

Browse Router Port                                     Layer 3 Switch
-----
Jump to VID: [1 ]      GO
-----
VID 1 to 8
-----
S: static router port
D: dynamic router port

*****
Function: Enter VID (1-4094).
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-88. Browse Router Port screen

To display a particular router port, enter the VLAN ID number in the **Jump to VID:[0.0.0.0]** field, highlight **GO**, and then press **Enter**.

IP Multicast Forwarding Table

To view the IP multicast forwarding table:

Highlight **IP Multicast Forwarding Table** from the **Network Monitoring Menu** and press **Enter**.


```

Browse IP Multicast Forwarding Table                                Layer 3 Switch
-----
Jump to Multicast Group: [0.0.0.0 ]   Source IP: [0.0.0.0   ]
      Source Mask: [0.0.0.0   ]       GO          Total Entries: 0
-----
Multicast Group Source IP Addr.   Source Mask   UpStream Neighbor Prune_T Prot
-----
*****
Function:
Message:
Esc= Previous screen  CTRL+R= Refresh  CTRL+N= Next Page  CTRL+P= Previous Page

```

Figure 6-89. Browse IP Multicast Forwarding Table screen

To display a particular multicast group, enter the IP address in the **Jump to Multicast Group:[0.0.0.0]** field, the source IP address in the **Source IP:[0.0.0.0]** field, and the source subnet mask in the **Source Mask:[0.0.0.0]** field, highlight **GO**, and press **Enter**.

IGMP Group Table

To browse the IGMP Group Table, highlight **IGMP Group Table** from the **Network Monitoring Menu** and press **Enter**.

```

IGMP Group Table                                     Layer 3 Switch
-----
Jump to Interface Name:[ ]
Multicast Group:[0.0.0.0 ] GO Total Entries: 0
-----
Interface Name Multicast Group Last Reporter IP Created Expire
-----
*****
Function:Enter the interface name.
Message:
Esc= Previous screen CTRL+R= Refresh CTRL+N= Next Page CTRL+P= Previous Page

```

Figure 6-90. IGMP Group Table screen

To display an IGMP Group Table, enter the name of the routing interface in the **Jump to Interface Name:[0.0.0.0]** and the **Multicast Group** in the second field, highlight **GO**, and press **Enter**.

DVMRP Routing Table

To view the DVMRP routing table, highlight **DVMRP Routing Table** from the **Network Monitoring Menu** and press **Enter**.

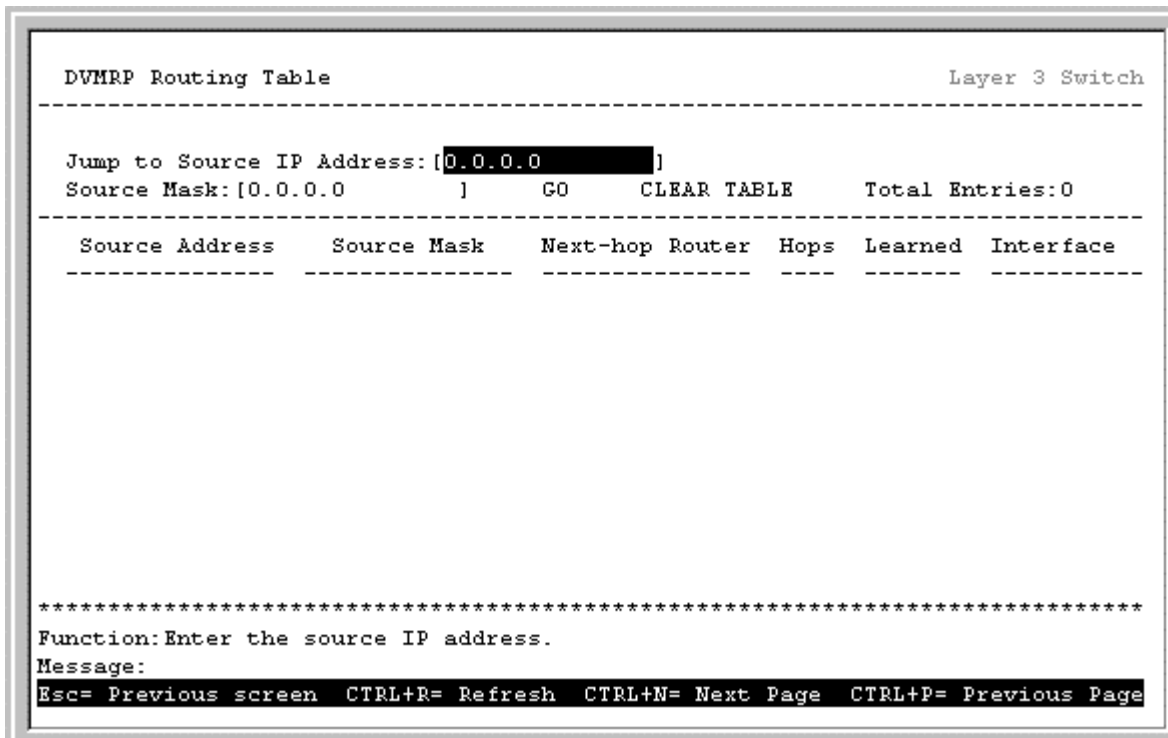


Figure 6-91. DVMRP Routing Table screen

To display a particular source IP address, enter the IP address in the **Jump to IP Address:[0.0.0.0]** field, the source subnet mask in the **Source Mask:[0.0.0.0]** field, highlight **GO**, and press **Enter**. Highlighting **CLEAR TABLE** and pressing **Enter** will empty the table.

Reboot and Factory Reset

To access the reboot, save, and factory reset options, highlight **Reboot** on the **Main Menu** and press **Enter**.

```
RebootLayer 3 Switch
-----
Reboot
Save Configuration & Reboot
Reboot & Load Factory Default Configuration
Reboot & Load Factory Default Configuration Except IP Address

*****
Function: Reboot the system.
Message:
CTRL+T = Root screen      Esc=Prev. screen      CTRL+R = Refresh
```

Figure 6-92. Reboot menu

The reboot options are as follows:

- **Reboot** simply restarts the switch. Any configuration settings not saved using **Save Changes** from the **Main Menu** will be lost. The Switch's configuration will be restored to the last configuration saved in NV-RAM.
- **Save Configuration & Reboot** saves the configuration to NV-RAM (identical to using **Save Changes**) and then restarts the switch.
- **Reboot & Load Factory Default Configuration** restarts the switch using the default factory configuration. All configuration data will be lost. This is identical to using **Factory Reset** and then **Reboot**.
- **Reboot & Load Factory Default Configuration Except IP Address** restarts the switch using the default factory configuration, except the user configured IP address will be retained. All other configuration data will be lost.

A confirmation screen will appear:

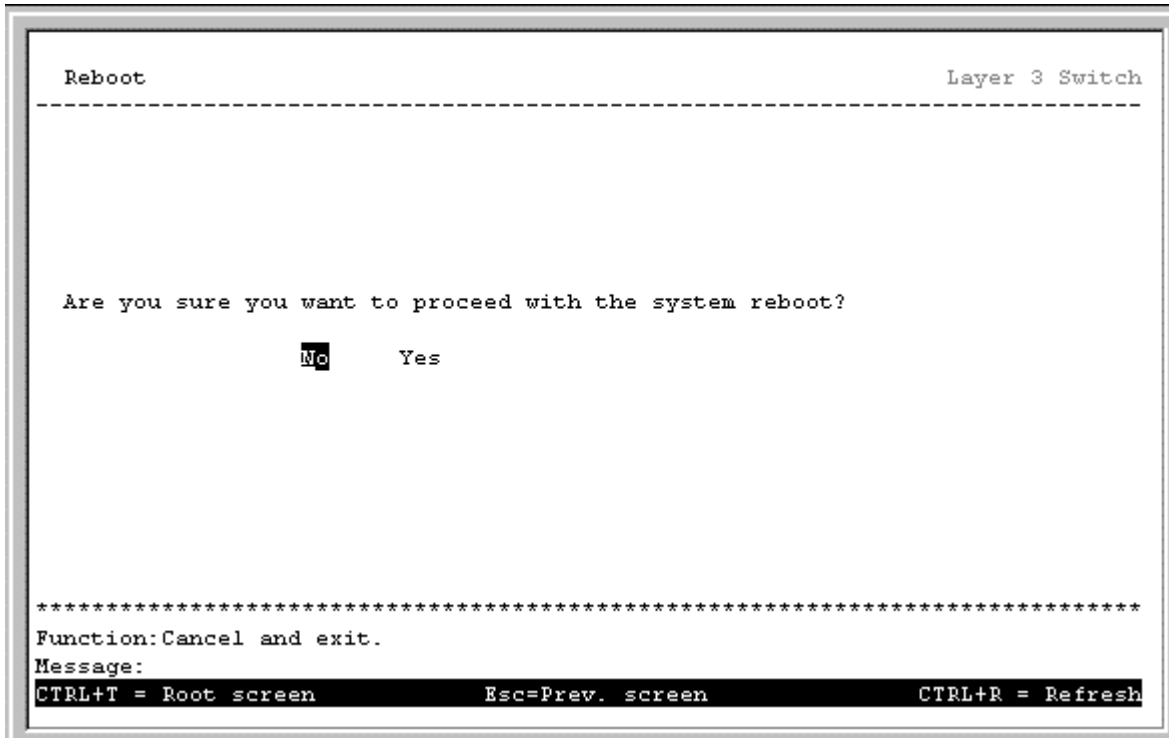


Figure 6-93. Reboot screen

To reboot the Switch, in the mode entered above, highlight **Yes** and press **Enter**.

Note: The factory defaults for the DGS-3308 are listed in Appendix D of this manual.

7

WEB-BASED NETWORK MANAGEMENT

Introduction

The DGS-3308 offers an embedded Web-based (HTML) interface allowing users to manage the Switch from anywhere on the network through a standard browser such as Netscape Navigator/Communicator or Microsoft Internet Explorer. The Web browser acts as a universal access tool and can communicate directly with the Switch using the HTTP protocol.

The Web-based management module and the Console program (and Telnet) are different ways to access the same internal switching software and configure it. Thus, all settings encountered in Web-based management are the same as those found in the console program.

Note: This Web-based Management Module does not accept Chinese language input (or other languages requiring 2 bytes per character).

Where there is a difference in the setup of the Switch between its two operational modes **Layer 2 Only** and **IP Routing**, the sections are divided to correspond with the switch operating mode that is applicable.

Note: **IP Routing** mode switch configuration settings that are saved NV-RAM using **Save Changes** from the **Main Menu** are retained in the switch's memory when the operational mode is changed. **IP Routing** mode settings are simply inactive when the switch is in **Layer 2 Only** mode.

Before You Start

The DGS-3308 Gigabit Ethernet Layer 3 Switch supports a wide array of functions and gives great flexibility and increased network performance by eliminating the routing bottleneck between the WAN or Internet and the Intranet. Its function in a network can be thought of as a new generation of router that performs routing functions in hardware, rather than software. It is a router that also has up to eight independent Gigabit Ethernet collision domains – each of which can be assigned an IP subnet.

This flexibility and rich feature set requires a bit of thought to arrive at a deployment strategy that will maximize the potential of the Switch.

General Deployment Strategy

1. Determine how the network would be best segmented. This is probably done using VLANs in an existing layer 2 switched network.
2. Develop an IP addressing scheme. This involves allocating a block of IP addresses to each network segment. Each network subnet is then assigned a network address and a subnet mask. See Chapter 5, “*Switch Management and Operating Concepts*,” in the section titled IP Addressing and Subnetting for more information.

3. Determine which network resources must be shared by the subnets. Shared resources may be connected directly to the Layer 3 switch, if need be. Static routes to each of the shared resources should be determined.
4. Determine how each subnet will communicate with the WAN or Internet. Again, static routes should be determined and default gateways identified.
5. Develop a security scheme. Some subnets on the network need more security or should be isolated from the other subnets. IP or MAC filtering can be used. Also, one or more VLANs on the Layer 3 switch can be configured without an IP subnet – in which case, these VLANs will function as a layer 2 VLAN and would require an external router to connect to the rest of the network.
6. Develop a policy scheme. Some subnets will have a greater need for multicasting bandwidth, for example. A policy is a mechanism to alter the normal packet forwarding in a network device, and can be used to intelligently allocate bandwidth to time-critical applications such as the integration of voice, video, and data on the network.
7. Develop a redundancy scheme. Planning redundant links and routes to network critical resources can save valuable time in case of a link or device failure. The DGS-3308 Series Spanning Tree function can be used to block the redundant link until it is needed.

VLAN Layout

VLANs on the DGS-3308 have rather more functions than on a traditional layer 2 switch, and must therefore be laid-out and configured with a bit more care. Layer 3 VLANs (VLANs with an IP interface assigned to them) could be thought of as network links – not just as a collection of associated end users. Further, layer 3 VLANs are assigned an IP network address and subnet mask to enable IP routing between them.

Layer 3 VLANs must be configured on the switch before they can be assigned IP subnets. Further, the static VLAN configuration is specified on a per port basis. On the DGS-3308, a VLAN can consist of end-nodes – just like a traditional layer 2 switch, but a VLAN can also consist of one or more layer 2 switches – each of which is connected to multiple end-nodes or network resources.

So, a Layer 3 VLAN, consisting of 4 ports, could be connected to 4 layer 2 switches. If these layer 2 switches each have 8 ports, then the Layer 3 VLAN would contain $4 \times 8 = 32$ end nodes. Assigning an IP subnet to the Layer 3 VLAN would allow wire-speed IP routing from the WAN to each end node and between end nodes.

So, the IP subnets for a network must be determined first, and the VLANs configured on the switch to accommodate the IP subnets. Finally, the IP subnets can be assigned to the VLANs.

Assigning IP Network Addresses and Subnet Masks to VLANs

The DGS-3308FG allows the assignment of IP subnets to individual VLANs. Any VLAN configured on the Switch that is not assigned an IP subnet, will behave as a layer 2 VLAN and will not be capable of IP routing – even if the switch is in IP Routing mode.

Developing an IP addressing scheme is a complex subject, but it is sufficient here to mention that the total number of anticipated end nodes – for each Layer 3 VLAN – must be accommodated with a unique IP address. It should be noted that the Switch regards a VLAN with an IP network address and corresponding subnet mask assigned as an IP interface in IP Routing mode.

Defining Static Routes

Routes between the IP interfaces and a default gateway or other router with a WAN connection should be determined beforehand and entered into the static/default routing table on the DGS-3308.

Existing WAN or Internet connections will probably have a router to connect the interface device to the network. This router can be connected to the DGS-3308 using a port designated as a 'router port'. Designating a port as a router port allows multicasting messages to be passed to the router with a WAN or Internet connection without flooding these messages throughout the network. This saves considerable bandwidth and increases performance without additional investment in network equipment.

Getting Started

The first step in getting started in using Web-based management for your Switch is to secure a browser. A Web browser is a program that allows a person to read hypertext, for example, Netscape Navigator or Microsoft Internet Explorer. Follow the installation instructions for the browser.

The second and last step is to configure the IP interface of the Switch. This can be done manually through a console (see the Configure IP Address section in chapter 6, "Using The Console Interface").

To begin managing your Switch simply run the browser you have installed on your computer and point it to the IP address you have defined for the device. The URL in the address bar should read something like: `http://123.123.123.123`, where the numbers 123 represent the IP address of the Switch.

Note: The factory default IP address for the Switch is 10.90.90.90.

In the page that opens, click on the **Login to DGS-3308FG (or DGS-3308TG) Manager** button:



Figure 7-1. Login Button

This opens the main page in the management module.

The switch management features available in the Web-based are explained below.

Configuring the Switch

User Accounts Management

Click **Setup User Accounts**, the fourth item on the **Remote Management Setup** menu, to access the following window:



Figure 7-2. User Accounts Control Table screen

Click **New** to add a user.

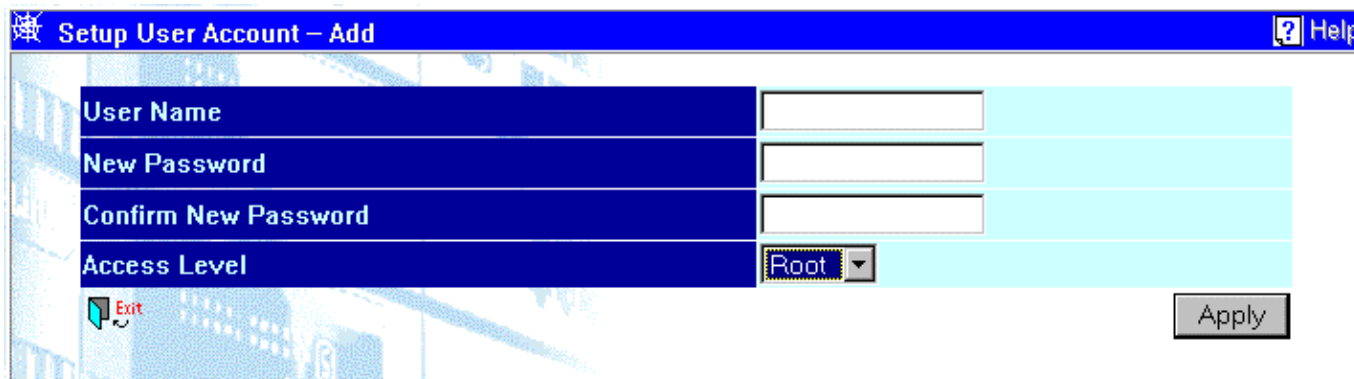


Figure 7-3. User Accounts Control Table – Add screen

1. Enter the new user name, assign an initial password, and then confirm the new password. Determine whether the new user should have *Root*, *User+*, or *User* privileges.
2. Click on **Apply** to make the user addition effective.
3. A listing of all user accounts and access levels is shown on the user accounts control table. This list is updated when Apply is executed.
4. Please remember that Apply makes changes to the switch configuration for the **current session only**. All changes (including User additions or updates) must be entered into non-volatile ram using the **Save Changes** command on the **Maintenance** menu - if you want these changes to be permanent.

Root, User+, and Normal User Privileges

There are three levels of user privileges: *Root*, *User+*, and *User*. Some menu selections available to users with *Root* privileges may not be available to those with *User+* and *User* privileges.

The following table summarizes the *Root*, *User+* and *User* privileges:

Switch Configuration	Privilege		
	Root	User+	User
Management			
Configuration	Yes	Read Only	Read Only
Network Monitoring	Yes	Read Only	Read Only
Community Strings and Trap Stations	Yes	Read Only	Read Only
Update Firmware and Configuration Files	Yes	No	No
System Utilities	Yes	Ping Only	Ping Only
Factory Reset	Yes	No	No
Reboot Switch	Yes	Yes	No
User Accounts Management			
Add/Update/Delete User Accounts	Yes	No	No
View User Accounts	Yes	No	No

Table 7-1. Root, User+, and User Privileges

After establishing a User Account with *Root*-level privileges, click **Apply** and then press **Save Changes** on the **Maintenance** menu. The Switch will save any changes to its non-volatile ram and reboot. You can logon again and are now ready to continue configuring the Switch.

Saving Changes

The DGS-3308 has two levels of memory; normal RAM and non-volatile or NV-RAM. Configuration changes are made effective by clicking **Apply** and then pressing **Save Changes** on the **Maintenance** menu. When this is done, the settings will be immediately applied to the switching software in RAM, and will immediately take effect.

Some settings, though, require you to restart the Switch before they will take effect. Restarting the Switch erases all settings in RAM and reloads the stored settings from the NV-RAM. Thus, it is necessary to save all setting changes to NV-RAM before rebooting the Switch.

To retain any configuration changes permanently, highlight **Save Changes** from the **Maintenance** menu. The following screen will appear to verify that your new settings have been saved to NV-RAM:

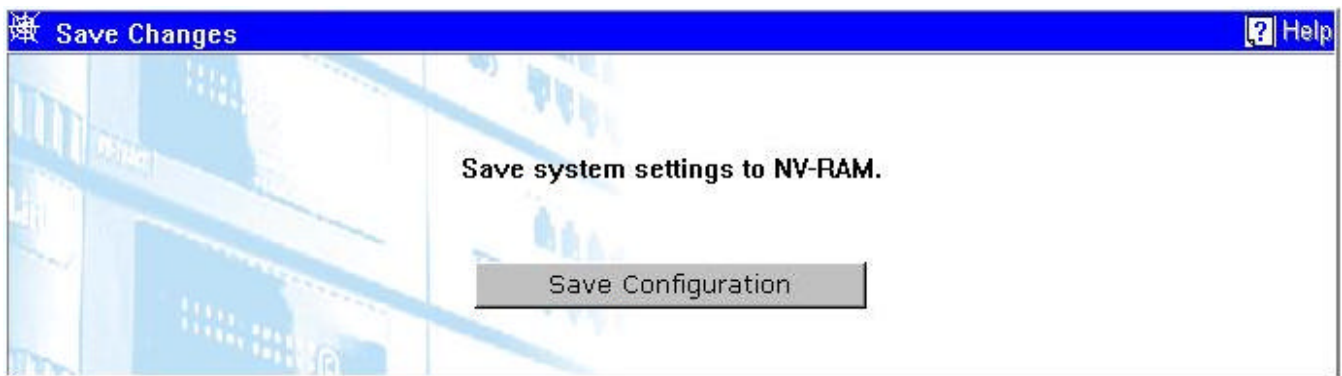


Figure 7-4. Save Changes screen

Once the switch configuration settings have been saved to NV-RAM, they become the default settings for the switch. These settings will be used every time the Switch is rebooted.

Factory Reset

The following menu is used to restart the Switch using only the configuration that was supplied by the factory. A factory reset returns all configuration options to their default values and restores the Switch's configuration to the factory settings.

All user-entered configuration information will be lost.

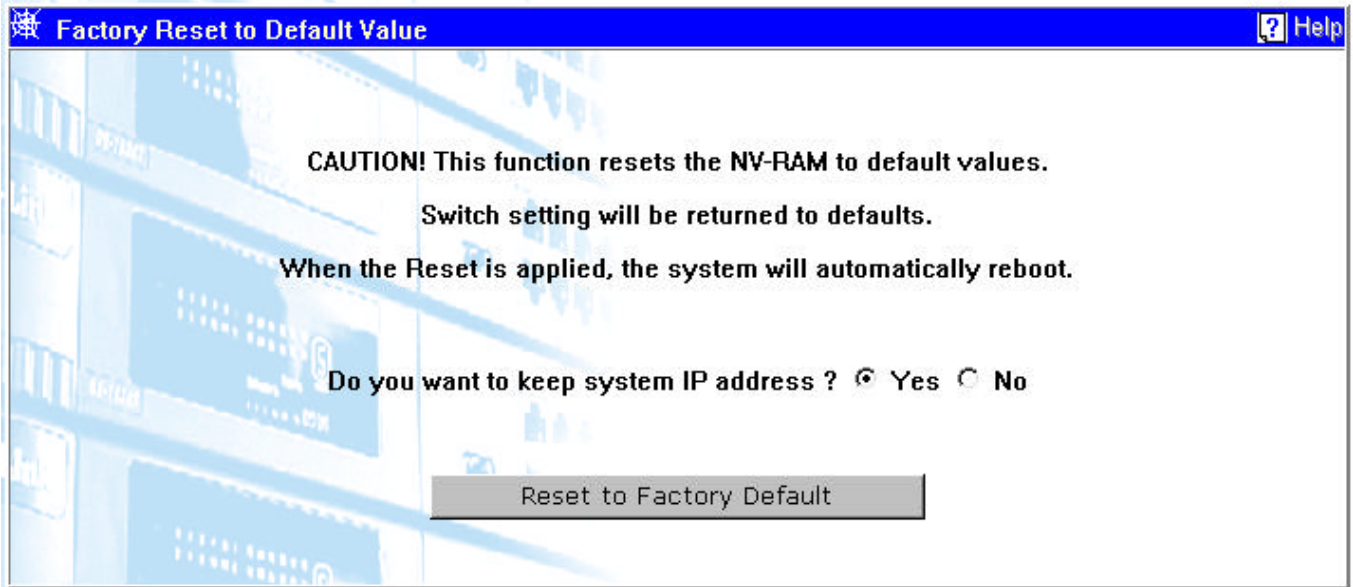


Figure 7-5. Factory Reset to Default Value screen

Select *Yes* if you want the Switch to retain its current IP address. Select *No* to reset the Switch's IP address to the factory default, 10.90.90.90.

Click the **Reset to Factory Default** button to restart the Switch.

Using Web-Based Management

Setting Up Web Management

Before running Web-based management, some basic configuration of the Switch may need to be performed. The following at a minimum must be configured or known for the Switch to be managed:

- IP Address
- Administrator password

In addition, several other parameters may need to be configured or known to properly communicate with the switch or allow full management capability. These include:

- Default Gateway
- Trap Destination and Community Name

Configuration of these items may be made from the User Interface, which is accessible via either the serial console or Telnet. Refer to the User Guide that came with your system for more information that describes the required configuration.

Setting an IP Address

The IP address for the Switch must be set before it can be managed with the Web-based manager. The Switch IP address may be automatically set using BootP protocol, in which case the actual address assigned to the Switch must be known.

The IP address may alternatively be set manually as follows:

1. Starting at the main window of the User Interface, click **Configuration** and then press **Switch IP Setup**.
2. Enter the IP address, the subnet mask, and the management VD in the fields offered.
3. Click **Apply** to make the change effective. Use **Save Changes** on the **Maintenance** menu to enter the IP address into NV-RAM.

Setting a Default Gateway

The default gateway parameter defines the IP address of a router or other network device to which IP packets are to be sent if destined for a subnet outside of that in which the switch is operating. This parameter must be set if you are attempting to manage the Switch from a remote network or across the Internet.

1. Starting at the main window of the User Interface, click **Configuration** and then press **Switch IP Setup**.
2. Enter the router IP address and click **Apply**. Use **Save Changes** on the **Maintenance** menu to enter the IP address into NV-RAM.

Setting the Administrator Password

Management access to the Switch is restricted based on the administrator password. Administrators have read/write access for parameters governing the SNMP agent. You should therefore assign a password to the default administrator as soon as possible, and store it in a safe place.

Setting Trap Destinations

If you wish to record SNMP traps, or events, generated by the Switch, you must configure a destination for the IP Trap Managers. A trap destination is the IP address of the computer system on which the Web-based manager is being run.

1. Starting at the main menu of the User Interface, click **Management** and then press **Trap Receivers**.
2. Enter the IP address and community name.
3. Move to the Status field, and select *Enabled*.
4. Click **Apply** to make the changes effective. Use **Save Changes** on the **Maintenance** menu to enter the configuration into NV-RAM.

Saving Configuration Changes

Clicking the **Apply** button makes any configuration change active, but only for the current session. If the Switch is restarted (rebooted) without entering the configuration changes into the non-volatile RAM (flash RAM), the configuration changes will be lost.

To enter configuration changes into the Switch's non-volatile RAM, select **Save Changes** from the **Maintenance** menu. Click on the **Save Configuration** button to enter the current configuration into NV-RAM. The configuration will then be loaded into the Switch's memory when it is restarted.

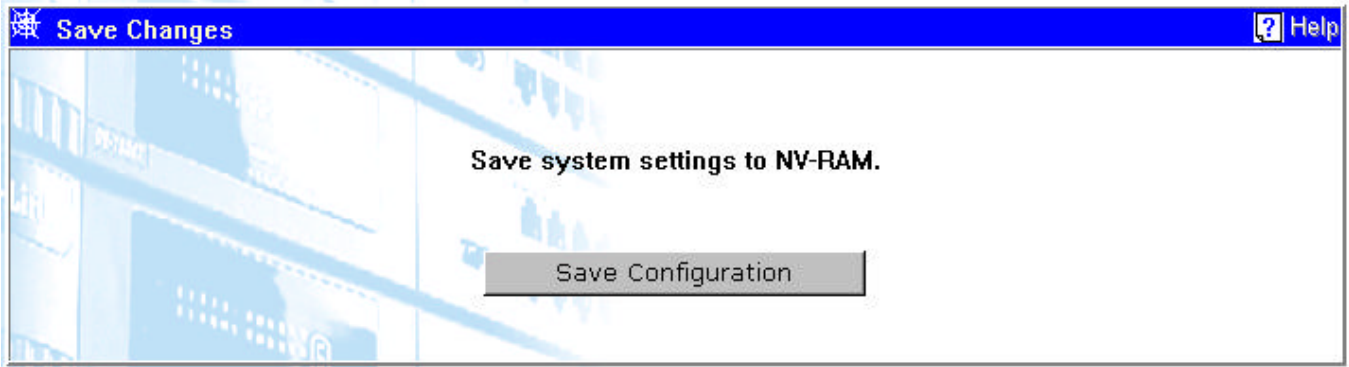


Figure 7-6. Save Changes screen

Starting and Stopping the Web-based Manager

Do the following to use the Web-based manager:

1. Start a Java-enabled Web browser from any machine with network access to the Switch. (Preferred browsers include Netscape Navigator 4.0 or above, or Internet Explorer 4.0 or above.)
2. Enter the IP address for the Switch you want to manage in the URL field of the browser.
3. The screen below will appear, prompting you to enter the user name and password for management access.



Figure 7-7. Enter Network Password screen

Use of the correct User Name and Password will allow read/write access to the Switch.

The full application will now launch. A three-frame page will display, including a view of the front panel in the top frame.

4. To stop the Web-based manager, close the Web browser application.

Web-based Manager's User Interface

The user interface provides access to various switch configuration and management screens, allows you to view performance statistics, and permits you to graphically monitor system status.

Areas of the User Interface

The figure below shows the user interface. The user interface is divided into 3 distinct areas.

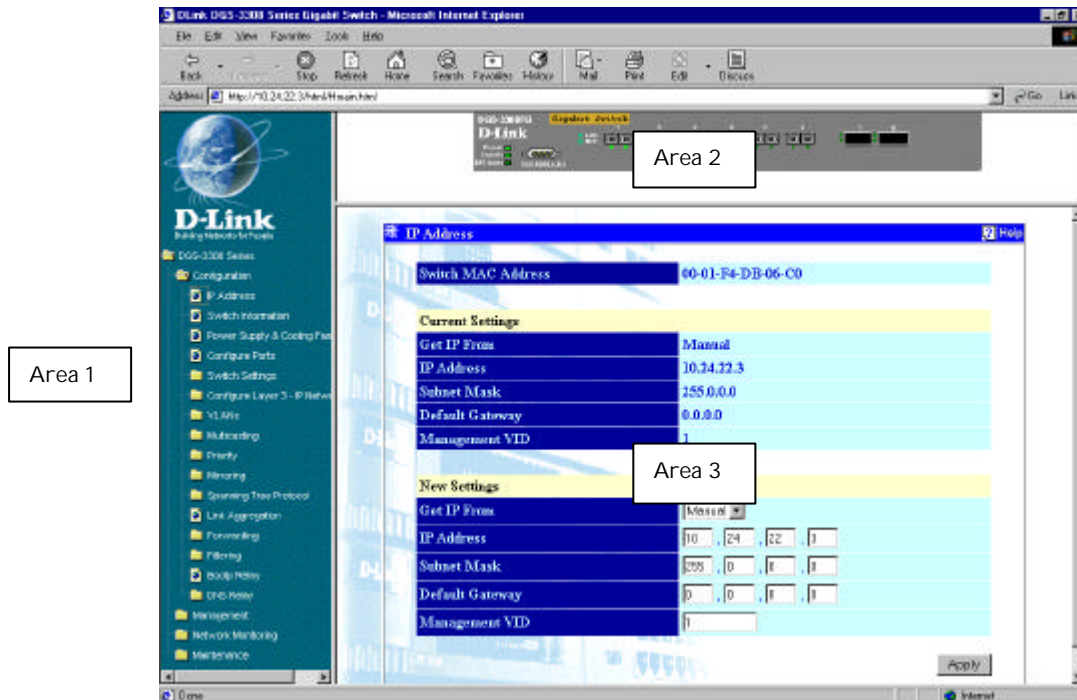


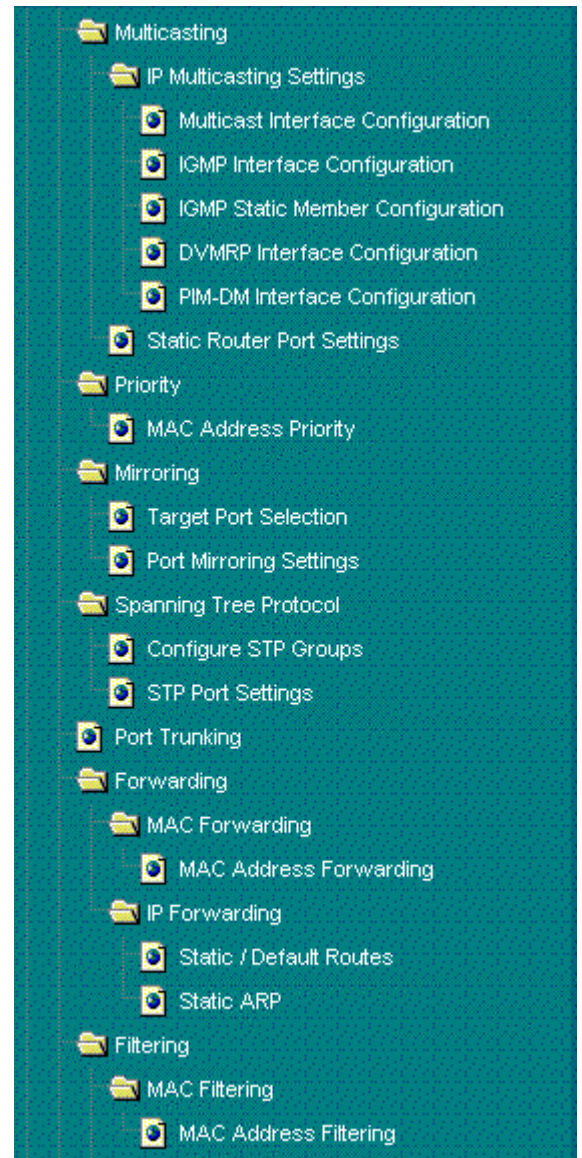
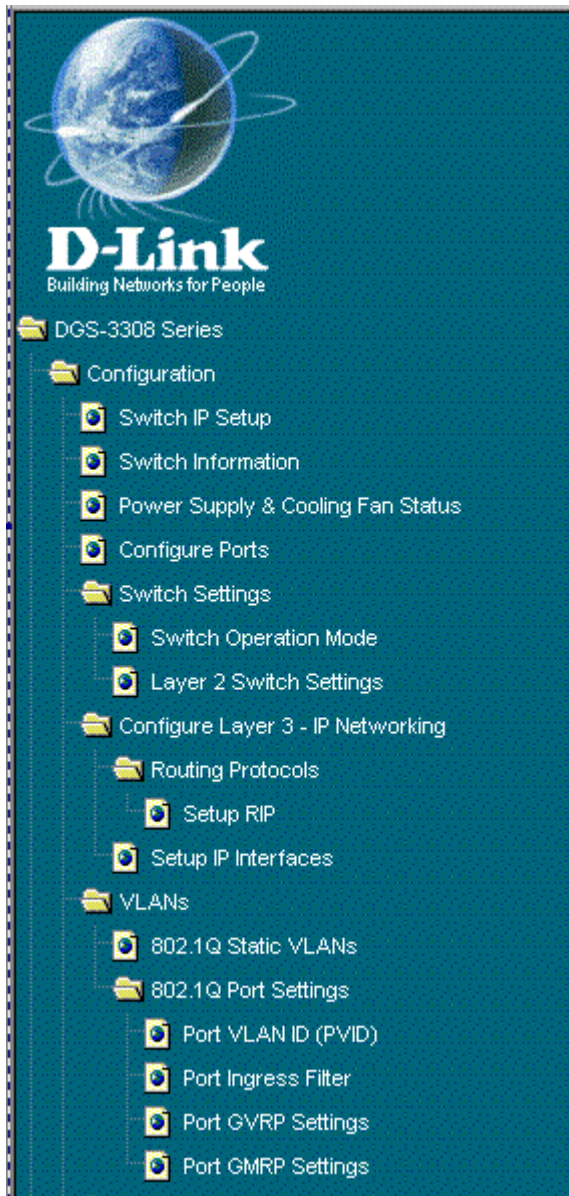
Figure 7-8. Main Web Manager screen

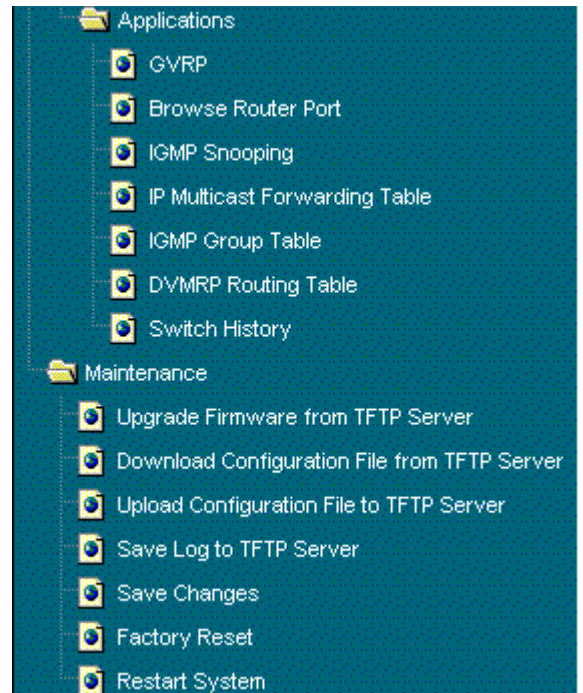
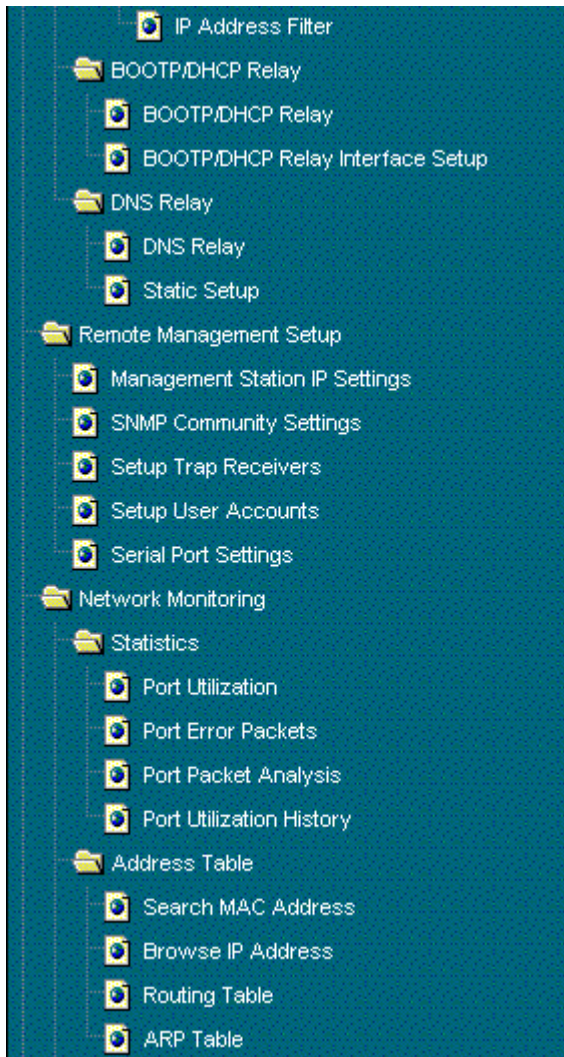
Area	Function
1	Presents a graphical near real-time image of the front panel of the Switch. This area displays the Switch's ports and expansion modules, showing port activity, duplex mode, or flow control, depending on the specified mode. Various areas of the graphic can be selected for performing management functions, including the ports, expansion modules, management module, or the case.
2	Allows the selection of commands.
3	Presents switch information based on your selection and the entry of configuration data.

Configuration

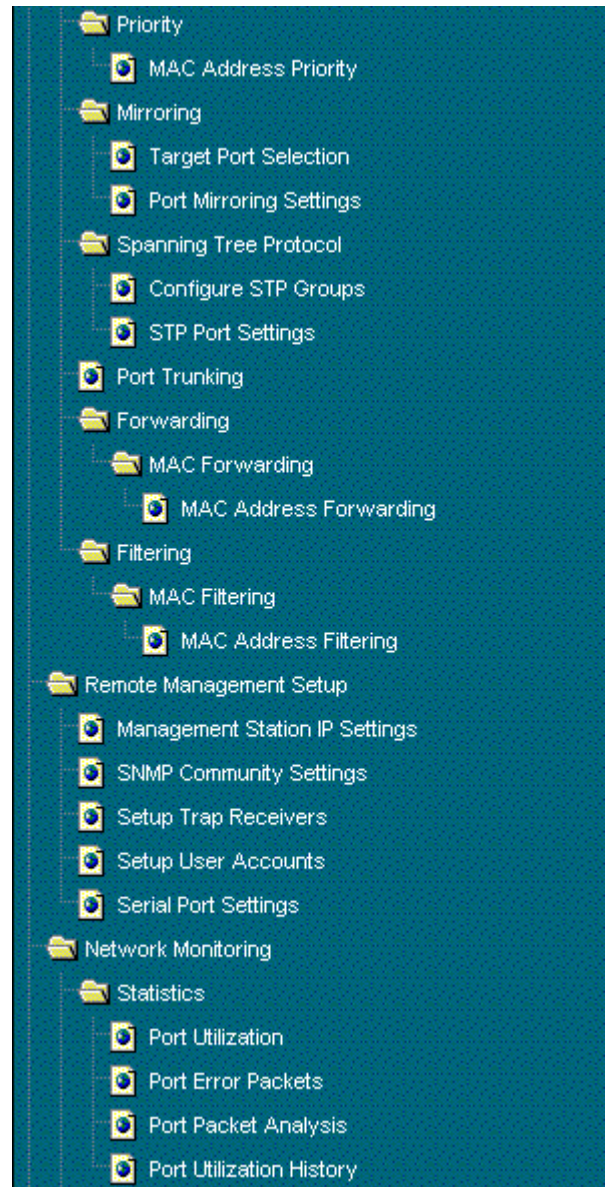
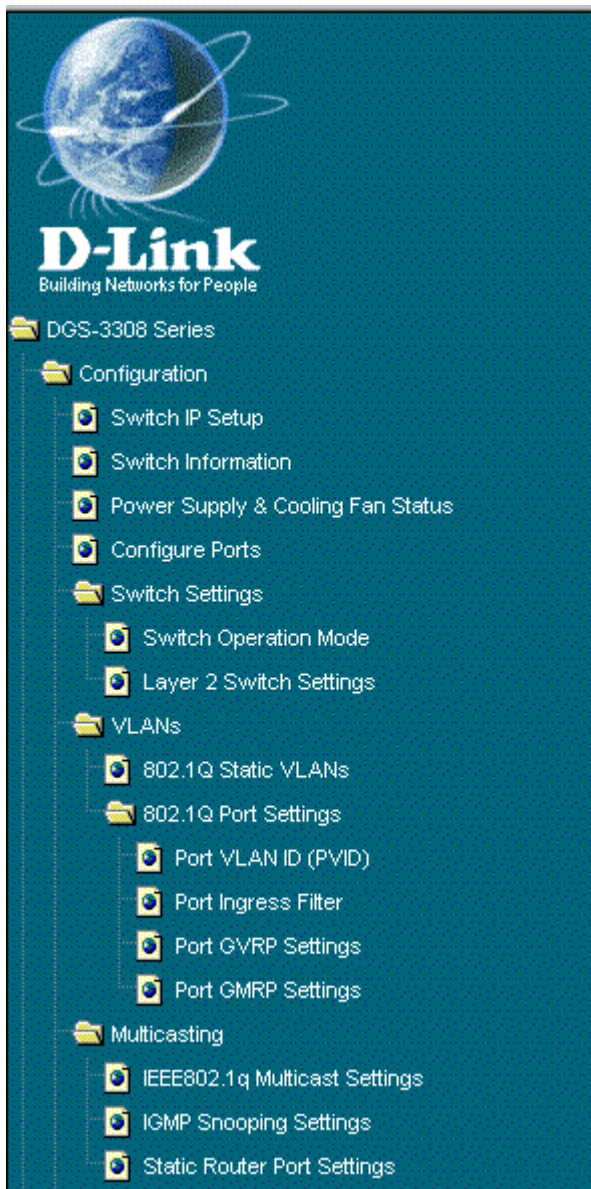
The Configuration menu offers you a wide range of functions and features.

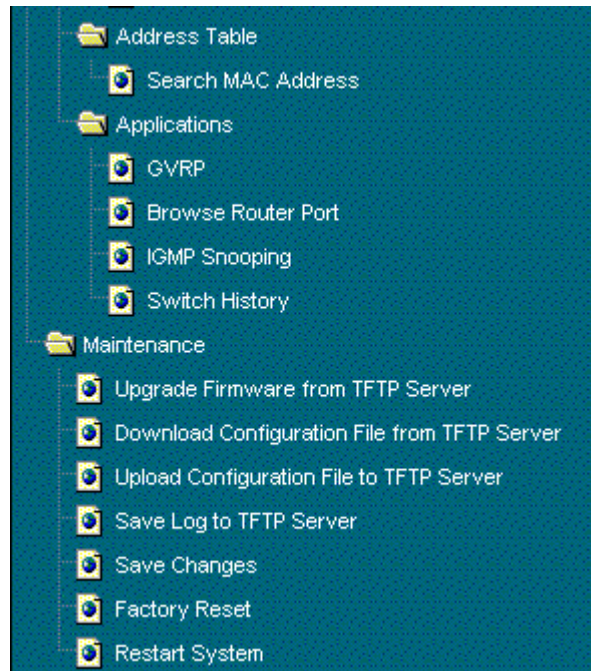
Layer 3 Mode





Layer 2 Mode





Switch IP Setup

Use the **IP Setup** window to set the boot-up option, or to manually configure the IP address for the agent module. The window shown below is described below in the following table.

The screenshot shows the 'IP Setup' window with a blue title bar and a 'Help' icon. It is divided into two main sections: 'Current Switch IP Settings' and 'New Switch IP Settings'. The 'Current' section is a table with the following values:

Current Switch IP Settings	
Get IP From	Manual
IP Address	10.24.22.8
Subnet Mask	255.0.0.0
Default Gateway	0.0.0.0
VID	1

The 'New Switch IP Settings' section is a form with the following fields:

New Switch IP Settings	
Get IP From	Manual
IP Address	10 . 24 . 22 . 8
Subnet Mask	255 . 0 . 0 . 0
Default Gateway	0 . 0 . 0 . 0
VID	1

An 'Apply' button is located at the bottom right of the window.

Figure 7-9. IP Setup screen

Items on the screen above include:

- **Get IP From** – Specifies the method used to assign the Switch an IP address. The options are *Manual*, *DHCP*, and *BOOTP*, the latter two available in Layer 2 mode only.
- **IP Address** – Allows the manual input of an IP address for the Switch.
- **Subnet Mask** – Allows the input of a Subnet Mask.
- **Default Gateway** – Allows the input of the IP address of a Default Gateway used to pass trap messages from the Switch's agent to the management station. Note that the gateway must be defined if the management station is located on a different IP segment than the Switch.
- **VID** – Allows the input of a VLAN VID to restrict access to the management module on the Switch to a single VLAN.

Switch Information

Use the **Switch Information** screen to display descriptive information about the Switch, or for quick system identification.

Switch Information - Basic Settings	
Device Type	DGS-3308 Layer 3 Gigabit Ethernet Switch
MAC Address	00:01:f4:db:06:c0
Boot PROM Version	0.2
Firmware Version	0.62
Hardware Version	v1.00
Device S/N	12345678
System Name	<input type="text" value="Gigabit Ethernet L2/L3 Switch"/>
System Location	<input type="text" value="53 Discovery Dr, Irvine CA 92620"/>
System Contact	<input type="text" value="D-Link Systems Inc."/>

Figure 7-10. Switch Information – Basic Settings screen

Items on the screen above include:

- **Device Type** – Type of Switch.
- **MAC Address** – The factory assigns each Switch a unique MAC address.
- **Boot PROM Version** – Device startup code.
- **Firmware Version** – System firmware version in ROM.
- **Hardware Version** – Hardware version of the main board.
- **Device S/N** – The factory assigns each Switch a unique serial number.
- **System Name** – Name assigned to the switch system.
- **System Location**¹ – Specifies the area or location where the system resides.
- **System Contact**¹ – Contact person for the system.

¹Maximum string length is 99, but the screen only displays 45 characters. You can use the arrow keys to browse the whole string.

Power Supply & Cooling Fan Status

The following window is used to view the current status of the power supply and each of the four cooling fans.

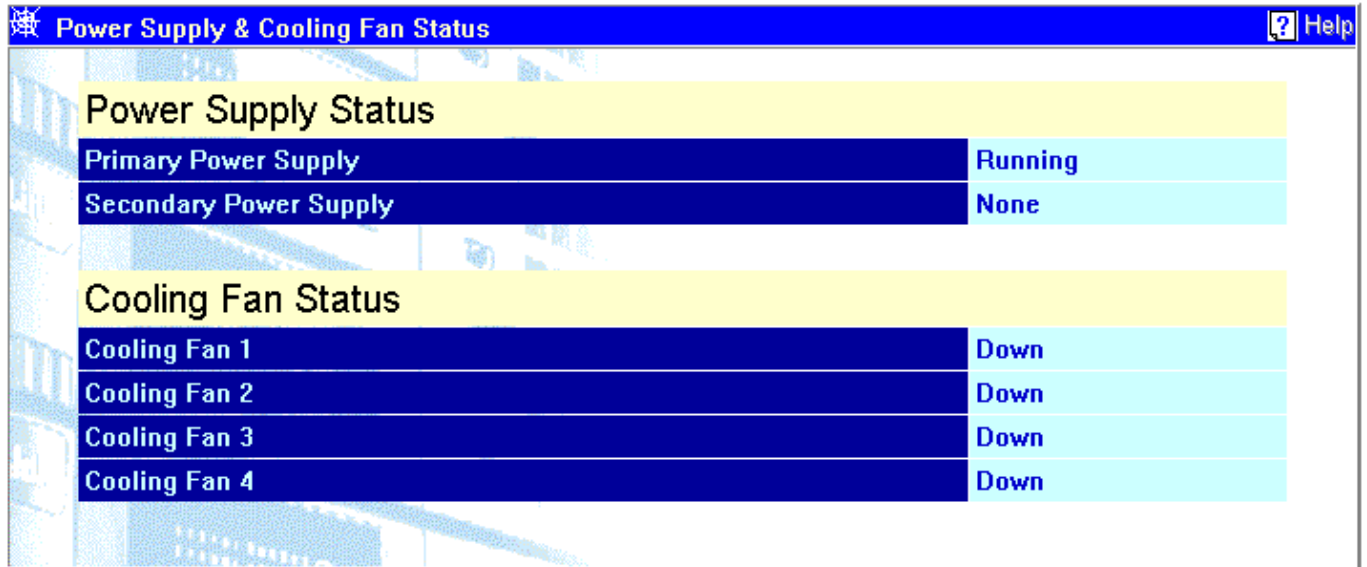


Figure 7-11. Power Supply & Cooling Fan Status screen

Configure Ports

You can select a port to be configured by clicking on the port at the top of the Web-based manager's user interface. This port then becomes the currently selected port and all entries in the following figure will apply to this port. To configure more than one port at a time, use the **Configure Port from 1 to** drop-down list at the bottom of the panel and then click **Apply**.

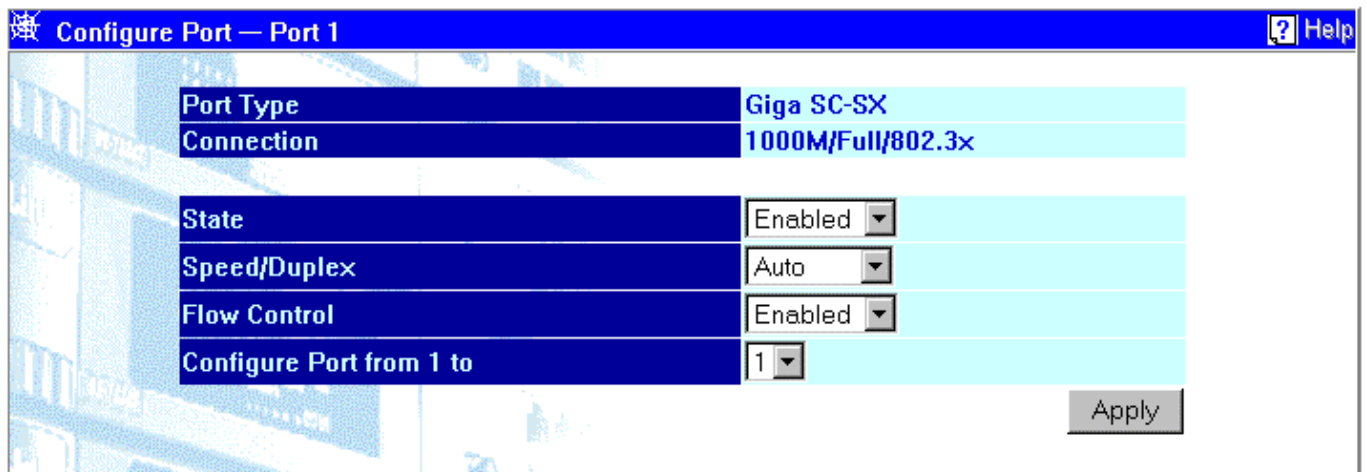


Figure 7-12. Configure Port screen

Items on the screen above include:

- **Port Type** – A read-only field that indicates the type of port currently selected.
- **Connection** – A read-only field that indicates the current status of the selected port.
- **State** – Allows the currently selected port to be *Enabled* or *Disabled*.
- **Speed/Duplex** – Allows the specification of the speed and full- or half-duplex state of the selected port. The choices are *Auto* and *1000/Full*.

- **Flow Control** – Allows flow control to be *Enabled* or *Disabled* for the selected port.
- **Configure Port from 1 to** – Select the port range to be configured.

Switch Settings

The Switch can operate in one of two modes:

- **Layer 2 Only with IEEE 802.1Q VLAN support** – The switching process is based upon the source and destination MAC addresses only. 802.1Q VLANs are supported and the Switch is considered as a VLAN-tag aware device.
- **IP Routing with IEEE 802.1Q VLAN support** – The switching process is based upon the IP source and destination addresses, if present. If the IP addresses are not present, the switching process is based upon the MAC addresses (as in Layer 2 above). 802.1Q VLANs are supported and the switch is considered as a VLAN-tag aware device.

The Switch must be rebooted when changing the operation mode before the new operation mode can take effect.

Switch Operation Mode

The field **Restart Mode** can be set using the drop-down menu on the **Switch Operation Mode** screen (under **Switch Settings** on the **Configuration** menu) to one of the two switch operation modes: **Layer 2 Only, Support IEEE 802.1Q VLANs** and **IP Routing, Support IEEE 802.1Q VLANs**.

To make a change in the operation mode of the Switch effective, click the **Apply** button. The Switch must be restarted to change the operating mode.

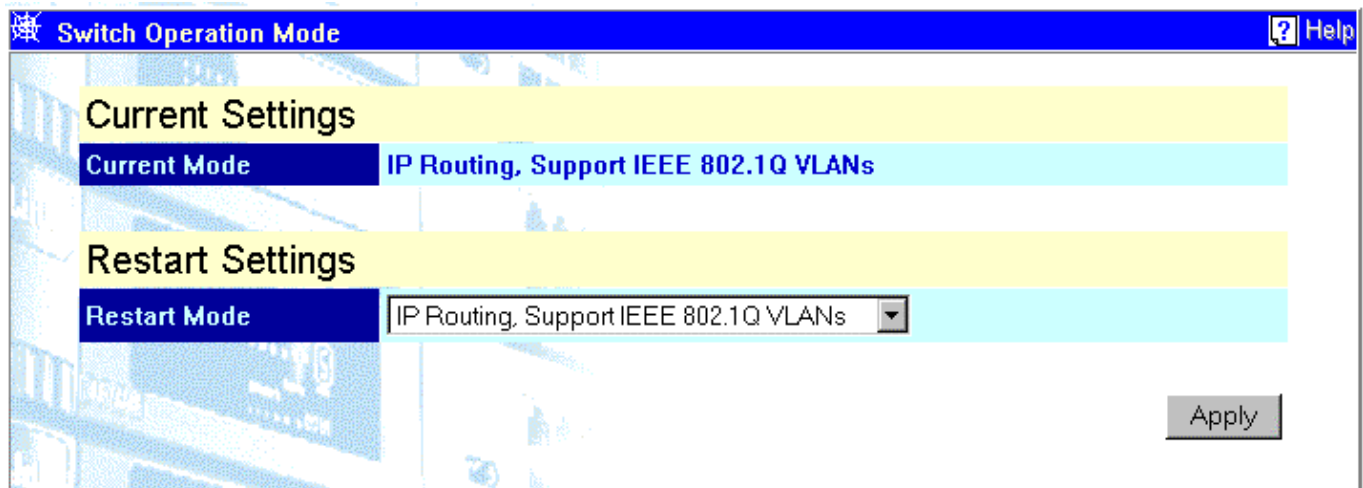


Figure 7-13. Switch Operation Mode screen

Items on the screen above include:

- **Current Mode** – Displays the Switch's current operating mode.
- **Restart Mode** – Allows the selection of the operating mode of the Switch after a switch restart. The options are Layer 2, Support IEEE 802.1Q VLANs, and IP Routing, Support IEEE 802.1Q VLANs.

Layer 2 Switch Settings

Note: Layer 2 Switch functions and settings are also available when the Switch is configured to operate in the IP Routing (Layer 3) mode.



Figure 7-14. Layer 2 Switch Settings screen

Items on the screen above include:

- **Broadcast/Multicast Storm Mode** – Allows the Broadcast/Multicast Storm control to be *Enabled* or *Disabled*. This enables or disables, globally, the Switch's reaction to Multicast storms, triggered at the threshold set below.
- **Upper Threshold (Kpps)** – This is the number of thousands Broadcast/Multicast packets per second received by the Switch – on one of the base ports – that will trigger the Switch's reaction to a Broadcast/Multicast storm.

Configure Layer 3 - IP Networking

Routing Protocols

Setup RIP

The Routing Information Protocol (RIP) is a distance-vector protocol that uses the hop count as its criteria for making routing decisions. RIP is an Interior Gateway Protocol (IGP), which means that it performs routing within a single autonomous system.

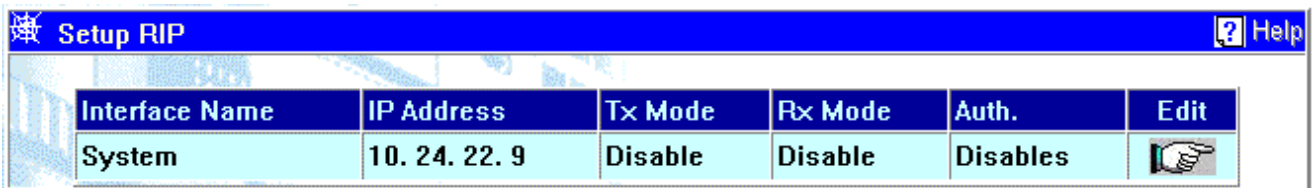


Figure 7-15. Setup RIP screen

Items on the screen above include:

- **Interface Name** – Displays the name of the subnet on which RIP is to be setup. This subnet must be previously configured on the Switch.
- **IP Address** – Displays the IP address corresponding to the subnet name above.
- **Tx Mode** – Displays whether transmitted RIP packets will be structured as *Rip V1*, *V1 Compatible*, *Rip V2*, or *Disable*. This entry specifies which version of the RIP protocol will be used to transmit RIP packets. *Disable* prevents the transmission of RIP packets.

- **Rx Mode** – Displays whether received RIP packets will be interpreted as RIP version *Rip V1*, *Rip V2*, *V1 and V2*, or *Disable*. This entry specifies which version of the RIP protocol will be used to receive RIP packets. The *Disable* entry prevents the reception of RIP packets.
- **Auth.** – Displays whether RIP is configured to use a password.
- **Edit** – A link to the **Setup RIP – Edit** screen.

Setup RIP – Edit

The following menu is used to edit the Switch's RIP setup.

Interface Name	System
IP Address	10.24.22.8
Password	
Tx Mode	Disabled
Rx Mode	Disabled
Authentication	Disabled

Figure 7-16. Setup RIP – Edit screen

Items on the screen above include:

- **Interface Name** – Displays the name of the subnet on which RIP is to be edited. This subnet must be previously configured on the Switch.
- **IP Address** – Displays the IP address corresponding to the subnet name above.
- **Password** – Enter the password for this RIP entry, if applicable.
- **Tx Mode** – Allows transmitted RIP packets to be structured as *Rip V1*, *V1 Compatible*, *Rip V2*, or *Disabled*. This entry specifies which version of the RIP protocol will be used to transmit RIP packets. *Disabled* prevents the transmission of RIP packets.
- **Rx Mode** – Determines how received RIP packets will be interpreted – as RIP version *Rip V1*, *Rip V2*, *V1 and V2*, or *Disabled*. This entry specifies which version of the RIP protocol will be used to receive RIP packets. The *Disabled* entry prevents the reception of RIP packets.
- **Authentication** – Allows RIP to be configured to use a password.

Setup IP Interfaces

The first menu displays the current IP interfaces on the Switch. The **IP Subnet - Edit** menu is used to add a new IP interface and to edit an existing IP interface.

Each IP interface on the Switch corresponds to a VLAN. The VLAN must be configured before the IP interface can be setup. The IP interface must have the same name (and the same VID number) as its corresponding VLAN.

Note: A VLAN that does not have a corresponding IP interface defined for it, will function as a **Layer 2 Only VLAN** – regardless of the **Switch Operation** mode.

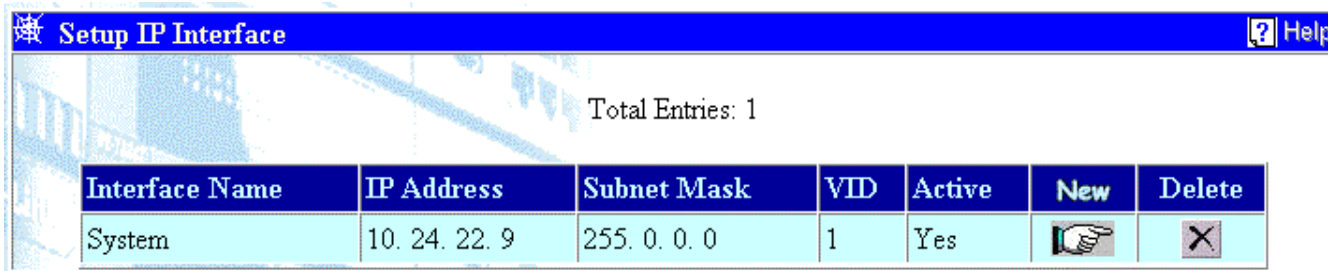


Figure 7-17. Setup IP Interface screen

Items on the screen above include:

- **Interface Name** – Displays the name of the IP interface corresponding to the IP address and subnet mask.
- **IP Address** – The IP address of the IP interface (sometimes referred to as a network address).
- **Subnet Mask** – The subnet mask corresponding to the IP address and IP interface name.
- **VID** – The VLAN ID of the VLAN corresponding to this IP interface.
- **Active** – Displays whether the IP interface is active or inactive.
- **New** – A link to the **IP Subnet - Add** menu.
- **Delete** – Click this icon to delete an IP subnet from this table.

IP Subnet - Edit

The following window is used to add or modify an IP interface to the Switch.

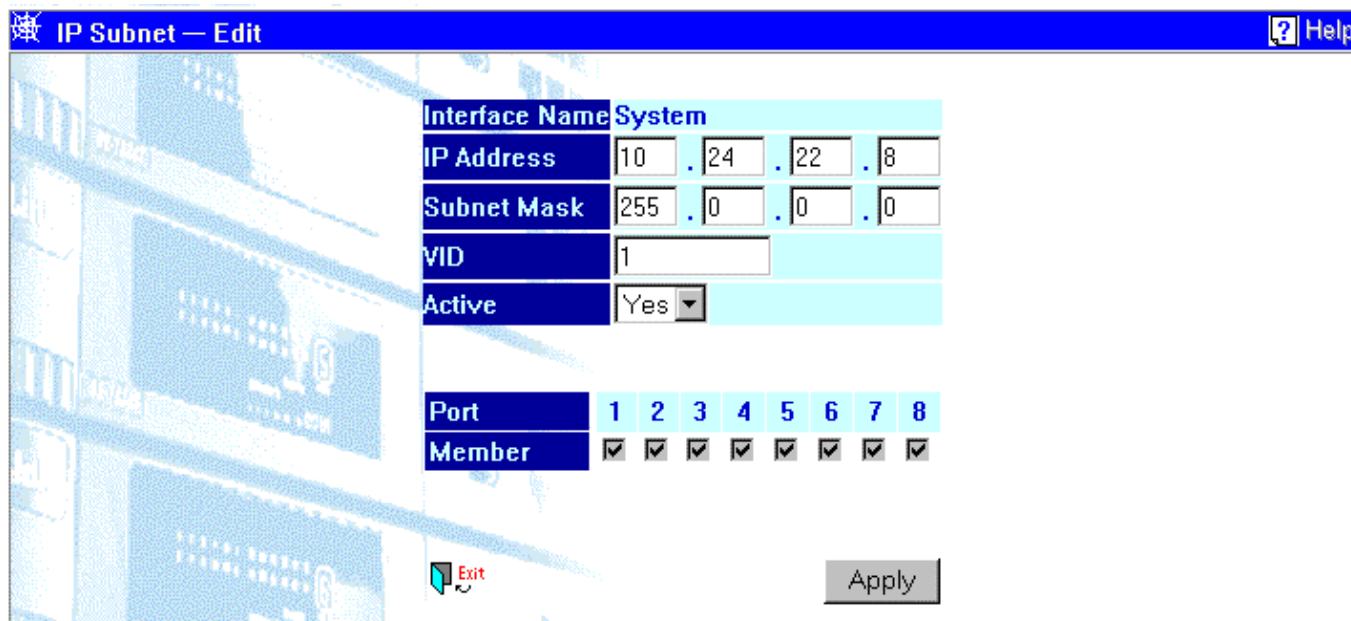


Figure 7-18. IP Subnet - Edit screen

Items on the window above include:

- **Interface Name** – A name given to identify this IP interface.
- **IP Address** – The IP address of this IP interface (sometimes referred to as a network address).
- **Subnet Mask** – The subnet mask for this IP interface.
- **VID** – The VLAN ID of the VLAN corresponding to this IP interface.
- **Active** – Allows this IP interface to be Active or Inactive on the Switch.
- **Port Member** – Allows the selection of ports to be members of this IP interface and its corresponding VLAN.

VLANs

The following section describes how to set up IEEE 802.1Q VLANs on the Switch.

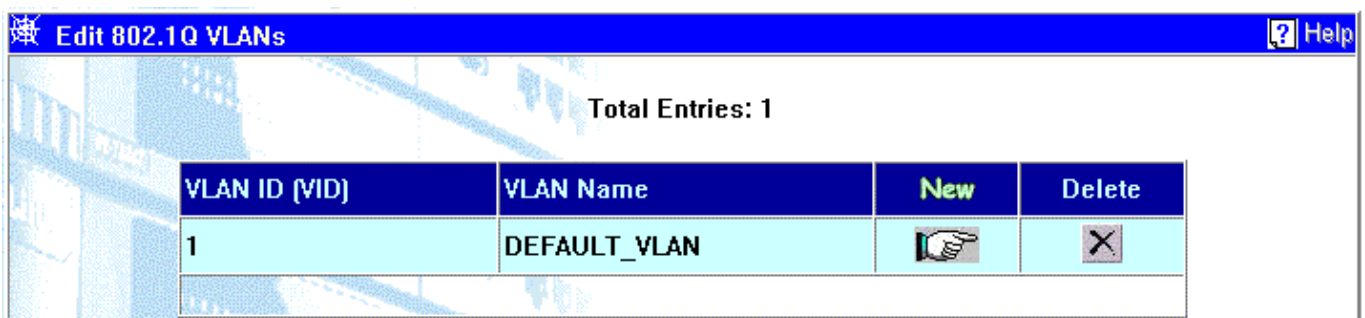


Figure 7-19. Edit 802.1Q VLANs screen

Items on the screen above include:

- **VLAN ID (VID)** – The VLAN ID of the VLAN on which the static router port resides.
- **VLAN Name** – The name of the VLAN for which ports are to be configured.
- **New** – A link to the **802.1Q Static VLANs Entry Settings - Edit** window.
- **Delete** – Click this icon to delete an entry from this table.

802.1Q Static VLANs Entry Settings - Edit

The following window allows you to edit an 802.1Q VLAN on the Switch.

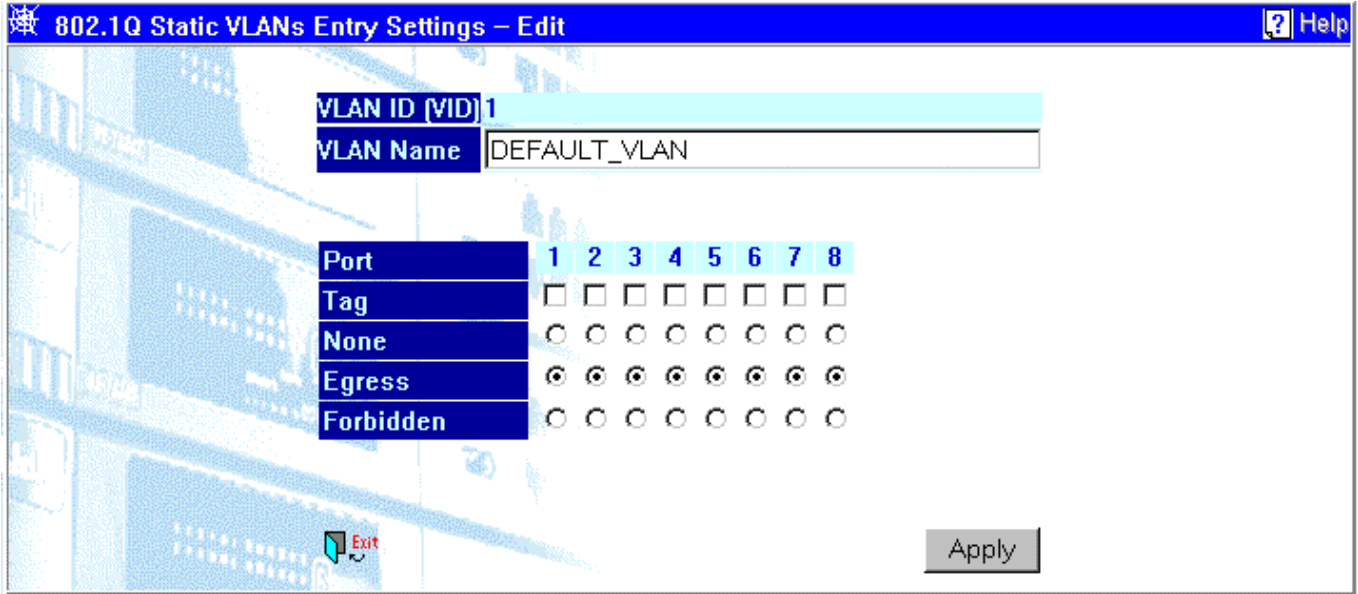


Figure 7-20. 802.1Q Static VLANs Entry Settings – Edit screen

Items on the screen above include:

- **VLAN (VID)** – The VLAN ID of the VLAN that is being created.
- **VLAN Name** – The name of the VLAN that is being created.
- **Port** – Corresponds to the ports that will be members of the VLAN.
- **Tag** – Specifies the port as either 802.1Q tagging or 802.1Q untagging. Checking the box will designate the port as Tagging.
- **None** – Specifies the port as not being a static member of the VLAN, but with no restrictions for joining the VLAN dynamically through GVRP.
- **Egress** – Specifies the port as being a static member of the VLAN. Egress Member Ports are ports that will be transmitting traffic for the VLAN.
- **Forbidden** – Specifies the port as not being a static member of the VLAN, and as being forbidden from joining the VLAN dynamically.

802.1Q Port Settings

The following read-only window allows you to view the current 802.1Q VLAN port settings on the Switch.



Figure 7-21. 802.1Q Port Settings screen

Port VLAN ID (PVID)

The Port VLAN ID is used by the port to tag outgoing, untagged packets, and to make filtering decisions about incoming packets. If the port is specified as tagging, and an untagged packet is forwarded to the port for transmission, the port will add an 802.1Q tag using the PVID to write the VID in the tag. When the packet arrives at its destination, the receiving device will use the PVID to make VLAN forwarding decisions. If a packet is received by the port, and Ingress filtering is enabled, the port will compare the VID of the incoming packet to its PVID. If the two are unequal, the port will drop the packet. If the two are equal, the port will receive the packet.

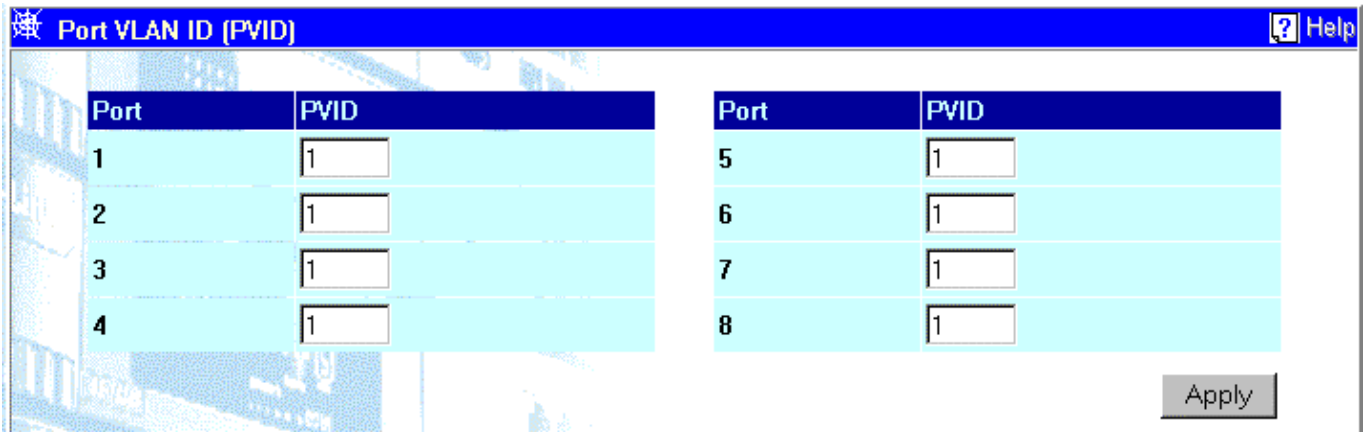


Figure 7-22. Port VLAN ID (PVID) screen

Description of item on the screen above:

- **PVID** – Shows the current PVID assignment for each port. The Switch's default is to assign all ports to the Default_VLAN with a VID of 1.

Port Ingress Filter

The following window allows you to configure a Port Ingress Filter on the Switch.

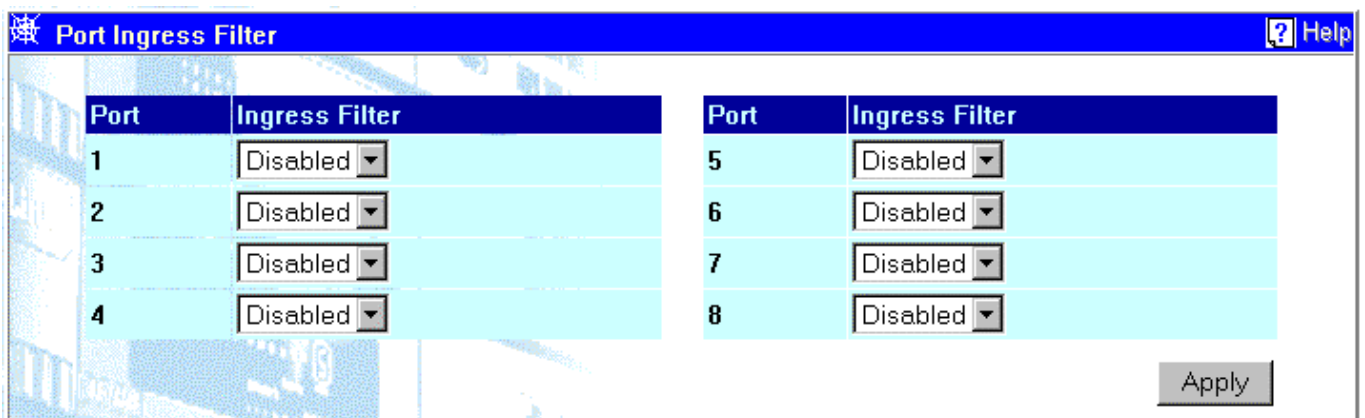


Figure 7-23. Port Ingress Filter screen

Items on the screen above include:

- **Port** – The number of the port for which ingress filtering is to be Enabled or Disabled.
- **Ingress Filter** – Specifies the port to check the VID of incoming packets against its VID or PVID. If the two are equal, the port will receive the packet. If the two are unequal, the port will drop the packet. This is used to limit traffic to a single VLAN.

Port GVRP Settings

The following read-only window is used to configure the Port Group VLAN Registration Protocol (GVRP) on the Switch.

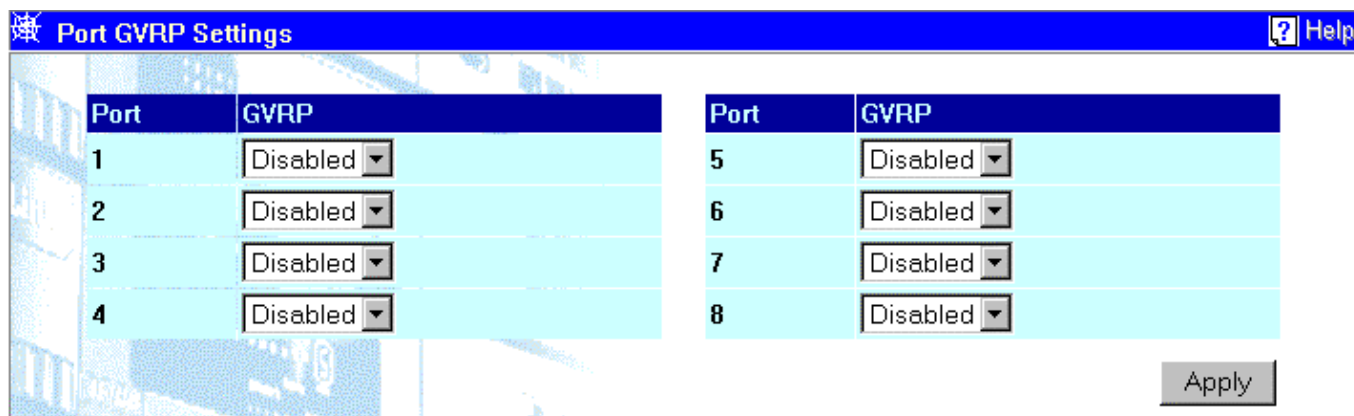


Figure 7-24. Port GVRP Settings screen

Items on the screen above include:

- **Port** – The number of the port for which GVRP is to be *Enabled* or *Disabled*.
- **GVRP** – For each corresponding port, GVRP can be *Enabled* or *Disabled*.

Port GMRP Settings

- The following read-only window is used to configure the Port Group Multicast Registration Protocol (GMRP) on the Switch. ***This function is not supported in the current version of the Switch software.***

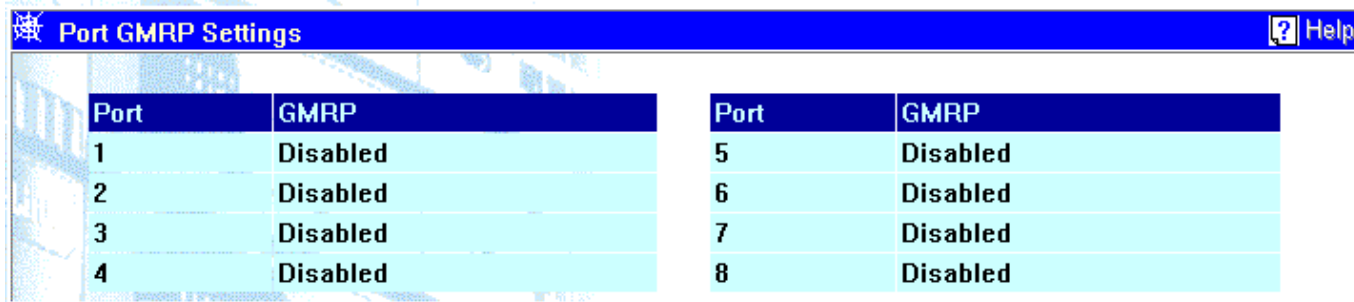


Figure 7-25. Port GMRP Settings screen

Items on the screen above include:

- **Port** – The number of the port for which GMRP is to be *Enabled* or *Disabled*.
- **GMRP** – For each corresponding port, GMRP can be *Enabled* or *Disabled*.

Multicasting

The following window enables you to set up Multicast forwarding on the Switch when you are in Layer 2 mode.

Setup IEEE802.1q Multicast Forwarding											
Add an Entry											
MAC Address	VID	PortMap								Apply	
		State	1	2	3	4	5	6	7		8
<input type="text"/>	<input type="text"/>	None	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="button" value="Apply"/>
		Egress	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
		Forbidden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Entries											
MAC Address	VID	PortMap								Remove	
		State	1	2	3	4	5	6	7		8

Figure 7-26. Setup IEEE 802.1Q Multicast Forwarding screen

Items on the screen above include:

- **MAC Address** – The MAC address of the static source of multicast packets.
- **VID** – The VLAN ID of the VLAN the above MAC address belongs to.
- **PortMap/State** – Allows the selection of ports that will be members of the static multicast group and ports that are either forbidden from joining dynamically, or that can join the multicast group dynamically, using GMRP. The options are: *None* – no restrictions on the port dynamically joining the multicast group, *Egress* – the port is a static member of the multicast group, and *Forbidden* – the port is restricted from joining the multicast group dynamically. For example, if *None* is chosen, then an end station attached to the port can join the multicast group using GMRP.

IGMP Snooping Settings

The following window enables you to set Internet Group Management Protocol (IGMP) snooping settings on the Switch when you are in Layer 2 mode.

IGMP Snooping Settings				
Switch IGMP Snooping	Disabled			
Querier State	Query Interval	Max Response	Robustness Variable	Apply
Non-Querier	125	10	2	<input type="button" value="Apply"/>
Age out = Robustness Variable * Query Interval + Max Response = 260				

Figure 7-27. IGMP Snooping Settings screen

Items on the screen above include:

- **Switch IGMP Snooping** – This enables or disables IGMP snooping on the Switch.
- **Querier State** – Select the version number of the IGMP to be used for the IP interface from the drop-down list.
- **Query Interval** – The time (in seconds) between the transmission of IGMP query packets.
- **Max Response** – The maximum number of respondents to an IGMP query. Range is between 1 and 25.
- **Robustness Variable** – This is a tuning variable to allow for sub-networks that are expected to lose a large number of packets. A value between 2 and 255 can be entered, with larger values being specified for sub-networks that are expected to lose larger numbers of packets.

Multicast Interface Configuration

The following window is used to configure a multicast interface (Layer 3 mode only).

Interface Name	IP Address	IGMP	Protocol	Apply
System	10.24.22.8	Disabled	INACT	Apply

Interface Name	IP Address	IGMP	Protocol
System	10.24.22.8	Disabled	INACT

Figure 7-28. Multicast Interface Configuration screen

Items on the screen above include:

- **Interface Name** – The name of the IP interface (previously defined) on the Switch for which a multicast interface is to be configured.
- **IP Address** – The IP address (sometimes referred to as a network address) that corresponds to the interface name above.
- **IGMP** – Allows IGMP to be *Enabled* or *Disabled* for the IP interface.
- **Protocol** – Allows the selection of the multicast routing protocol to be used with the above IP interface. The options are: *DVMRP* – Distance Vector Multicast Routing Protocol, *PIMDM* – Protocol Independent Multicasting Dense Mode, and *INACT* – the interface is inactive. For example, if *DVMRP* is chosen, then this routing protocol will be used to forward multicast packets for the above IP interface.

IGMP Interface Configuration

The following window is used to configure Internet Group Management Protocol (IGMP) on the Switch (Layer 3 mode only).

Interface Name	IP Address	Querier State	Query Interval	Max Resp	Robustness Var	Apply
System	10.24.22.8	V2-Querier	125	10	2	Apply

Interface Name	IP Address	Querier State	Query	Max Resp	Robustness Var
System	10.24.22.8	V2-Querier	125	10	2

Figure 7-29. IGMP Interface Configuration screen

Items on the screen above include:

- **Interface Name** – The name of the IP interface (previously defined) on the switch for which a multicast interface is to be configured.
- **IP Address** – The IP address corresponding to the IP interface name.
- **Querier State** – Select the version number of the IGMP to be used for the IP interface from the drop-down list.
- **Query Interval** – The time (in seconds) between the transmission of IGMP query packets.
- **Max Resp** – The maximum number of respondents to an IGMP query. Range is between 1 and 25.
- **Robustness Var** – The Robustness Variable is a numeric value between 1 and 255 defining the maximum time (in seconds) between the receipt of IGMP queries. If this timer expires without the receipt of another IGMP query, the Switch assumes the querier is no longer present.

DVMRP Interface Configuration

The following window is used for the configuration of DVMRP on the Switch (Layer 3 mode only).

Interface Name	IP Address	Probe Interval	Neighbor Time-Out Interval	Route Metric	Include Unknown Neighbor Report	State	Apply
System	10.24.22.8	10	35	1	Disabled	Disabled	Apply

Interface Name	IP Address	Probe Interval	Neighbor Time-Out Interval	Route Metric	Include Unknown Neighbor Report	State
System	10.24.22.8	10	35	1	Disabled	Disabled

Figure 7-30. DVMRP Interface Configuration screen

Items on the screen above include:

- **Interface Name** – The name of the IP interface (previously defined) on the Switch for which a multicast interface is to be configured.
- **IP Address** – The IP address (sometimes referred to as a network address) corresponding to the interface name above.
- **Probe Interval** – This field allows an entry between 0 and 65,535 seconds and defines the interval between 'probes'. The default is 10. DVMRP defines an extension to IGMP that allows routers to query other routers to determine if a multicast group is present on an given IP interface or not.
- **Neighbor Time-Out Interval** – This field allows an entry between 1 and 65,535 seconds and defines the time period for which DVMRP will hold Neighbor Router reports before issuing poison route messages. The default is 35 seconds.
- **Route Metric** – Allows the assignment of a DVMRP route cost to the above IP interface. A DVMRP route cost is a relative number that represents the real cost of using this route in the construction of a multicast delivery tree. It is similar to, but not defined as, the hop count in RIP. The default value is 1.
- **Include Unknown Neighbor Report** – Allows the Layer 3 switch to accept a DVMRP route report from a non-adjacent neighbor.
- **State** – Allows DVMRP to be *Disabled* or *Enabled* for the above IP interface. The default is *Disabled*.

PIM-DM Interface Configuration

The following window is used to configure a Protocol Independent Multicast - Dense Mode (PIMDM) interface on the Switch (Layer 3 mode only).

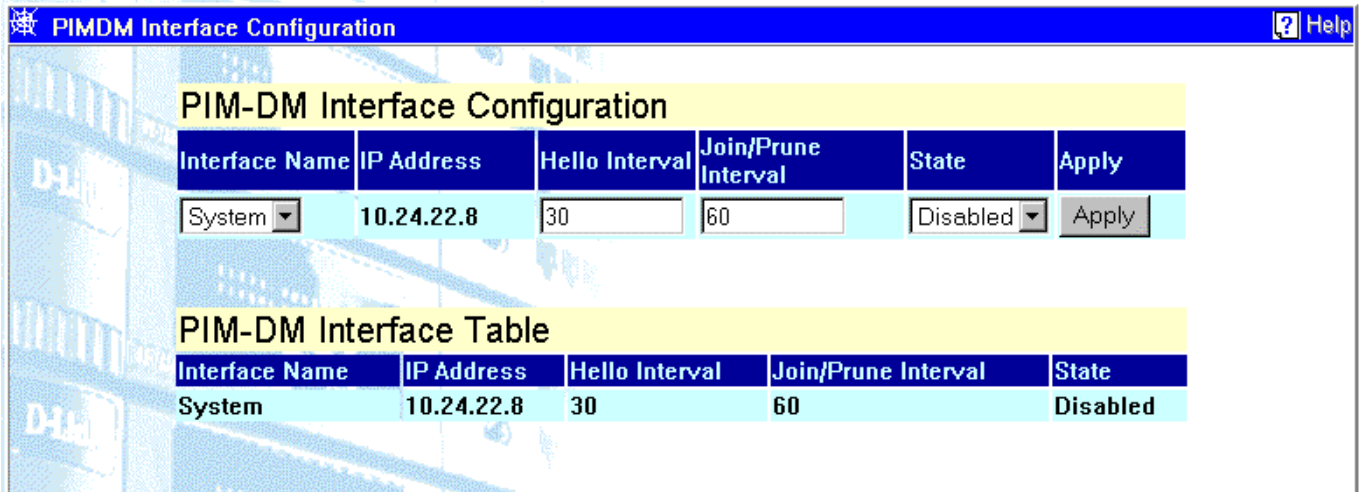


Figure 7-31. PIMDM Interface Configuration screen

Items on the screen above include:

- **Interface Name** – The name of the IP interface (previously defined) on the switch for which a multicast interface is to be configured.
- **IP Address** – The IP address (sometimes referred to as a network address) corresponding to the interface name above.
- **Hello Interval** – This field allows an entry of between 1 and 18,724 seconds and determines the interval between sending Hello packets to other routers on the network. The Hello messages are used by the router to determine if it is the root router on the delivery tree or not. If the router does not receive a Hello message within the Hello Interval, it will begin transmitting Hello messages to advertise its availability to become the root router. The default is 30 seconds.
- **Join/Prune Interval** – This field allows an entry of between 1 and 18,724 seconds and determines the interval between transmitting (flooding to all interfaces) multicast messages to downstream routers, and automatically 'pruning' a branch from the multicast delivery tree. This interval also determines the time interval the router uses to automatically remove prune information from a branch of a multicast delivery tree and begin to flood multicast messages to all branches of that delivery tree. These two actions are equivalent. The default is 60 seconds.
- **State** – Allows PIMDM to be *Disabled* or *Enabled* for the above IP interface. The default is *Disabled*.

Setup Static Router Port

The following window allows you to set up a static router port on the Switch.

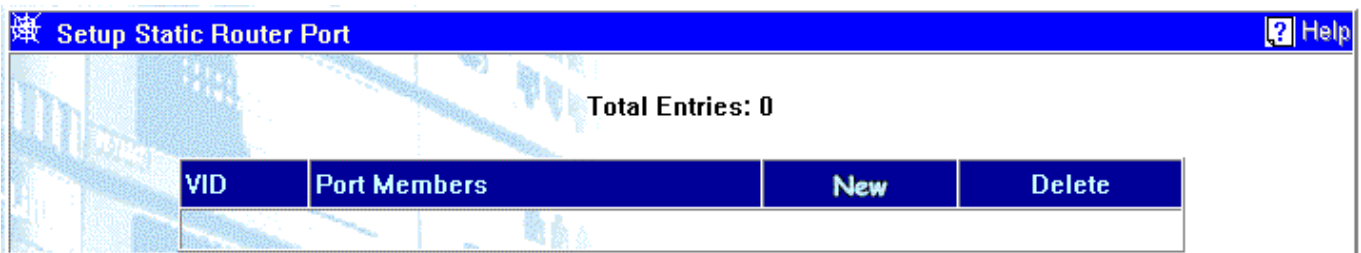


Figure 7-32. Setup Static Router Port screen

Items on the screen above include:

- **VID** – The VLAN ID of the VLAN the static router port resides on.
- **Port Members** – The ports that are set up as static router ports.
- **New** – A link to the **Static Router Port Settings – Add** window.
- **Delete** – Click on the icon to delete the entry from the static router port table.

Add a Static Router Port

The following figure and table describe how to add a static router port on the Switch. Click on the Exit icon to return to the **Static Router Port Settings** window.

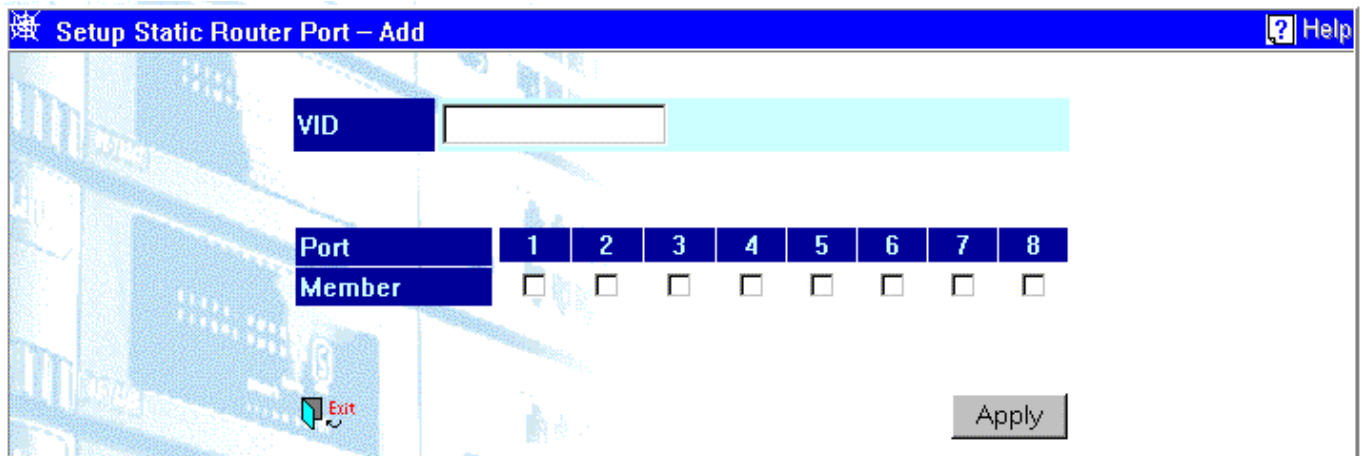


Figure 7-33. Setup Static Router Port – Add screen

Items on the screen above include:

- **VID** – The VLAN ID of the VLAN on which the static router port resides.
- **Port Member** – Click the box corresponding to the port that will be a static router port.

Priority

The following window allows you to set up an entry in the Switch's priority table.

MAC Address Priority

Setup MAC Address Priority Help

Add an Entry

VID	MAC Address	Priority Level	Src/Dst	Apply
<input type="text"/>	<input type="text"/>	Low	Src.	Apply

Total Entries: 0

Entries

VID	MAC Address	Priority Level	Src/Dst	Delete
-----	-------------	----------------	---------	--------

Figure 7-34. Setup MAC Address Priority screen

Items on the screen above include:

Add an Entry

- **VID** – The VLAN ID of the VLAN on which the MAC address above resides.
- **MAC Address** – The MAC address for which priority on the Switch is to be established.
- **Priority Level** – The priority of the above MAC address. The options are; *Low*, *Med-L* – medium low, *Med-H* – medium high, and *High*.
- **Src/Dst** – The state under which the above priority will be active. The options are; *Dst.* – destination, *Src.* – source, and *Either*. When *Dst.* is chosen, packets with the above MAC address as their destination will be given the selected priority. When *Src.* is chosen, packets with the above MAC address as their source will be given the selected priority. When *Either* is chosen, all packets with the above MAC address will be given the selected priority.

Entries

- **VID** – Displays the VLAN ID of the VLAN on which the MAC address above resides.
- **MAC Address** – Displays the MAC address for which priority on the Switch is to be established.
- **Priority Level** – Displays the priority of the above MAC address. The options are: *Low*, *Med-L* – medium low, *Med-H* – medium high, and *High*.
- **Src/Dst** – Displays the state under which the above priority will be active. The options are; *Dst.* – destination, *Src.* – source, and *Either*.

Mirroring

Traffic from any source port to a target port can be mirrored for real-time analysis. A logic analyzer or an RMON probe can then be attached to study the traffic crossing the source port in a completely unobtrusive manner. When mirroring port traffic, note that the target port must be configured in the same VLAN and be operating at the same speed as the source port. If the target port is operating at a lower speed, the source port will be forced to drop its operating speed to match that of the target port.

The **Target Port Selection** window can be used to designate a single RJ-45 port pair for mirroring as shown below:

Target Port Selection

The following window is used to select a target port. A target port in a port mirroring pair is the port that will receive packets that are duplicated at the mirror port.

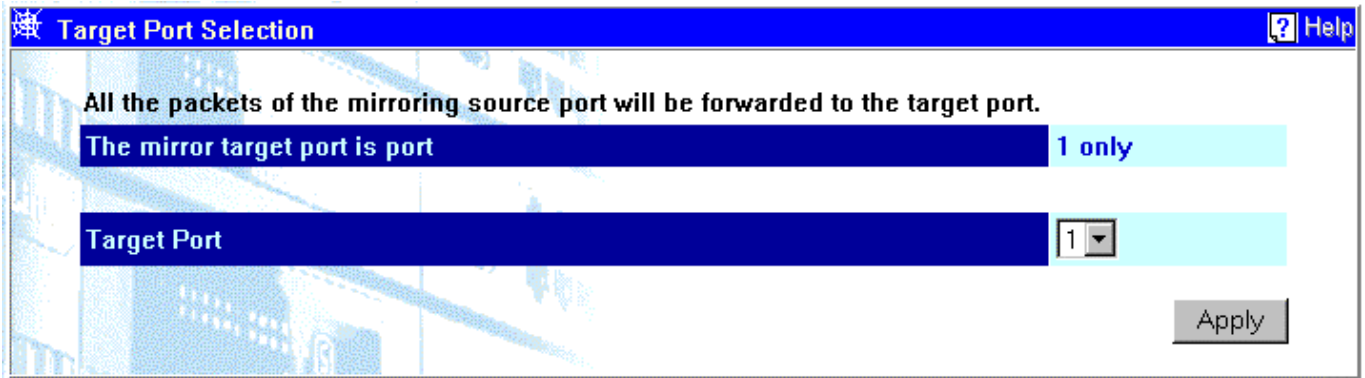


Figure 7-35. Target Port Selection screen

The item on the screen above includes:

- **Target Port** – The port that will receive the packets duplicated at the mirror port.

Port Mirroring Settings

The following window is used in setting up a mirror port for port mirroring. A mirror port is the port (of a target – mirror pair) that will have its traffic duplicated and forwarded to the target port.

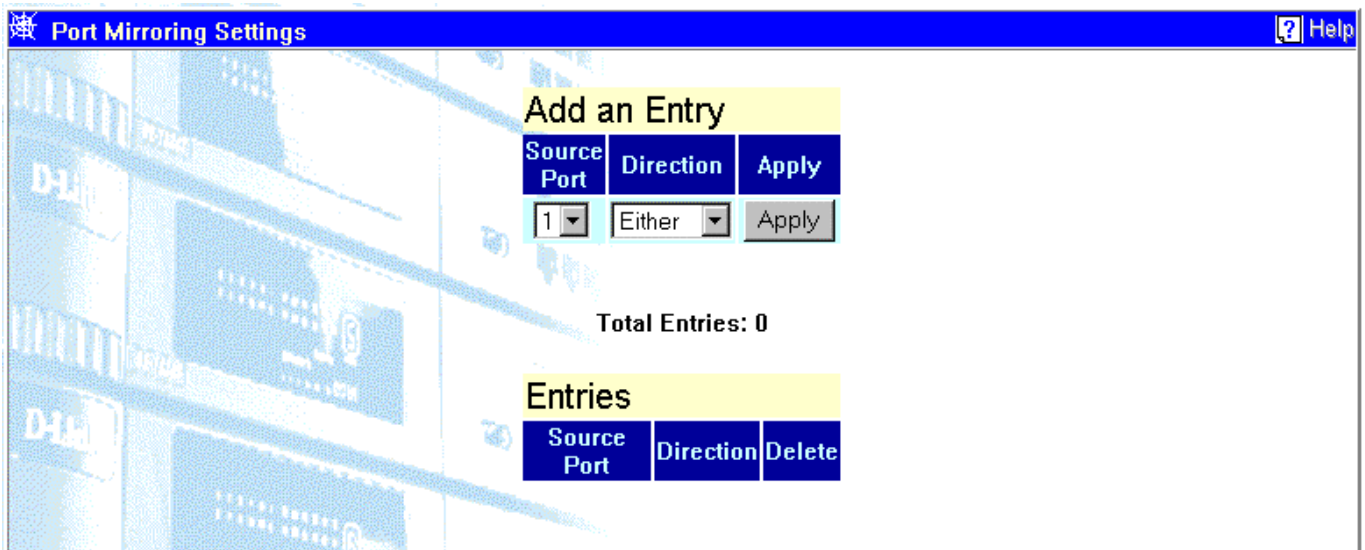


Figure 7-36. Port Mirroring Settings screen

Items on the screen above include:

Add an Entry

- **Source Port** – The port that will be mirrored. All packets entering and leaving the source port can be duplicated in the mirror port.

- **Direction** – Allows the specification of which packets will be mirrored based upon whether the packets are flowing into or out of a port, or all packets (both directions). The options are: *Ingress* – packets flowing into the mirror port, *Egress* – packets flowing out of the mirror port, and *Either* – both in to and out of the mirror port. For example, if *Ingress* is chosen, all packets flowing into the mirror port will be duplicated and forwarded to the target port.

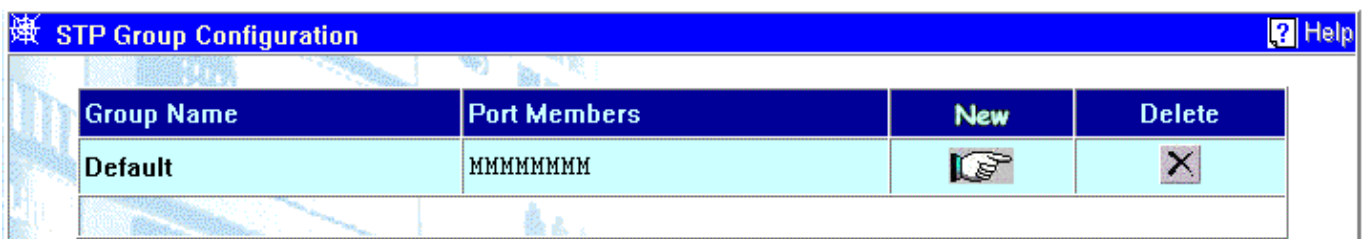
Entries

- **Source Port** – Displays the port that will be mirrored.
- **Direction** – Allows the specification of which packets will be mirrored based upon whether the packets are flowing into or out of a port, or all packets (both directions). The options are: *Ingress* – packets flowing into the mirror port, *Egress* – packets flowing out of the mirror port, and *Either* – both in to and out of the mirror port.

Spanning Tree Protocol

The Spanning Tree Protocol can be used to detect and disable network loops, and to provide backup links between switches, bridges, or routers. This allows the Switch to interact with other bridging devices (that is, STP compliant switches, bridges, or routers) in your network to ensure that only one route exists between any two stations on the network. For a more detailed description of how to use this protocol, refer to “*Spanning Tree Concepts*”, in Chapter Five.

STP Group Configuration





Group Name	Port Members	New	Delete
Default	MMMMMMMM		

Figure 7-37. STP Group Configuration screen

The DGS-3308 allows you to configure Spanning Tree Groups that consist of a group of ports that will be handled as though they were a single spanning tree device.

Note: This function is available only when the Switch is in IP Routing mode.

Items on the screen above include:

- **Group Name** – A name given to identify a given STP group.
- **Port Members** – A list of the ports that belong to a given group.
- **New** – A link to the **STP Group Configuration - Add** window.
- **Pointer Icon** – A link to the **STP Group Configuration - Edit** window.
- **Delete** – Click this icon to remove an entry from this table.

STP Group Configuration - Add

The following window allows you to add an STP Group. Click on the Exit icon to return to the **STP Group Configuration** menu.

Group Name	<input type="text"/>
Status	Enabled <input type="button" value="v"/>
Max Age: [6 .. 40 sec]	<input type="text" value="20"/>
Hello Time: [1 .. 10 sec]	<input type="text" value="2"/>
Forward Delay: [4 .. 30 sec]	<input type="text" value="15"/>
Priority: [0 .. 65535]	<input type="text" value="32768"/>

The above values must conform to:
 $2 * (\text{Hello Time} + 1) \leq \text{Max Age} \leq 2 * (\text{Forward Delay} - 1)$

Port	1	2	3	4	5	6	7	8
Member	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Exit

Figure 7-38. STP Group Configuration – Add screen

Items on the screen above include:

- **Group Name** – The group name of the Spanning Tree group to be added.
- **Status** – Allows STP to be *Enabled* or *Disabled*.
- **Max Age: [6..40 sec]** – The maximum time (in seconds) a device can wait without receiving a configuration message before attempting to reconfigure. All device ports (except for designated ports) should receive configuration messages at regular intervals. Any port that ages out STP information (provided in the last configuration message) becomes the designated port for the attached LAN. If it is a root port, a new root port is selected from among the device ports attached to the network.

The minimum value is the higher of 6 or $[2 \times (\text{Hello Time} + 1)]$.

The maximum value is the lower of 40 or $[2 \times (\text{Forward Delay} - 1)]$.

- **Hello Time: [1..10 sec]** – The time interval (in seconds) at which the root device transmits a configuration message.
- **Forward Delay:[4..30 sec]** – The maximum time (in seconds) the root device will wait before changing states (i.e., from the listening to learning to forwarding). This delay is required because every device must receive information about topology changes before it starts to forward packets. In addition, each port needs time to listen for conflicting information that would make it return to a blocking state; otherwise, temporary data loops might result.

Maximum value is 30

Minimum value is $4 [(\text{Max. Age} / 2) + 1]$

- **Priority:[0..65535]** – Device priority used in selecting the root device, root port, and designated port. The device with the highest priority becomes the STP root device. The lower the numeric value, the higher the priority. If all devices have the same priority, the device with the lowest MAC address will become the root device.
- **Port Member** – Check the ports you want to be member of the STP group.

STP Group Configuration - Edit

The following window is used to configure Spanning Tree Protocol (STP) for a group on the Switch.

The screenshot shows a window titled "STP Group Configuration - Edit" with a "Help" button. The window contains two tables of configuration parameters. The first table has a light blue background and the second has a light green background. A red warning message is displayed between the two tables.

Group Name	Default
Status	Enabled <input type="button" value="v"/>
Max Age: (6 .. 40 sec)	<input type="text" value="20"/>
Hello Time: (1 .. 10 sec)	<input type="text" value="2"/>
Forward Delay: (4 .. 30 sec)	<input type="text" value="15"/>
Priority: (0 .. 65535)	<input type="text" value="32768"/>

**The above values must conform to:
 $2 * (\text{Hello Time} + 1) \leq \text{Max Age} \leq 2 * (\text{Forward Delay} - 1)$**

Designated Root Bridge	00-80-c2-66-66-66
Root Priority	1
Cost to Root	29
Root Port	1
Last Topology Change	5214 seconds
Topology Change Count	6

Designated Root Bridge	00-80-c2-66-66-66							
Root Priority	1							
Cost to Root	29							
Root Port	1							
Last Topology Change	5214 seconds							
Topology Change Count	6							

Port	1	2	3	4	5	6	7	8
Member	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Exit Apply

Figure 7-39. STP Group Configuration - Edit screen

Items on the screen above include:

- **Group Name** – The group name of the Spanning Tree group being edited.
- **Status** – Allows STP to be *Enabled* or *Disabled*.
- **Max Age: [6..40 sec]** – The maximum time (in seconds) a device can wait without receiving a configuration message before attempting to reconfigure. All device ports (except for designated ports) should receive configuration messages at regular intervals. Any port that ages out STP information (provided in the last configuration message) becomes the designated port for the attached LAN. If it is a root port, a new root port is selected from among the device ports attached to the network.

The minimum value is the higher of 6 or $[2 \times (\text{Hello Time} + 1)]$.

The maximum value is the lower of 40 or $[2 \times (\text{Forward Delay} - 1)]$.

- **Hello Time: [1..10 sec]** – The time interval (in seconds) at which the root device transmits a configuration message.
- **Forward Delay:[4..30 sec]** – The maximum time (in seconds) the root device will wait before changing states (i.e., from the listening to learning to forwarding). This delay is required because every device must receive information about topology changes before it starts to forward packets. In addition, each port needs time to listen for conflicting information that would make it return to a blocking state; otherwise, temporary data loops might result.

Maximum value is 30

Minimum value is $4 [(\text{Max. Age} / 2) + 1]$

- **Priority:[0..65535]** – Device priority used in selecting the root device, root port, and designated port. The device with the highest priority becomes the STP root device. The lower the numeric value, the higher the priority. If all devices have the same priority, the device with the lowest MAC address will become the root device.
- **Port Member** – Check the ports you want to be member of the STP group.

STP Port Settings

The following window is used to configure the current STP port settings on the Switch.

Port	Cost	Priority	Status	Group Name	Fast STP
1	10	128	Forwarding	Default	Disabled
2	10	128	Disabled	Default	Disabled
3	10	128	Disabled	Default	Disabled
4	10	128	Disabled	Default	Disabled
5	10	128	Disabled	Default	Disabled
6	10	128	Disabled	Default	Disabled
7	10	128	Disabled	Default	Disabled
8	10	128	Disabled	Default	Disabled

Apply

Figure 7-40. STP Port Settings screen

Items on the screen above include:

- **Cost** – A port cost can be set between 1 and 65535. The lower the cost, the greater the probability the port will be chosen as the designated port (chosen to forward packets).
- **Priority** – A port priority can be set between 0 to 255. The lower the priority, the greater the probability the port will be chosen as the root port.
- **Status** – Displays the status for the corresponding port.
- **Group Name** – Displays the previously assigned name for the STP group the corresponding port belongs to.
- **Fast STP** – Allows you to set the delay to *Enabled* or *Disabled*.

Port Trunking

Port trunks can be used to increase the bandwidth of a network connection or to ensure fault recovery. You can configure up to 4 trunk connections (combining 2 to 8 ports into a fat pipe) between any two DGS-3308 or other Layer 2 switches. However, before making any physical connections between devices, use the Trunk Configuration menu to specify the trunk on the devices at both ends. When using a port trunk, note that:

- The ports used in a trunk must all be of the same media type (RJ-45, 100 Mbps fiber, or 1000 Mbps fiber). The ports that can be assigned to the same trunk have certain other restrictions (see below).
- Ports can only be assigned to one trunk.
- The ports at both ends of a connection must be configured as trunk ports.
- None of the ports in a trunk can be configured as a mirror source port or a mirror target port.
- All of the ports in a trunk have to be treated as a whole when moved from/to, added or deleted from a VLAN.
- The Spanning Tree Protocol will treat all the ports in a trunk as a whole.

- Enable the trunk prior to connecting any cable between the switches to avoid creating a data loop.
- Disconnect all trunk port cables or disable the trunk ports before removing a port trunk to avoid creating a data loop.

Use the **Port Trunking Configuration** screen to set up port trunks as shown below.

Group ID	Master Port	Group Width	Method	Anchor
1	1	2	Disabled	-
2	1	2	Disabled	-
3	1	2	Disabled	-
4	1	2	Disabled	-

Apply

Figure 7-41. Port Trunking screen

Items on the screen above include:

- **Group ID** – The Switch allows up to 4 port trunks groups to be configured. The group number identifies each of these groups.
- **Master Port** – The port of the trunk group whose configuration (speed, full- or half-duplex, etc.) will be used by all of the ports in the trunk group.
- **Group Width** – The number of contiguous ports in the selected trunk group.
- **Method** – Allows the trunk group to be *Enabled* or *Disabled*.
- **Anchor** – This port displays what port is receiving BPDUs, SNMP packets, etc. This is usually the same as the Master Port. However, if the link is down for the Master Port, the closest port with a valid link will become the new anchor port.

Forwarding

The following figures and tables describe how to setup static packet forwarding on the Switch.

MAC Forwarding

The screenshot shows the 'MAC Address Forwarding' configuration window. At the top, there is a blue header bar with the title and a help icon. Below the header, there is a yellow bar labeled 'Add an Entry'. Underneath, there are two input fields: 'MAC Address' and 'VID'. To the right of these fields is a 'PortMap' section consisting of eight radio buttons labeled 1 through 8. An 'Apply' button is located to the right of the PortMap section. Below the 'Add an Entry' section, it says 'Total Entries: 0'. At the bottom, there is another yellow bar labeled 'Entries'. Below this, there is a table with columns: 'MAC Address', 'VID', 'PortMap' (with sub-columns for ports 1-8), and 'Delete'.

Figure 7-42. MAC Address Forwarding screen

Items on the screen above include:

Add an Entry

- **MAC Address** – The MAC address to which packets will be statically forwarded.
- **VID** – The VLAN ID number of the VLAN to which the above MAC address belongs.
- **PortMap** – Allows the designation of the port on which the above MAC address resides.

Entries

- **MAC Address** – Displays the MAC address corresponding to the static forwarding table entry.
- **VID** – Displays the VLAN ID number of the VLAN to which the above MAC address belongs.
- **PortMap** – Displays the port on which the above MAC address resides.

IP Forwarding

The following window is used for the entry of a Static/Default Routes into the IP routing table.

Static/Default Routes

The screenshot shows the 'Static / Default Routes' configuration window. It has a blue header bar with the title and a help icon. Below the header, there is a table with the following columns: 'IP Address', 'Subnet Mask', 'Gateway IP', 'Metric', 'New', and 'Delete'. The table contains one row of data: IP Address: 0.0.0.0, Subnet Mask: 0.0.0.0, Gateway IP: 10.254.254.251, Metric: 1, New: -, and Delete: X.

Figure 7-43. Static/Default Routes screen

Items on the screen above include:

- **IP Address** – Displays the IP addresses statically entered into the IP forwarding table.
- **Subnet Mask** – Displays the corresponding subnet mask for the IP address above.
- **Gateway IP** – Displays the corresponding IP address of the next hop gateway for the IP address above.
- **Metric** – Displays the Routing Information Protocol (RIP) metric. This is the number of hops between the IP address and the Gateway. This is a number between 1 and 15.
- **New** – A link to **Static/Default Routes – Add** window.
- **Delete** – Click on this icon to delete the entry.

Static/Default Routes – Add

The following figure and table describe the entry of a Static/Default Route into the Switch's IP routing table. Click on the Exit icon to return to the **Static/Default Routes** window.

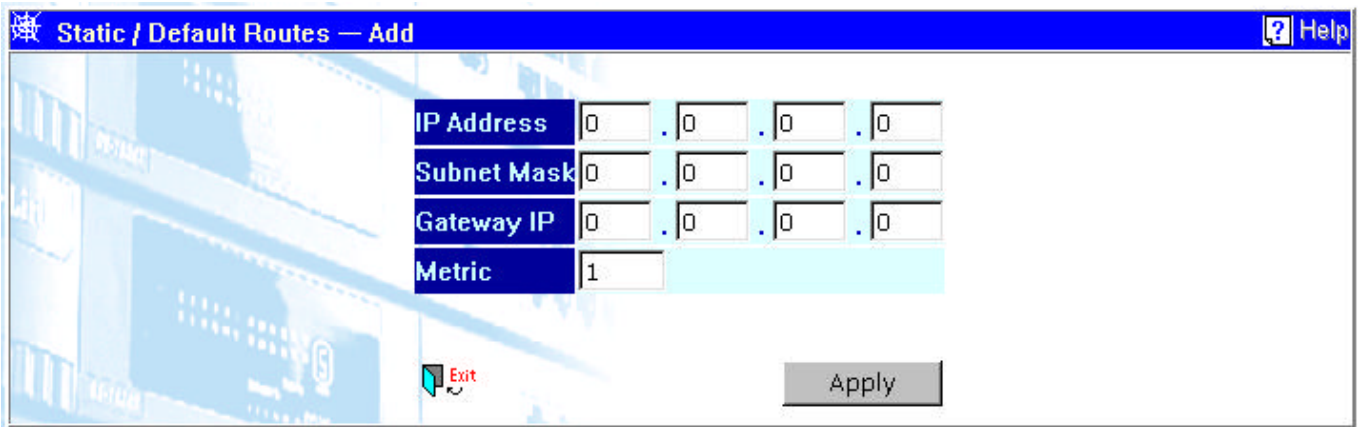


Figure 7-44. Static/Default Routes – Add screen

Items on the screen above include:

- **IP Address** – The IP address to be statically entered into the IP forwarding table.
- **Subnet Mask** – The corresponding subnet mask for the IP address above.
- **Gateway IP** – The corresponding IP address of the next hop gateway for the IP address above.
- **Metric** – The Routing Information Protocol (RIP) metric. This is the number of hops between the IP address and the Gateway. This is a number between 1 and 15.

Static ARP

The following window is used for the entry of a static Address Resolution Protocol (ARP) into the Switch's static ARP table.



Figure 7-45. Static ARP screen

Items on the screen above include:

- **Interface Name** – Displays the IP interface on which the IP address previously entered into the static ARP table resides.
- **Interface IP** – Displays the corresponding network address or IP address of the IP interface name above.
- **IP Address** – Displays the IP address of the end node or station.
- **MAC Address** – Displays the MAC address corresponding to the IP address above.
- **New** – A link to the **Static ARP – Add** window.
- **Delete** – Click on the icon to delete the static ARP entry.

Static ARP – Add

The following figure and table describe adding an entry to the Switch's static ARP table. Click on the Exit icon to return to the **Static ARP** menu.

Interface Name	
IP Address	0 . 0 . 0 . 0
MAC Address	00-00-00-00-00-00

Figure 7-46. Static ARP – Add screen

Items on the screen above include:

- **Interface Name** – The IP interface on which the IP address to be added to the static ARP table resides.
- **IP Address** – The IP address of the end node or station.
- **MAC Address** – The MAC address corresponding to the IP address above.

Filtering

The following figures and tables describe how to add a MAC or IP address to the MAC or IP filtering tables on the Switch.

MAC Filtering

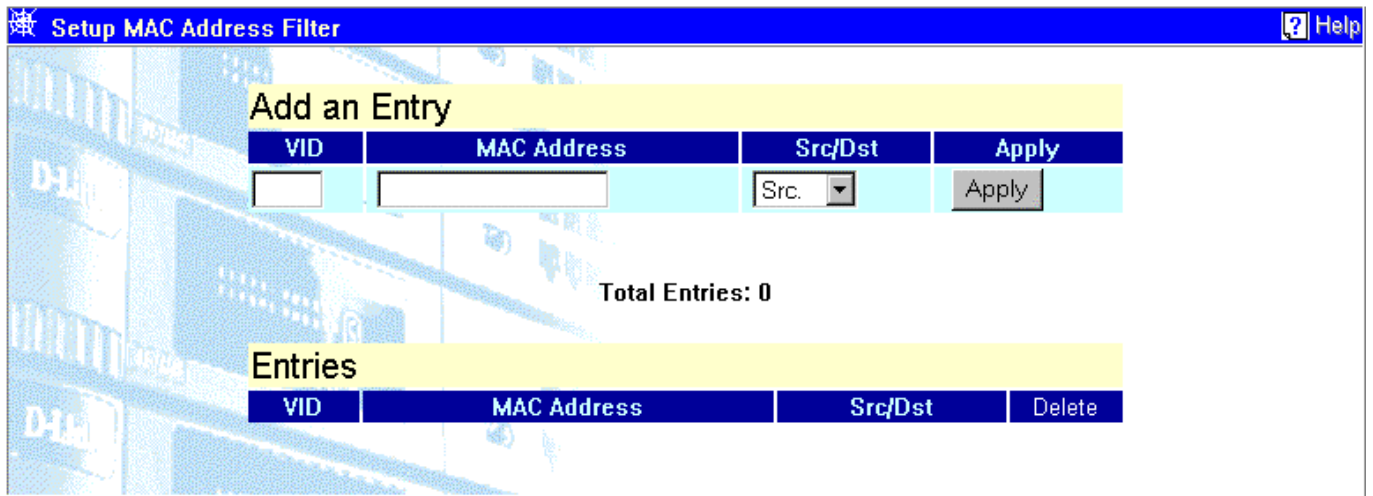


Figure 7-47. Setup MAC Address Filter screen

Items on the screen above include:

Add an Entry

- **VID** – The VLAN ID number of the VLAN on which the MAC address above resides.
- **MAC Address** – The MAC address that is to be filtered on the Switch.
- **Src/Dst** – Allows the selection of the state of the MAC address under which packets will be dropped by the Switch. The options are; *Dst* – destination, *Src* – source, and *Either*. When *Dst* is chosen, packets with the above MAC address as their destination will be dropped. When *Src* is chosen, packets which the above MAC address as their source will be dropped. When *Either* is chosen, all packets to or from the above MAC address will be dropped by the Switch.

Entries

- **VID** – Displays the VLAN ID number of the VLAN on which the MAC address resides.
- **MAC Address** – Displays the MAC address that is to be filtered on the Switch.
- **Src/Dst** – Displays the state of the MAC address under which packets will be dropped by the Switch. The options are; *Dst* – destination, *Src* – source, and *Either*.
- **Delete** – Click the icon to remove the entry from the filtering table.

IP Filtering

The following window is used to enter an IP address into the Switch's filtering table.

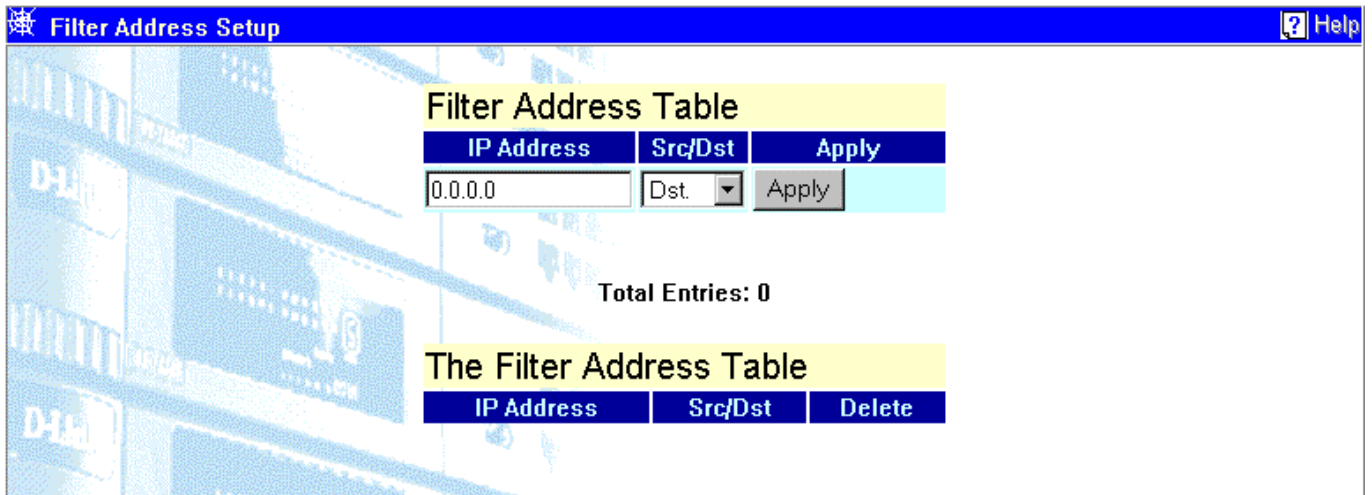


Figure 7-48. Filter Address Setup screen

Filter Address Table

Items on the screen above include:

- **IP Address** – The IP address that is to be filtered on the Switch.
- **Src/Dst** – Select how you want packets to be dropped by the Switch. The options are: *Dst* – destination address, *Scr* – source address, and *Either* – either a destination or a source address. When *Dst* is chosen, packets with the above IP address as their destination will be dropped, When *Scr* is chosen, packets with the above IP address as their source will be dropped. When *Either* is chosen, all packets with the above IP address will be dropped by the Switch.

The Filter Address Table

- **IP Address** – Displays the IP address that is to be filtered on the Switch.
- **Src/Dst** – Displays the state of the above IP address under which packets will be dropped by the Switch. The options are; *Dst* – destination address, *Scr* – source address, and *Either* – either a destination or a source address.
- **Delete** – Click the icon to remove the entry from the filtering table.

BOOTP/DHCP Relay

BOOTP/DHCP relay enables end stations to use a BOOTP or DHCP server to obtain TCP/IP configuration information or boot files to be loaded into memory, even if the servers are not on the local IP interface.

If the BOOTP or DHCP server and end station are on the same IP interface, no relay is necessary. If the servers and the end stations are on different IP interfaces, a relay agent is necessary for the switch to forward the messages.

The relay agent forwards these packets between IP interfaces, and therefore must know the IP addresses of the BOOTP and DHCP servers and their respective subnet names (or IP interface names).

When the Switch receives packets destined for a BOOTP or DHCP server, it forwards them to specific servers as defined in the following configuration. The Switch also forwards packets from the BOOTP or DHCP servers to the appropriate subnets.

The first task is to set some parameters for the relay agent to decide whether or not to forward a given BOOTP/DHCP packet.

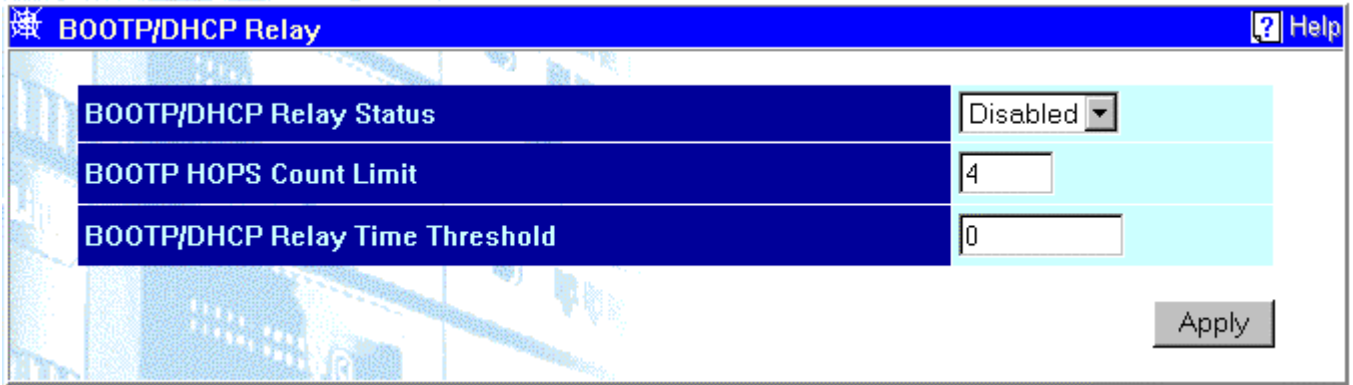


Figure 7-49. BOOTP/DHCP Relay screen

Items on the screen above include:

- **BOOTP/DHCP Relay Status** – Allows the BootP/DHCP relay function to be *Enabled* or *Disabled*.
- **BOOTP HOPS Count Limit** – Allows the maximum number of hops (routers) that the BootP messages can be relayed through to be set. If a packet's hop count is more than the hop count limit, the packet is dropped. The range is between 1 and 16 hops. The default value is 4.
- **BOOTP/DHCP Relay Time Threshold** – Sets the minimum time (in seconds) that the switch will wait before forwarding a BOOTREQUEST packet. If the value in the seconds field of the packet is less than the relay time threshold, the packet will be dropped. The range is between 0 and 9999 seconds. The default value is 0 seconds.

BOOTP/DHCP Relay Interface Setup

The second task is to tell the BOOTP/DHCP relay agent where the servers are located in terms of IP addresses and subnet names (IP interface names).

The following figure and table describe how to set up the static Bootp Relay function on the Switch.

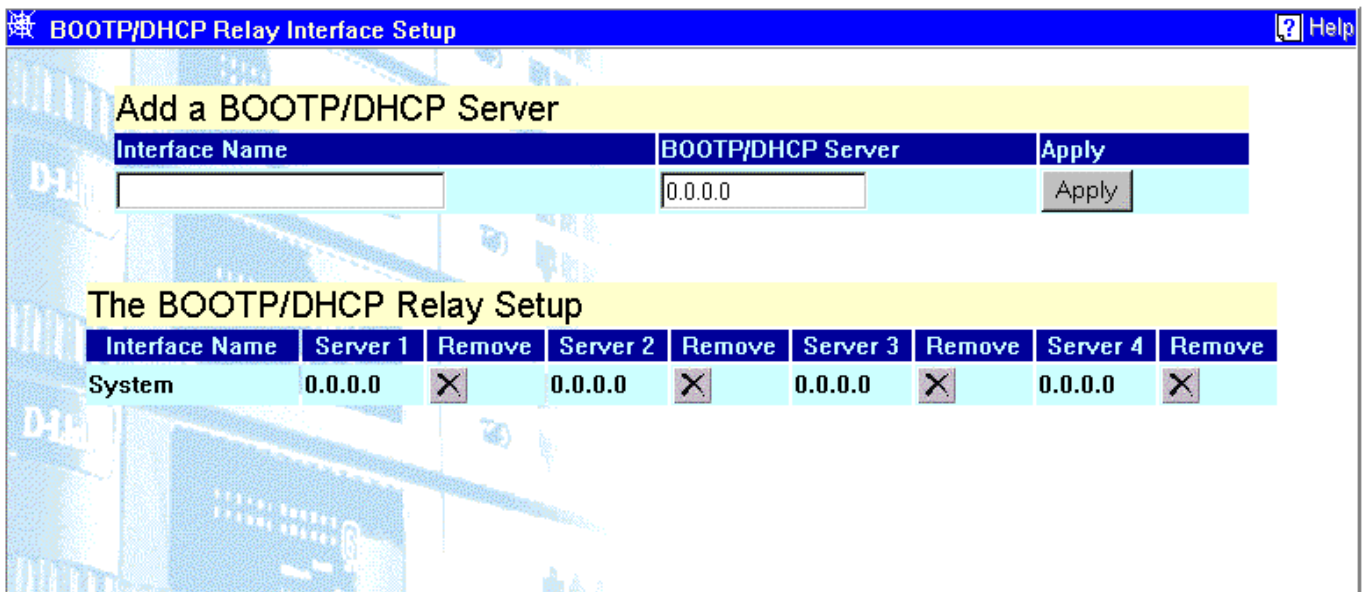


Figure 7-50. BOOTP/DHCP Relay Interface Setup screen

Items on the screen above include:

- **Interface Name** – The subnet name, or IP interface name, of the network that the BOOTP server is located on.
- **BOOTP/DHCP Server** – The IP address of the BOOTP/DHCP relay server. Multiple servers may be entered for a given subnet name (IP interface name).
- **Remove** – Click on the icon to remove the entry from the table.

DNS Relay

DNS relay enables end stations to use a DNS server to resolve domain names into IP addresses, even if the server and the end station are not on the local IP interface.

If the DNS server and end station are on the same IP interface, no relay is necessary. If the servers and the end stations are on different IP interfaces, a relay agent is necessary for the switch to forward the messages.

The relay agent forwards these packets between IP interfaces, and therefore must know the IP addresses of the DNS servers and their respective subnet names (or IP interface names).

When the switch receives packets destined for a DNS server, it forwards them to specific servers as defined in the following configuration. The Switch also forwards packets from the DNS servers to the appropriate subnets.

The first task is to set some parameters for the relay agent to decide whether or not to forward a given DNS packet.

DNS Relay State	Disabled
Primary Name Server	0.0.0.0
Secondary Name Server	0.0.0.0
DNS Relay Cache Server Status	Disabled
DNS Relay Static Table Lookup Status	Disabled

Apply

Figure 7-51. DNS Relay Setup screen

Items on the screen above include:

- **DNS Relay State** – Allows the DNS relay function to be *Enabled* or *Disabled* on the Switch.
- **Primary Name Server** – The IP address of the primary DNS server.
- **Secondary Name Server** – The IP address of a secondary DNS server.
- **DNS Relay Cache Server Status** – Allows the DNS cache on the Switch to be *Enabled* or *Disabled*.
- **DNS Relay Static Table Lookup Status** – Allows the DNS Static Table Lookup function on the Switch to be *Enabled* or *Disabled*.

Static Setup

The second task is to tell the DNS relay agent where the servers are located in terms of IP addresses and subnet names (IP interface names).

The following window is used to set up the static DNS Relay function on the Switch.

Domain Name	IP Address	State	Apply
<input type="text"/>	0.0.0.0	Enabled	Apply

Total Entries: 0

Domain Name	IP Address	State	Delete
-------------	------------	-------	--------

Figure 7-52. Static DNS Relay Setup screen

Items on the screen above include:

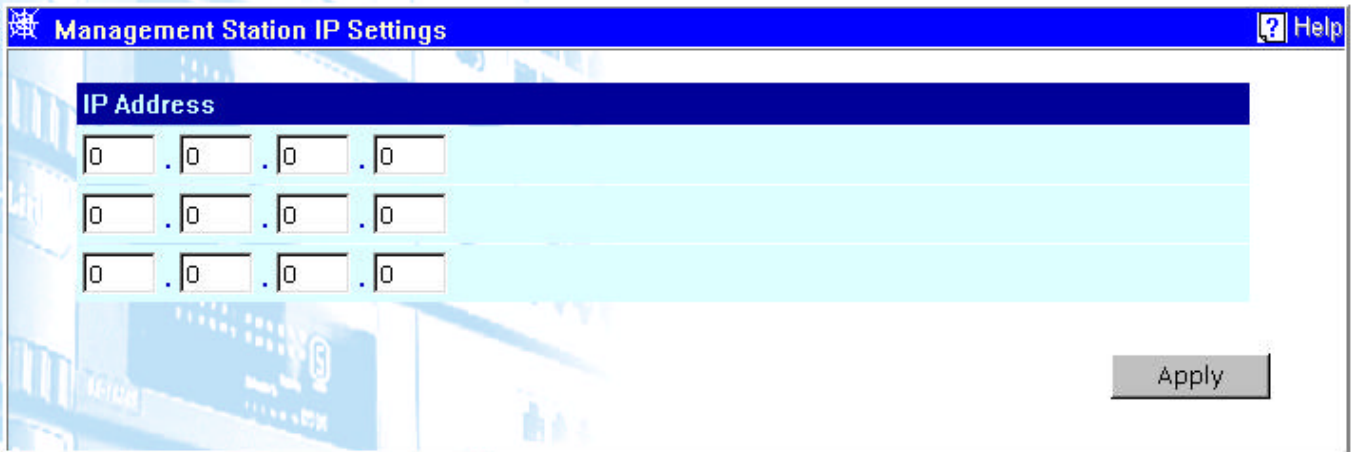
- **Domain Name** – The host name of the IP address, for example, “accounting.”
- **IP Address** – The IP address of the domain name.
- **State** – Toggle to enable or disable this DNS Static Table entry.

Remote Management Setup

Use the five Remote Management Setup windows—which are the same whether the Switch is in Layer 2 mode or Layer 3 mode—to configure the IP addresses of up to 3 Management stations, to configure SNMP Community strings, to enter the IP addresses of Trap receivers, to create and manage user accounts, and to configure the Serial Port settings.

Management Station IP Settings

You can specify the IP addresses of up to 3 management stations that will be allowed to access the management agent of the Switch. If you enter IP addresses in this menu, then only management stations with those IP addresses will be allowed to access the management agent of the switch. All other IP addresses will be blocked.



The screenshot shows a web interface titled "Management Station IP Settings". At the top right is a "Help" button. Below the title bar is a section labeled "IP Address" with a dark blue header. Underneath, there are three rows of IP address input fields, each consisting of four boxes separated by dots (e.g., 0.0.0.0). At the bottom right of the form is an "Apply" button.

Figure 7-53. Management Station IP Settings screen

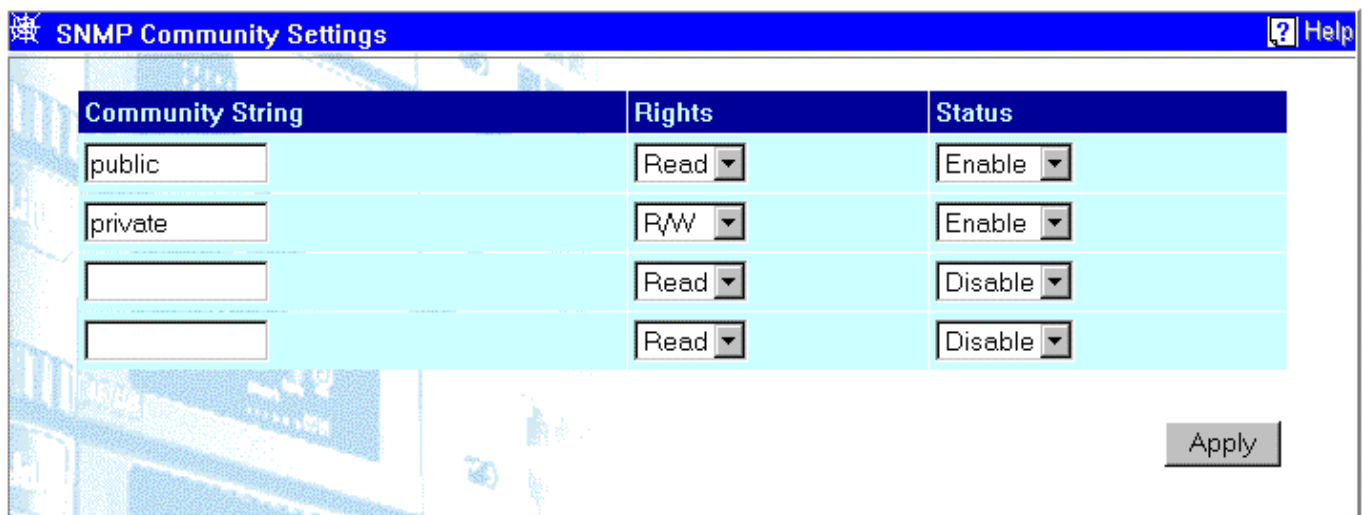
The item on the screen above is:

- **IP Address** – The IP address of the management station that you want to give access to the switch's management agent. Entering an IP address in this menu will block access by an IP address not listed in this table.

SNMP Community Settings

Use the **Community Strings** screen to display and modify parameters for the Simple Network Management Protocol (SNMP). The Switch includes an on-board SNMP agent that monitors the status of its hardware, as well as the traffic passing through its ports. A computer attached to the network, called a Network Management Station (NMS), can be used to access this information. Access rights to the on-board agent are controlled by community strings. To communicate with the switch, the NMS must first submit a valid community string for authentication.

The following window is used to configure the community strings authorized for management access. Up to 4 community names may be entered.



The screenshot shows a web interface titled "SNMP Community Settings". At the top right is a "Help" button. Below the title bar is a table with three columns: "Community String", "Rights", and "Status". There are four rows in the table. The first row has "public" in the first column, "Read" in the second, and "Enable" in the third. The second row has "private" in the first column, "R/W" in the second, and "Enable" in the third. The third and fourth rows have empty input boxes in the first column, "Read" in the second, and "Disable" in the third. At the bottom right of the form is an "Apply" button.

Community String	Rights	Status
public	Read	Enable
private	R/W	Enable
	Read	Disable
	Read	Disable

Figure 7-54. SNMP Community Settings screen

Items on the screen above include:

- **Community String** – A string of up to 20 characters used for authentication of users wanting access to the Switch's SNMP agent.

- **Rights** – Specifies the level of access for an authorized user. The levels can be *Read*, for read only, or *R/W*, for read-write.
- **Status** – Specifies whether the current string is *Valid* or *Invalid*. This is used to temporarily limit access to the Switch's SNMP agent.

Setup Trap Receivers

The following figure and table describe how to specify management stations that will receive authentication failure messages or other trap messages from the Switch. Up to 4 trap managers may be entered.

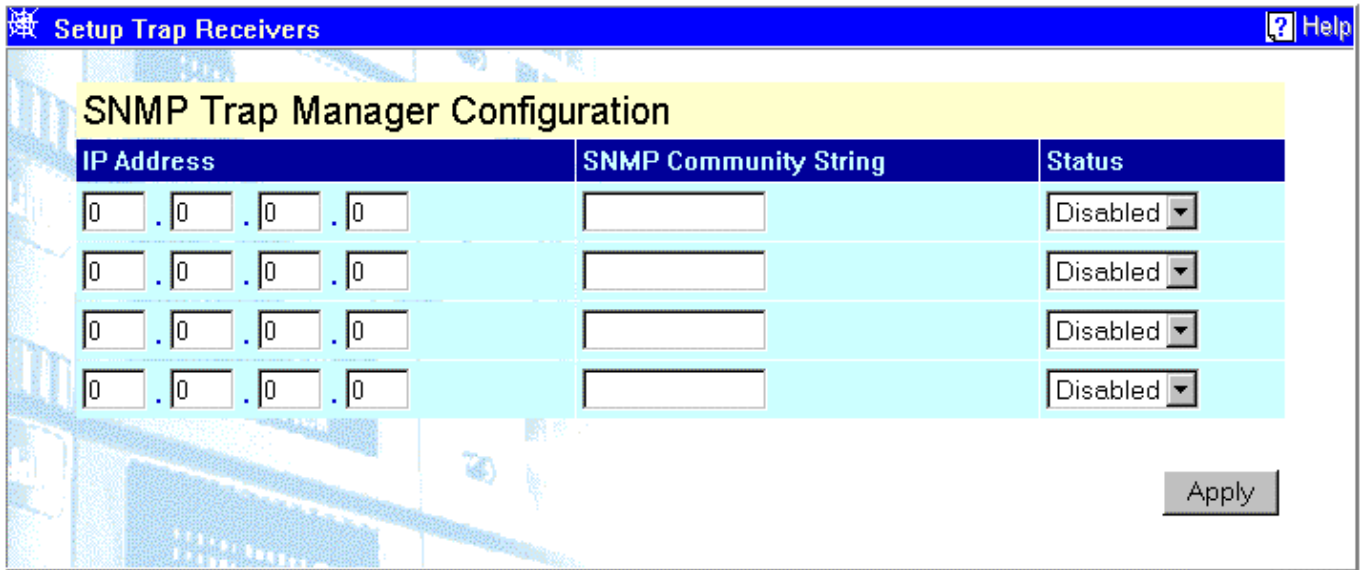


Figure 7-55. Setup Trap Receivers screen

Items on the screen above include:

- **IP Address** – The IP address of the management station that will receive traps generated by the Switch.
- **SNMP Community String** – A string of up to 20 characters used for authentication of users wanting to receive traps from the Switch's SNMP agent.
- **Status** – Specifies whether the current string is *Enabled* or *Disabled*. This is used to temporarily limit the receipt of traps generated by the Switch.

Setup User Accounts

Click **Setup User Accounts** to access the following window:

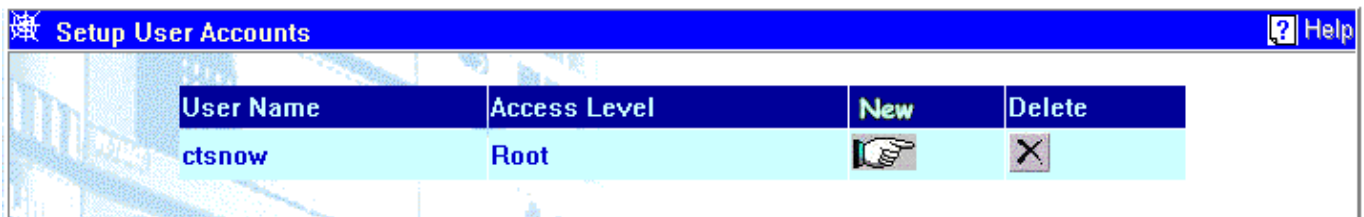


Figure 7-56. Setup User Accounts screen

Items on the screen above include:

- **User Name** – The name given to identify the user account.
- **Access Level** – Indicates the access level: *Root*, *User+*, or *User*.
- **New** – A link to the **Setup User Account - Add** window.
- **Pointer Icon** – A link to the **Setup User Account - Edit** window.
- **Delete** – Click this icon to remove a user from this table.

Setup User Account – Add

Figure 7-57. Setup User Account – Add screen

Enter the new user name, assign an initial password, and then confirm the new password. Determine whether the new user should have *Root*, *User+*, or *User* privileges. Click on **Apply** to make the user addition effective.

A listing of all user accounts and access levels is shown on the **Setup User Accounts** table. This list is updated when **Apply** is executed.

Please remember that **Apply** makes changes to the switch configuration for the **current session only**. All changes (including User additions or updates) must be entered into non-volatile ram using the **Save Changes** command on the **Maintenance** menu - if you want these changes to be permanent.

Setup User Account – Edit

Figure 7-58. Setup User Account – Edit screen

Enter the old password, the new password, and then confirm the new password. Determine whether the new user should have *Root*, *User+*, or *User* privileges. Click on **Apply** to make the user addition effective.

A listing of all user accounts and access levels is shown on the **Setup User Accounts** table. This list is updated when Apply is executed.

Please remember that Apply makes changes to the switch configuration for the **current session only**. All changes (including User additions or updates) must be entered into non-volatile ram using the **Save Changes** command on the **Maintenance** menu - if you want these changes to be permanent.

Serial Port Settings

The following screens are used to configure the Switch's serial port (sometimes referred to as a 'console port').

Serial Port Setting	Console
Console Settings	
Baud Rate	9600
Data Bits	8
Stop Bits	1
Auto-Logout	Never
Telnet Settings	
Time Out	10 minutes
Sessions	1

Apply

Figure 7-59. Serial Port Settings screen

Items on the screen above include:

Console Settings:

- **Baud Rate** – Specifies the rate data will be exchanged over the serial link. The default value is 9600 baud.
- **Data Bits** – Specifies the number of bits that will carry data over the serial link. The default value is 8 bits.
- **Stop Bits** – Specifies the number of bits that indicate when a serial word ends. The default value is 1 bit.
- **Auto-Logout** – Specifies length of time a management session can be idle. When this time has expired, the Switch's management agent will disconnect the user. The default value is 10 minutes.

Telnet Settings:

- **Time Out** – Specifies length of time a Telnet session can be idle. When this time has expired, the Switch will disconnect the user. The default value is 10 minutes.
- **Sessions** – The number of Telnet sessions ranges from 1 to 4.

Network Monitoring

The Networking Monitoring menu has been divided into three main sections: Statistics, Address Table, and Applications.

Statistics

The Web Manager allows various statistics about the Switch's performance to be viewed.

Port Utilization

The following port utilization statistics are compiled by the Switch's management agent:

Port	Tx frames/sec	Rx frames/sec	% of Utilization	Port	Tx frames/sec	Rx frames/sec	% of Utilization
1	0	52	0	5	0	0	0
2	0	0	0	6	0	0	0
3	0	0	0	7	0	0	0
4	0	0	0	8	0	0	0

Figure 7-60. Port Utilization screen

The statistic counters displayed are defined as follows:

- **Update Interval** – The interval (in seconds) that the table is updated. The default is *Suspend*.
- **TX frames/sec** – The number of good bytes sent from the respective port per second.
- **RX frames/sec** – The number of good bytes received per second. This also includes local and dropped packets.
- **% of Utilization** – This shows the percentage of available bandwidth each port is using over the amount of time specified by the update interval. For example, when a 10 Mbps port is relaying packets at 5 Mbps, the utilization is 50%.

Port Error Packets

The following port error statistics are compiled by the Switch's management agent:

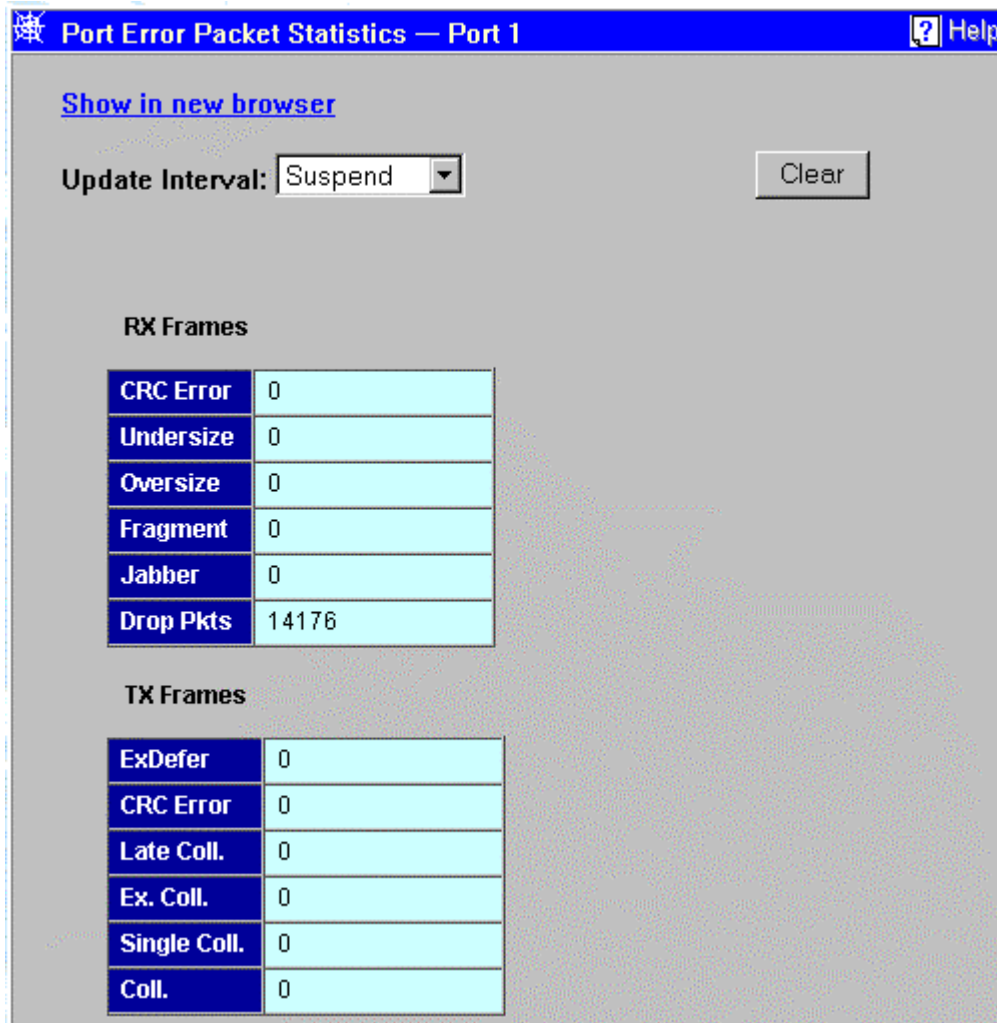


Figure 7-61. Port Error Packet screen

Items on the screen above include:

- **Update Interval** – The interval (in seconds) that the table is updated. The default is *Suspend*.

Rx Received packets

- **CRC Error** – For 10 Mbps ports, the counter records CRC errors (FCS or alignment errors). For 100 Mbps ports, the counter records the sum of CRC errors and code errors (frames received with rxerror signal).
- **Undersize** – The total number of frames received that were less than 64 octets long (excluding framing bits, but including FCS octets) and were otherwise well formed.
- **Oversize** – The total number of frames received that were longer than 1518 octets (excluding framing bits, but including FCS octets) and were otherwise well formed.
- **Fragments** – The total number of frames received that were less than 64 octets in length (excluding framing bits, but including FCS octets) and had either an FCS or an alignment error.
- **Jabbers** – The total number of frames received that were longer than 1518 octets (excluding framing bits, but including FCS octets), and had either an FCS or an alignment error.

- **Drop Pkts** – The total number of events in which packets were dropped due to a lack of resources.
- **Tx** – Transmitted packets.
- **ExDefer** – The number of frames for which the first transmission attempt on a particular interface was delayed because the medium was busy.
- **CRC Error** – For 10 Mbps ports, the counter records CRC errors (FCS or alignment errors). For 100 Mbps ports, the counter records the sum of CRC errors and code errors (frames received with rxerror signal).
- **Late Coll.** – Late Collisions. The number of times that a collision is detected later than 512 bit-times into the transmission of a packet.
- **Ex. Coll.** – Excessive Collisions. The number of frames for which transmission failed due to excessive collisions.
- **Single Coll.** – Single Collision Frames. The number of successfully transmitted frames for which transmission is inhibited by more than one collision.
- **Coll.** – An estimate of the total number of collisions on this network segment.

Port Packet Analysis

The following port packet statistics are compiled by the Switch's management agent:

Port Packet Analysis — Port 1

[Show in new browser](#)

Update Interval: 15 seconds

Frame Size/Type	Frames	Frames/sec	Packet Type	Total	Total/
64	248435	21	Rx	Bytes	62166001 6953
65-127	157379	24		Frames	468150 50
128-255	39573	2	Tx	Bytes	1212057 215
256-511	9700	0		Frames	2290 0
512-1023	737	0			
1024-1518	14616	1			
	Frames	Frames/sec			
Unicast RX	186910	27			
Multicast RX	53763	4			
Broadcast RX	227477	19			

Figure 7-62. Port Packet Analysis screen

Items on the screen above include:

- **Update Interval** – The interval (in seconds) that the table will be updated. The default is *Suspend*.

- **Frame Size/Type** – The size in octets (bytes) of frames transferred through the switch.
- **Frames** – The total number of frames transferred through the switch of the corresponding size indicated.
- **Frames/sec** – The number of frames per second transferred through the switch of the corresponding size indicated.
- **Packet Type Rx** – This displays both the bytes and frames received.
- **Packet Type Tx** – This displays both the bytes and frames transmitted.
- **Clear** – Click this button to clear all counters.

Port Utilization History

The Switch allows you to display a graphical representation of a selected port's utilization. These figures are the percentage of bandwidth being used.

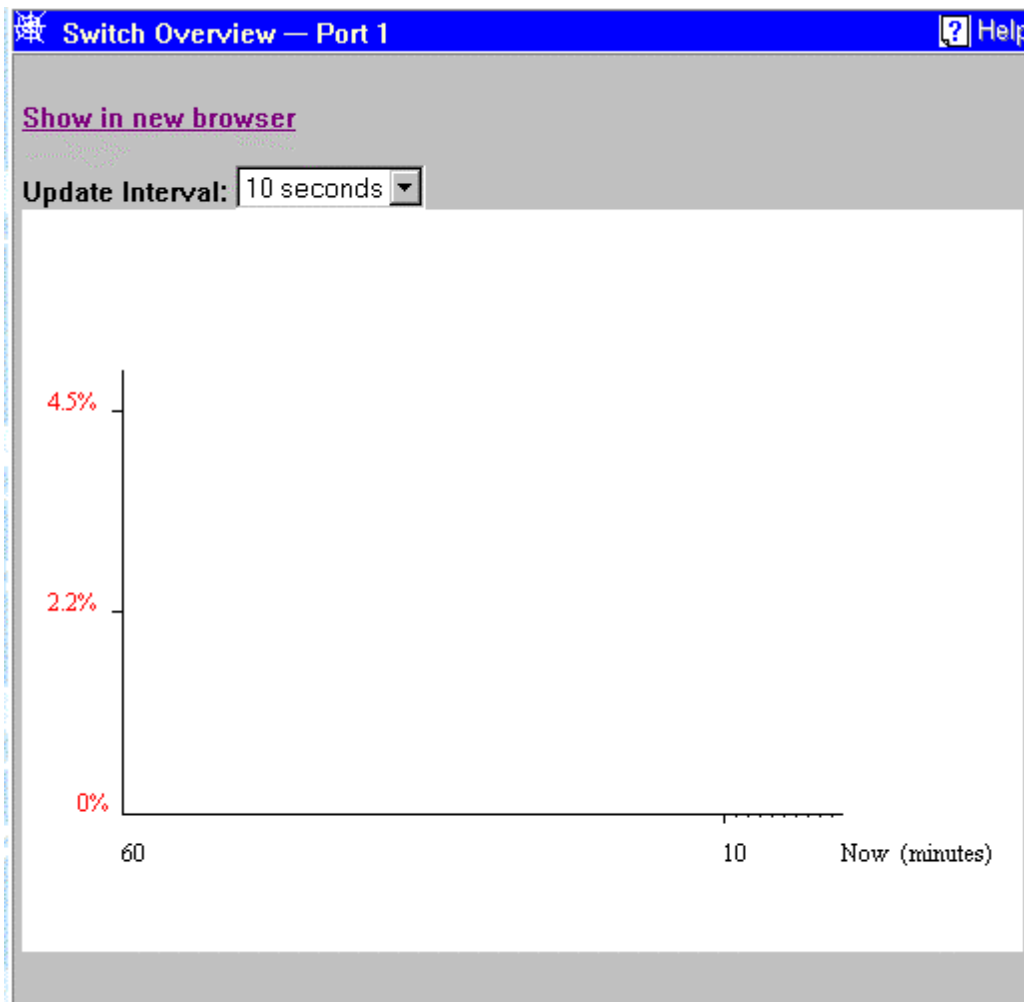


Figure 7-63. Switch Overview screen

Select the desired polling increment in the **Update Interval** field: *10 seconds*, *20 seconds*, *30 seconds*, *60 seconds*, or *Suspend*.

Address Table

The following section describes how to browse the Switch's address tables.

Browse MAC Address Table

The Web Manager allows the Switch's MAC address table (sometimes referred to as a forwarding table) to be viewed.

Browse MAC Address Table ?			
MAC Address Aging Time (10 ... 1000000 sec)			<input type="text" value="300"/> <input type="button" value="Apply"/>
VID	MAC Address	Port	Learned
1	00-00-81-9a-f2-f4	1	dynamic
1	00-00-86-4e-e1-01	1	dynamic
1	00-01-02-03-04-00	1	dynamic
1	00-01-30-fa-5f-00	1	dynamic
1	00-01-96-9c-06-00	1	dynamic
1	00-01-f4-db-06-c0	CPU	self
1	00-01-f4-db-07-00	1	dynamic
1	00-05-5d-12-12-20	1	dynamic
1	00-10-6f-03-0f-b1	1	dynamic
1	00-16-79-01-02-03	1	dynamic
1	00-22-44-88-77-99	1	dynamic
1	00-22-44-88-77-9b	1	dynamic
1	00-40-05-41-af-bf	1	dynamic
1	00-40-05-51-84-2e	1	dynamic
1	00-40-05-51-de-04	1	dynamic
1	00-48-54-56-fb-04	1	dynamic
1	00-50-8b-44-57-3e	1	dynamic
1	00-50-ba-00-00-ff	1	dynamic
1	00-50-ba-00-04-32	1	dynamic
1	00-50-ba-00-04-33	1	dynamic
Total Addresses in Table: 101			<input type="button" value="Next"/>

The screenshot displays three search sections for the MAC Address Table:

- Search Table By VID:** A search bar with a blue header, a label 'VID' in a blue box, an empty text input field, and a 'Find' button.
- Search Table By MAC Address:** A search bar with a blue header, a label 'MAC Address' in a blue box, a text input field containing '00-00-00-00-00-00', and a 'Find' button.
- Search Table By Port:** A search bar with a blue header, a label 'Port' in a blue box, a dropdown menu showing '1', and a 'Find' button.

Below the search sections are two buttons: 'Clear Table By Port' and 'Clear All Table'.

Figure 7-64. Browse MAC Address Table screen

Items on the screen above include:

- **MAC Address Aging Time (10...1000000 sec)** – Specifies the length of time a learned MAC Address will remain in the forwarding table without being accessed (that is, how long a learned MAC Address is allowed to remain idle). The Aging Time can be set to any value between *10* and *1,000,000* seconds.
- **VID** – The VLAN ID of the VLAN the port is a member of.
- **MAC Address** – The MAC address entered into the address table.
- **Port** – The port that the MAC address above corresponds to.
- **Learned** – How the Switch discovered the MAC address. The possible entries are Dynamic, Self, and Static.

IP Address Table

The Web Manager allows you to view the IP address table.

IP Address Table			
Interface Name	IP Address	Port	Learned
System	10.0.0.46	1	Dynamic
System	10.0.51.2	1	Dynamic
System	10.0.58.6	1	Dynamic
System	10.0.85.168	1	Dynamic
System	10.1.1.10	1	Dynamic
System	10.1.1.101	1	Dynamic
System	10.1.1.151	1	Dynamic
System	10.1.1.152	1	Dynamic
System	10.1.1.153	1	Dynamic
System	10.1.1.155	1	Dynamic
System	10.1.1.157	1	Dynamic
System	10.1.1.158	1	Dynamic
System	10.1.1.161	1	Dynamic
System	10.1.1.162	1	Dynamic
System	10.1.1.163	1	Dynamic
System	10.1.1.164	1	Dynamic
System	10.1.1.166	1	Dynamic
System	10.1.1.167	1	Dynamic

Figure 7-65. IP Address Table screen

To display a particular IP address, enter the IP address in the **Jump to IP Address** field and click **GO**.

Routing Table

The Web Manager allows you to view the contents of the routing table.

Routing Table

Jump to Destination Address: 0.0.0.0 Mask: 0.0.0.0 Gateway: 0.0.0.0 Go

Clear Table

Total Entries: 2

Destination Address	Destination Mask	Gateway	Interface Name	Hops	Protocol
0.0.0.0	0.0.0.0	10.254.254.251	System	1	Default
10.0.0.0	255.0.0.0	10.24.22.8	System	1	Local

[Prev] [Next]

Figure 7-66. Routing Table screen

To display a particular Destination IP address, enter the IP address, netmask, and default gateway in the three fields above and then click **Go**. Clicking **Clear Table** will empty the table.

ARP Table

The Web Manager allows you to view the ARP table.

Jump to Interface Name: IP Address:

Total Entries: 435

Browse ARP Table				
Interface Name	Interface IP Address	IP Address	MAC Address	Type
System	10.24.22.8	10.0.0.0	ff:ff:ff:ff:ff:ff	Local/Broadcast
System	10.24.22.8	10.0.0.46	00:80:c8:91:15:eb	Dynamic
System	10.24.22.8	10.0.51.2	00:80:c8:4c:69:fb	Dynamic
System	10.24.22.8	10.0.58.6	00:80:c8:7e:ec:77	Dynamic
System	10.24.22.8	10.0.85.168	00:50:ba:11:08:e4	Dynamic
System	10.24.22.8	10.1.1.10	00:50:8b:5c:14:fb	Dynamic
System	10.24.22.8	10.1.1.101	00:80:c8:f5:e0:bb	Dynamic
System	10.24.22.8	10.1.1.151	00:50:ba:70:d6:d0	Dynamic
System	10.24.22.8	10.1.1.152	00:13:00:00:00:01	Dynamic
System	10.24.22.8	10.1.1.153	00:50:ba:70:b9:31	Dynamic
System	10.24.22.8	10.1.1.155	00:50:ba:70:d6:9a	Dynamic
System	10.24.22.8	10.1.1.157	00:50:ba:71:20:d6	Dynamic
System	10.24.22.8	10.1.1.158	00:50:ba:f5:a5:55	Dynamic
System	10.24.22.8	10.1.1.161	00:50:ba:70:e4:89	Dynamic
System	10.24.22.8	10.1.1.162	00:50:ba:70:e4:5a	Dynamic
System	10.24.22.8	10.1.1.163	00:50:ba:70:e4:55	Dynamic

Figure 7-67. ARP Table screen

To browse the ARP table, enter the IP interface name in the first field, the IP address in the second field, and then click **Go**. Clicking **Clear Table** will empty the table.

Applications

The following figures and tables describe the applications available when using the Web-based manager.

GVRP

The following read-only table displays current GVRP information.

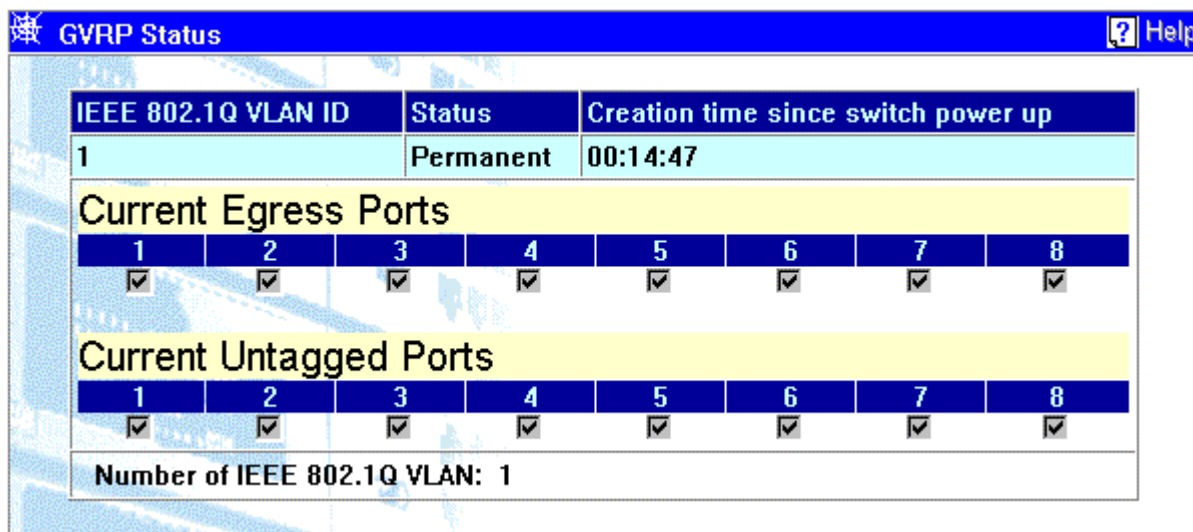


Figure 7-68. GVRP Status screen

Browse Router Port

A static router port is simply a port that has a router attached to it. Generally, this router would have a connection to a WAN or to the Internet. Establishing a router port allows multicast packets coming from the router to be propagated throughout the network, as well as allowing multicast messages coming from the network to be propagated to the attached router.

The purpose of a router port is to enable UDP multicast packets, and IGMP multicast group membership messages to reach multiple ports of a multicast-enabled router. Routers do not implement IGMP snooping or transmit/forward IGMP report packets. Thus, forwarding all IP UDP multicast packets to a static router port guarantees that all ports of a multicast-enabled router – attached to the Switch – can reach all multicast group members through the attached router's other ports.

The Switch monitors each port for UDP multicast packets and IGMP multicast group membership reports. When these packets are detected on a port, that port is dynamically assigned as router port.

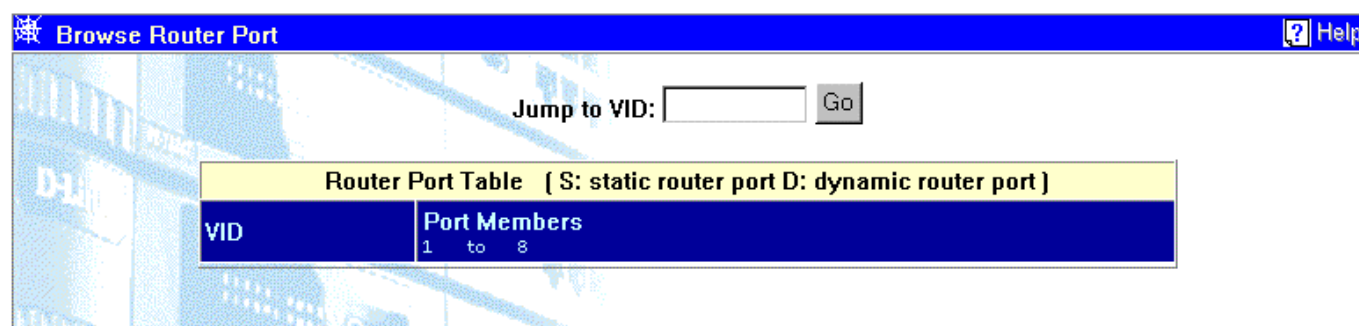


Figure 7-69. Browse Router Port screen

Items on the screen above include:

- **Jump to VID** – Allows a VID to be specified to search the router port table with.
- **Go** – Click this button to search the router port table using the VID entered above.
- **VID** – The VLAN ID number.

- **Port Members** – Ports that are router ports, both statically and dynamically assigned.

IGMP Snooping

The Switch's IGMP snooping table can be browsed using the Web Manager. The table is displayed by VLAN IP (VID).

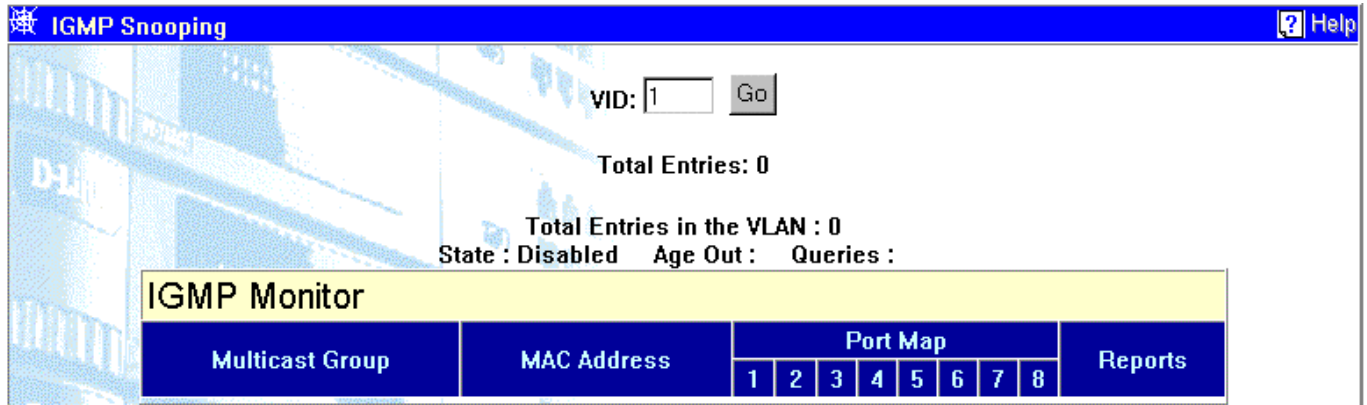


Figure 7-70. IGMP Snooping Table screen

Items on the screen above include:

- **VID** – VLAN ID of the VLAN for which the IGMP Snooping table is to be displayed.
- **Go** – Click on this button to display the IGMP Snooping Table for the current VID.
- **Multicast Group** – The IP address of a multicast group learned by IGMP snooping.
- **MAC Address** – The corresponding MAC address learned by IGMP snooping.
- **Port Map** – Displays the ports that have forwarded multicast packets from the above source.
- **Reports** – The number of IGMP reports for the listed source.

IP Multicast Forwarding Table

The Web Manager allows you to view the IP multicast forwarding table.

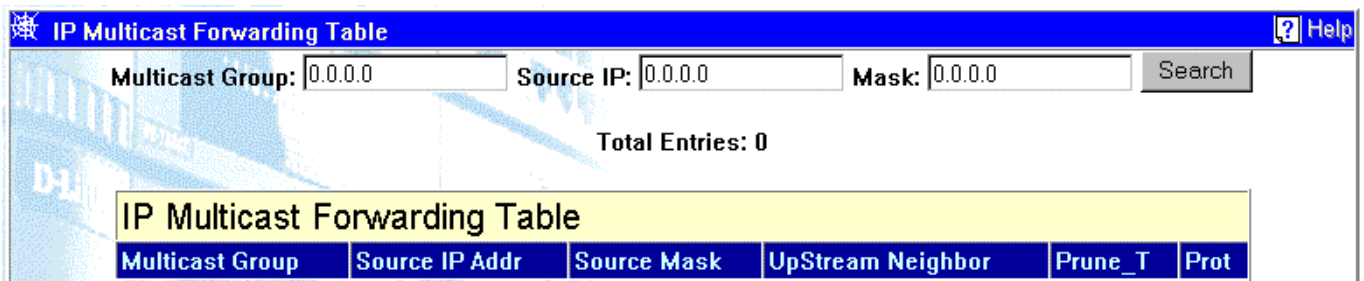


Figure 7-71. IP Multicast Forwarding Table screen

To display a particular multicast group, enter the IP address of the multicast group, the source IP Address, and the netmask in the first three fields, respectively, and then click **Search**.

IGMP Group Table

The Web Manager allows you to display an IGMP Group Table.

Figure 7-72. IGMP Group Table screen

To display an IGMP group table, enter name of the routing interface and the IP address of the multicast group in the first two fields and then click **Go**.

DVMRP Routing Table

The Web Manager allows you to display a DVMRP routing table.

Figure 7-73. DVMRP Routing Table screen

To display a DVMRP routing entries, enter the IP address and source subnet mask in the first two fields and click **GO**. Clicking **Clear Table** will empty the table.

Switch History

The Web-based manager allows the Switch's history log, as compiled by the Switch's management agent, to be viewed.

Sequence #	Time	Log Text
161	000d00h01m	Successful login through web.
160	000d00h00m	Topology Change
159	000d00h00m	Successful login through console.
158	000d00h00m	New Root
157	000d00h00m	Link change on port 8 Link-Down
156	000d00h00m	Link change on port 7 Link-Down
155	000d00h00m	Link change on port 6 Link-Down
154	000d00h00m	Link change on port 5 Link-Down
153	000d00h00m	Link change on port 4 Link-Down
152	000d00h00m	Link change on port 3 Link-Down
151	000d00h00m	Link change on port 2 Link-Down
150	000d00h00m	Link change on port 1 1000M/Full/802.3x
149	000d00h00m	Authentication Failure.
148	000d00h00m	Cold Start
147	000d00h15m	Change switch mode to Layer 3 with IEEE802.1q vlan.
146	000d00h01m	Successful login through web.
145	000d00h00m	Topology Change
144	000d00h00m	Successful login through console.
143	000d00h00m	New Root
142	000d00h00m	Link change on port 8 Link-Down

Figure 7-74. Switch History screen

Items on the screen above include:

- **Sequence #** – A counter incremented whenever an entry to the switch's history log is made. The table displays the last entry (highest sequence number) first.
- **Time** – Displays the time in days, hours, and minutes since the switch was last restarted the history log entry was made.
- **Log Text** – Displays text describing the event that triggered the history log entry.

Maintenance

The Maintenance menu—which is the same whether the Switch is in Layer 2 mode or Layer 3 mode—offers a range of utilities, including various TFTP services. Trivial File Transfer Protocol (TFTP) services allow the Switch firmware to be upgraded by downloading a new firmware file from a TFTP server to the Switch. A configuration file can also be loaded into the Switch, and Switch settings can be saved to a TFTP server. In addition, the Switch's history log can be uploaded from the Switch to a TFTP server.

Upgrade Firmware from TFTP Server

Note: The TFTP server must be on the same IP subnet as the Switch.

The following figure and table describe how to update the Switch's firmware from a server.



Figure 7-75. Upgrade Firmware from TFTP Server screen

Items on the screen above include:

- **Server IP Address** – The IP address of the TFTP server.
- **Path and File Name** – The full file name, including path, of the new firmware file on the TFTP server.

Download Configuration File from TFTP Server

A configuration file can be downloaded from a TFTP server to the Switch. This file is then used by the Switch to configure itself.

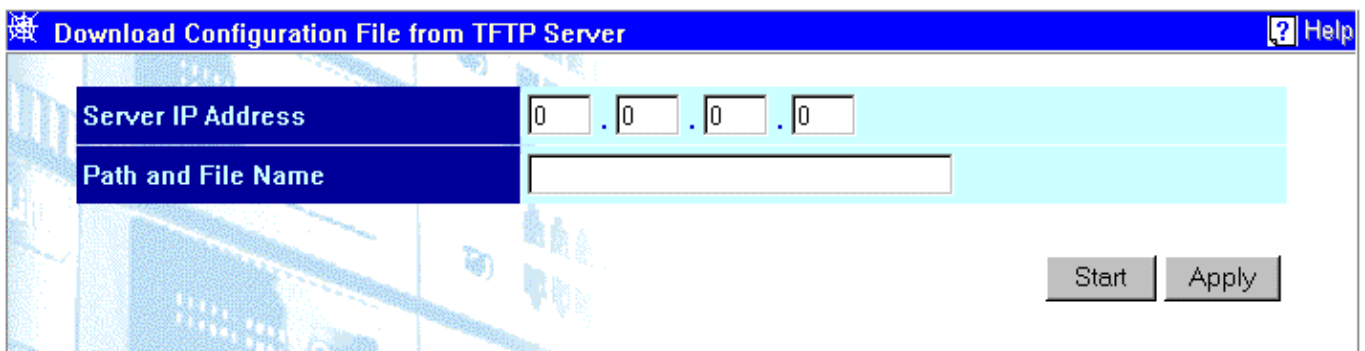


Figure 7-76. Download Configuration File from TFTP Server screen

Items on the screen above include:

- **Server IP Address** – The IP address of the TFTP server.
- **Path and File Name** – The full file name, including path, of the configuration file on the TFTP server.

Upload Configuration File to TFTP Server

The Switch's current settings can be uploaded to a TFTP Server by the Switch's management agent.

Figure 7-77. Upload Configuration File to TFTP Server screen

Items on the screen above include:

- **Server IP Address** – The IP address of the TFTP server.
- **Path and File Name** – The full file name, including path, of the settings file on the TFTP server.

Save Log to TFTP Server

The switch's management agent can upload its history log file to a TFTP server.

Figure 7-78. Save Log To TFTP Server screen

Items on the screen above include:

- **Server IP Address** – The IP address of the TFTP server.
- **Path and File Name** – The full file name, including path, of the history file on the TFTP server.

Save Changes

The DGS-3308 has two levels of memory, normal RAM and non-volatile or NV-RAM.

To retain any configuration changes permanently, highlight **Save Changes** on the **Maintenance** menu. The following screen will appear to verify that your new settings have been saved to NV-RAM:

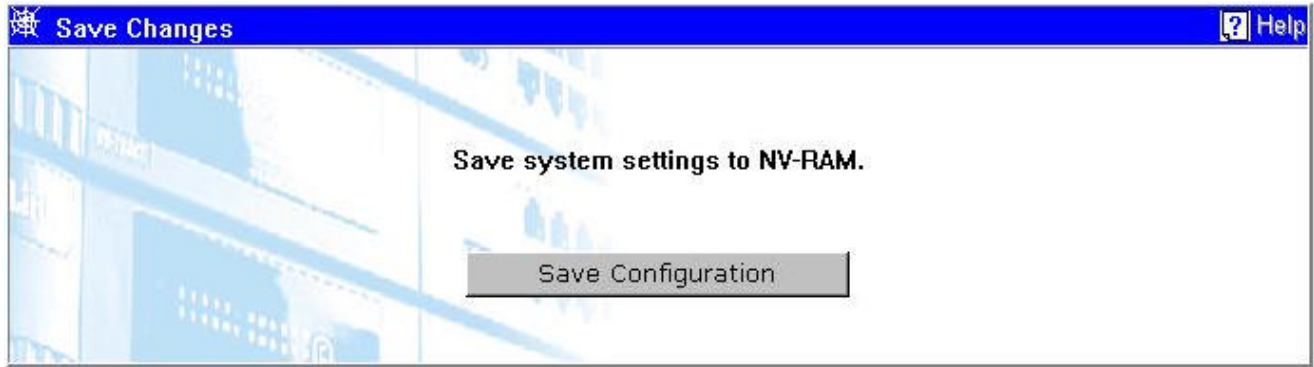


Figure 7-79. Save Changes screen

Once the Switch configuration settings have been saved to NV-RAM, they become the default settings for the Switch. These settings will be used every time the Switch is rebooted.

Factory Reset

The following menu is used to restart the Switch using only the configuration that was supplied by the factory. A factory reset returns all configuration options to their default values and restores the Switch's configuration to the factory settings.

All user-entered configuration information will be lost.

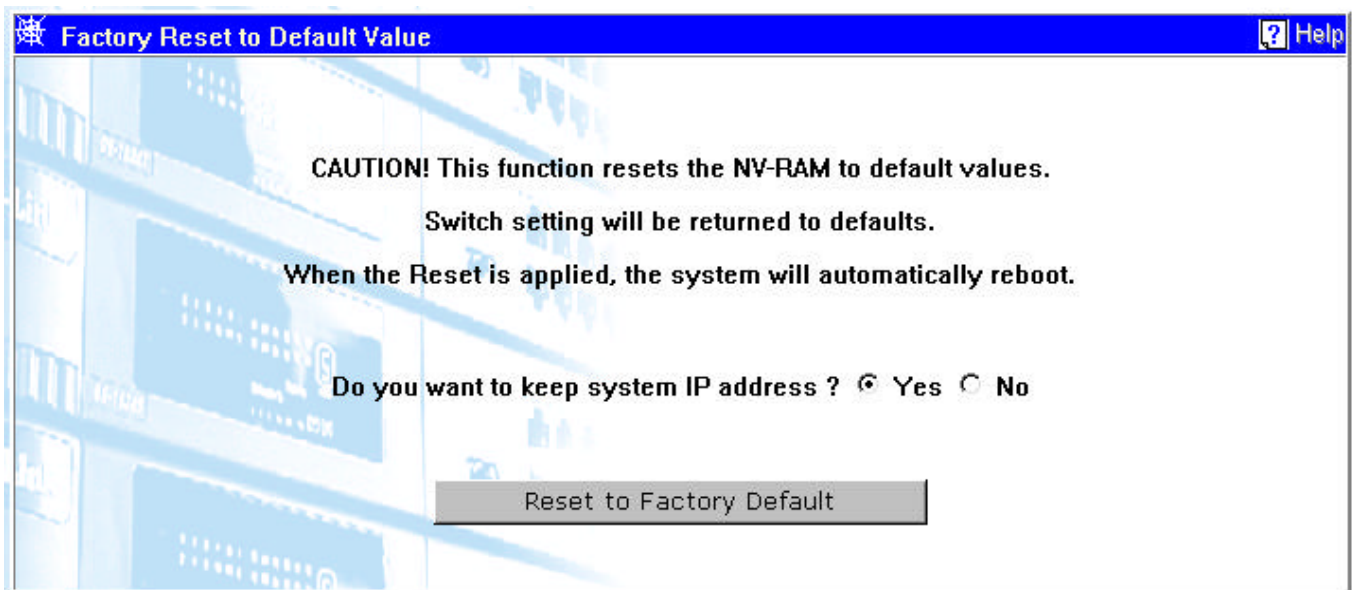


Figure 7-80. Factory Reset screen

Click *Yes* if you want the Switch to retain its current IP address. Click *No* to reset the Switch's IP address to the factory default, 10.90.90.90.

Click the **Reset to Factory Default** button to restart the Switch.

Restart System

The following menu is used to restart (reboot) the Switch. Click *Yes* to save the current Switch configuration to non-volatile RAM (flash RAM), or *No* if you want to restart the Switch using the last-saved (previous) configuration.

Click the **Restart** button to restart the Switch.

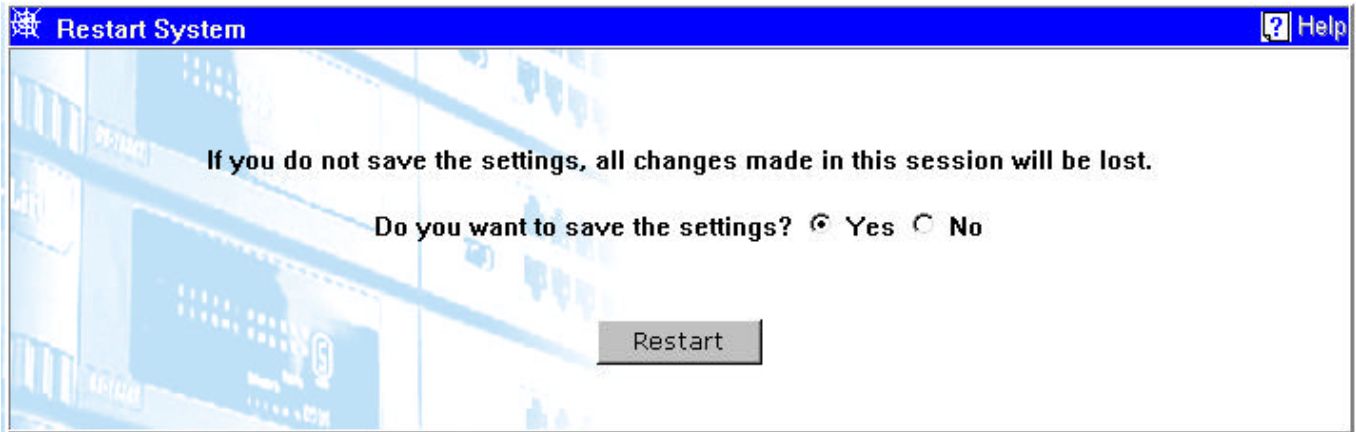


Figure 7-81. Restart System screen

TECHNICAL SPECIFICATIONS

General													
Standards:	<p>IEEE 802.3 10BASE-T Ethernet (DGS-3308TG)</p> <p>IEEE 802.3u 100BASE-TX Fast Ethernet (DGS-3308TG)</p> <p>IEEE 802.3z 1000BASE-SX Gigabit Ethernet (DGS-3308FG)</p> <p>IEEE 802.3ab 1000BASE-T Gigabit Ethernet (DGS-3308TG)</p> <p>IEEE 802.1 P/Q VLAN</p> <p>IEEE 802.3x Full-duplex Flow Control</p> <p>ANSI/IEEE 802.3 NWay auto-negotiation</p>												
Protocols:	CSMA/CD												
Data Transfer Rates:	<table border="0"> <tr> <td></td> <td>Half-duplex</td> <td>Full-duplex</td> </tr> <tr> <td>Ethernet</td> <td>10 Mbps</td> <td>20Mbps</td> </tr> <tr> <td>Fast Ethernet</td> <td>100Mbps</td> <td>200Mbps</td> </tr> <tr> <td>Gigabit Ethernet</td> <td>n/a</td> <td>2000Mbps</td> </tr> </table>		Half-duplex	Full-duplex	Ethernet	10 Mbps	20Mbps	Fast Ethernet	100Mbps	200Mbps	Gigabit Ethernet	n/a	2000Mbps
	Half-duplex	Full-duplex											
Ethernet	10 Mbps	20Mbps											
Fast Ethernet	100Mbps	200Mbps											
Gigabit Ethernet	n/a	2000Mbps											
Topology:	Star												
Network Cables:	<p>10BASE-T: 2-pair UTP Cat. 3, 4, 5 (100 m) EIA/TIA- 568 100-ohm STP (100 m)</p> <p>100BASE-TX: 2-pair or 4-pair UTP Cat. 5 (100 m) EIA/TIA-568 100-ohm STP (100 m)</p> <p>100BASE-FX 50µm and 62.5µm multi-mode fiber</p> <p>1000BASE-SX: 50µm and 62.5µm multi-mode fiber</p>												

General	
1000BASE-LX:	50µm and 62.5µm multi-mode fiber or 10µm single-mode fiber
Fiber Optic:	IEC 793-2:1992 Type A1a - 50/125um multimode Type A1b - 62.5/125um multimode Both types use SC optical connectors
Number of Ports:	8 Gigabit Ethernet (including 2 GBIC-based)

Physical and Environmental	
AC inputs:	100 - 240 VAC, 50/60 Hz (internal universal power supply)
Power Consumption:	40 watts maximum
DC fans:	3 built-in 40 x 40 x10 mm fans
Operating Temperature:	0 to 50 degrees Celsius
Storage Temperature:	-25 to 55 degrees Celsius
Humidity:	Operating: 5% to 95% RH non-condensing; Storage: 0% to 95% RH non-condensing
Dimensions:	441 mm x 210 mm x 43 mm (1U), 19 inch rack-mount width
Weight:	2.6 kg
EMI:	FCC Class A, CE Mark, VCCI Class 1, BSMI Class A, C-Tick Class A
Safety:	UL/CUL, TUV/GS

Performance	
Transmission Method:	Store-and-forward
RAM Buffer:	512 KB per device
Filtering Address Table:	8K MAC address per device
Packet Filtering/ Forwarding Rate:	Full-wire speed for all connections. 1,488,000 pps per port
MAC Address Learning:	Automatic update.

Performance	
Forwarding Table Age Time:	Max age: 10-1000000 seconds. Default = 300.
IP Address	2K per device

B

RJ-45 PIN SPECIFICATION

When connecting the Switch to another switch, a bridge or a hub, a normal cable is necessary. Please review the following for matching cable pin assignment.

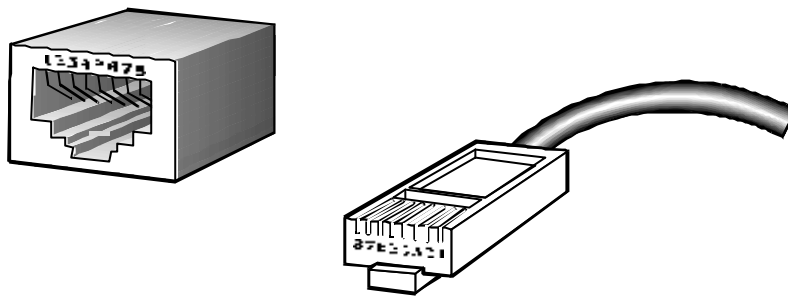


Figure B-1. The standard RJ-45 receptacle/connector

RJ-45 Connector pin assignment	
Contact	Media Direct Interface Signal
1	Tx + (transmit)
2	Tx - (transmit)
3	Rx + (receive)
4	Not used
5	Not used
6	Rx - (receive)
7	Not used
8	Not used

Table B-1. The standard Category 3 cable, RJ-45 pin assignment

RUNTIME SWITCHING SOFTWARE DEFAULT SETTINGS

Load Mode	Ethernet
Switch Operation Mode	Layer 2
Configuration update	Disable
Firmware update	Disable
Configuration file name	None
Firmware file name	None
Out-of-band baud rate	9600
RS232 mode	Console
IP address	10.90.90.90
Subnet mask	255.0.0.0
Default Gateway	0.0.0.0
BootP service	Disable
TFTP server IP address	0.0.0.0
IGMP Snooping	Disable
Console time out	10 min
User name	None
Password	None
Device STP	Enable
Port STP	Enable
Port enable	Enable
Bridge max age	20 secs
Bridge hello time	2 sec
Bridge forward delay	15 sec
Bridge priority	32768
Port STP cost	19 (Gigabit=10)
Port STP priority	128
Forwarding table aging time	300 secs
Nway	Enable
Flow control	Enable
Broadcast storm rising threshold	128Kpps
Community string	"public", "private"
VLAN mode	IEEE 802.1Q
SNMP VLAN(802.1Q)	All
Default port VID	1
Ingress rule checking	Disable
Mirror	Disable

D

UNDERSTANDING AND TROUBLESHOOTING THE SPANNING TREE PROTOCOL

When the spanning-tree algorithm determines a port should be transitioned to the forwarding state, the following occurs:

- The port is put into the listening state where it receives BPDUs and passes them to the Switch's CPU. BPDU packets from the CPU are processed. If no BPDUs that suggest the port should go to the blocking state are received:
- The port waits for the expiration of the forward delay timer. It then moves to the learning state.
- In the learning state, the port learns station location information from the source address of packets and adds this information to its forwarding database.
- The expiration of forwarding delay timer moves the port to the forwarding state, where both learning and forwarding are enabled. At this point, packets are forwarded by the port.

Blocking State

A port in the blocking state does not forward packets. When the switch is booted, a BPDU is sent to each port in the switch putting these ports into the blocking state. A switch initially assumes it is the root, and then begins the exchange of BPDUs with other switches. This will determine which switch in the network is the best choice for the root switch. If there is only one switch on the network, no BPDU exchange occurs, the forward delay timer expires, and the ports move to the listening state. All STP enabled ports enter the blocking state following switch boot.

A port in the blocking state does the following:

- Discards packets received from the network segment to which it is attached.
- Discards packets sent from another port on the switch for forwarding.
- Does not add addresses to its forwarding database
- Receives BPDUs and directs them to the CPU.
- Does not transmit BPDUs received from the CPU.
- Receives and responds to network management messages.

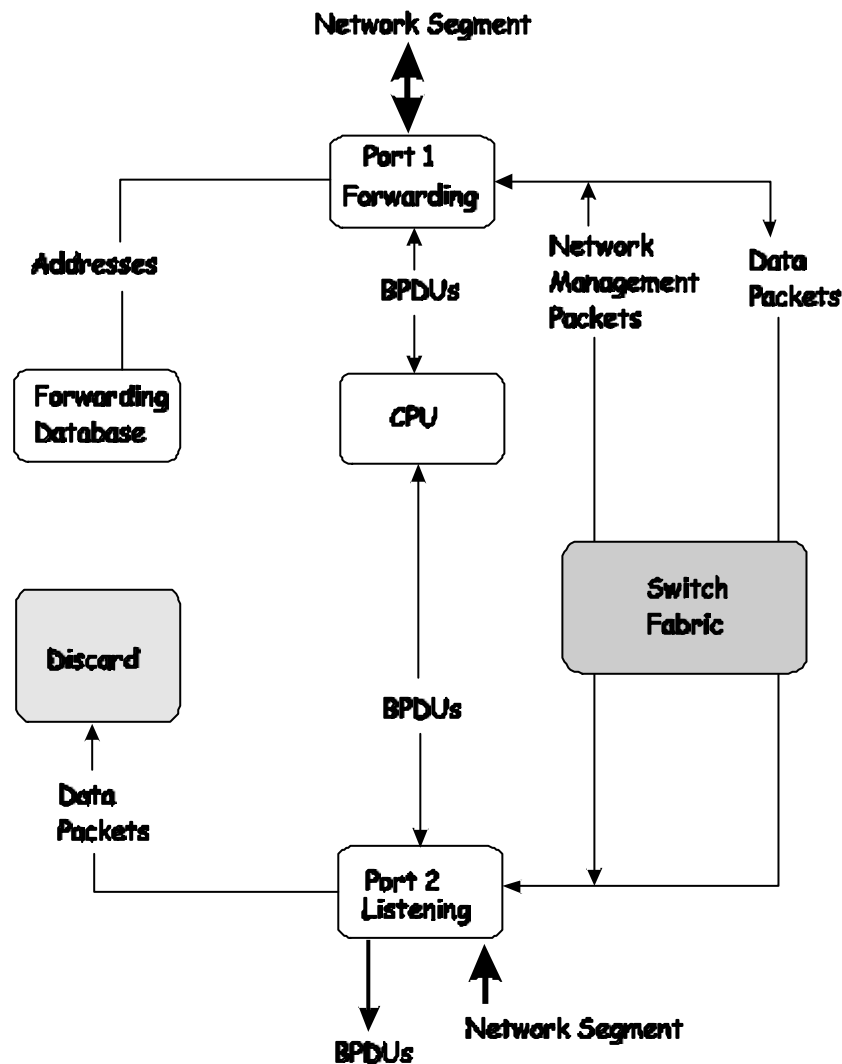
Listening State

The listening state is the first transition for a port from the blocking state. Listening is an opportunity for the switch to receive BPDUs that may tell the switch that the port should not continue to transition to the forwarding state, but should return to the blocking state (that is, a different port is a better choice).

There is no address learning or packet forwarding from a port in the listening state.

A port in the listening state does the following:

- Discards frames received from the network segment to which it is attached.
- Discards packets sent from another port on the switch for forwarding.
- Does not add addresses to its forwarding database
- Receives BPDUs and directs them to the CPU.
- Processes BPDUs received from the CPU.
- Receives and responds to network management messages.

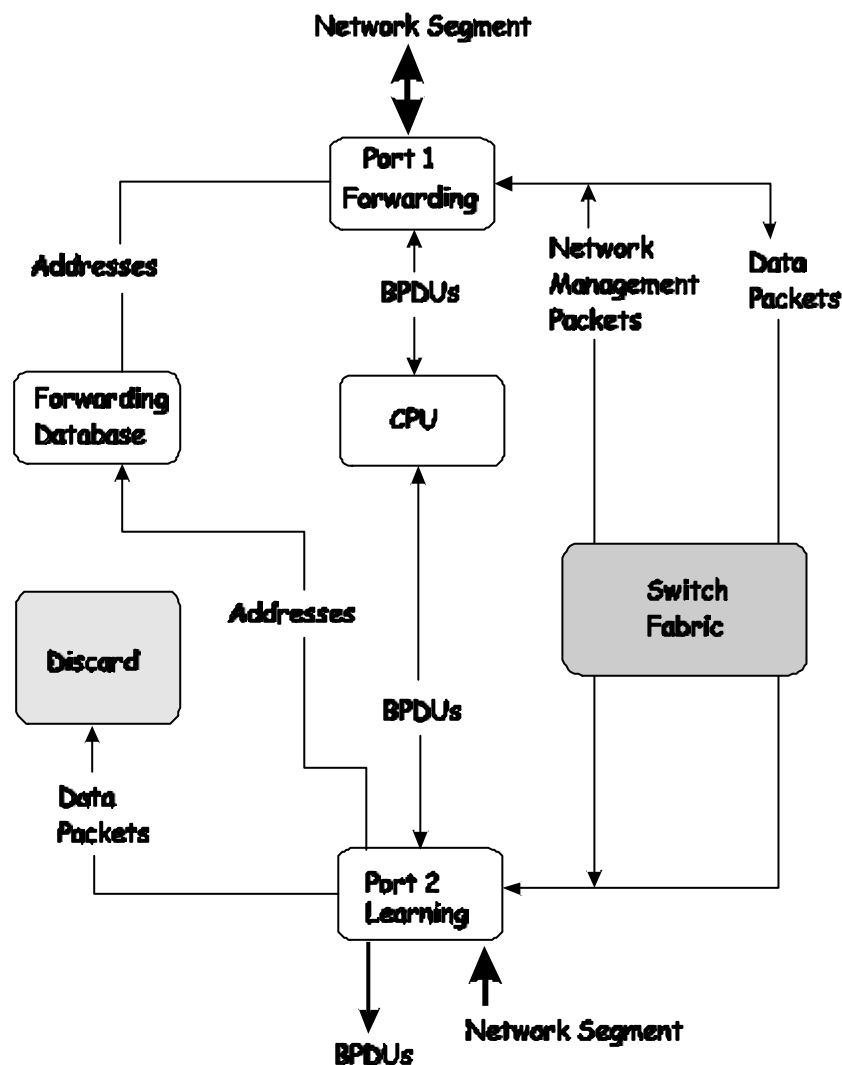


Learning State

A port in the learning state prepares to participate in frame forwarding. The port enters the learning state from the listening state.

A port in the learning state does the following:

- Discards frames received from the network segment to which it is attached.
- Discards packets sent from another port on the switch for forwarding.
- Adds addresses to its forwarding database.
- Receives BPDUs and directs them to the CPU.
- Processes and transmits BPDUs received from the CPU.
- Receives and responds to network management messages.

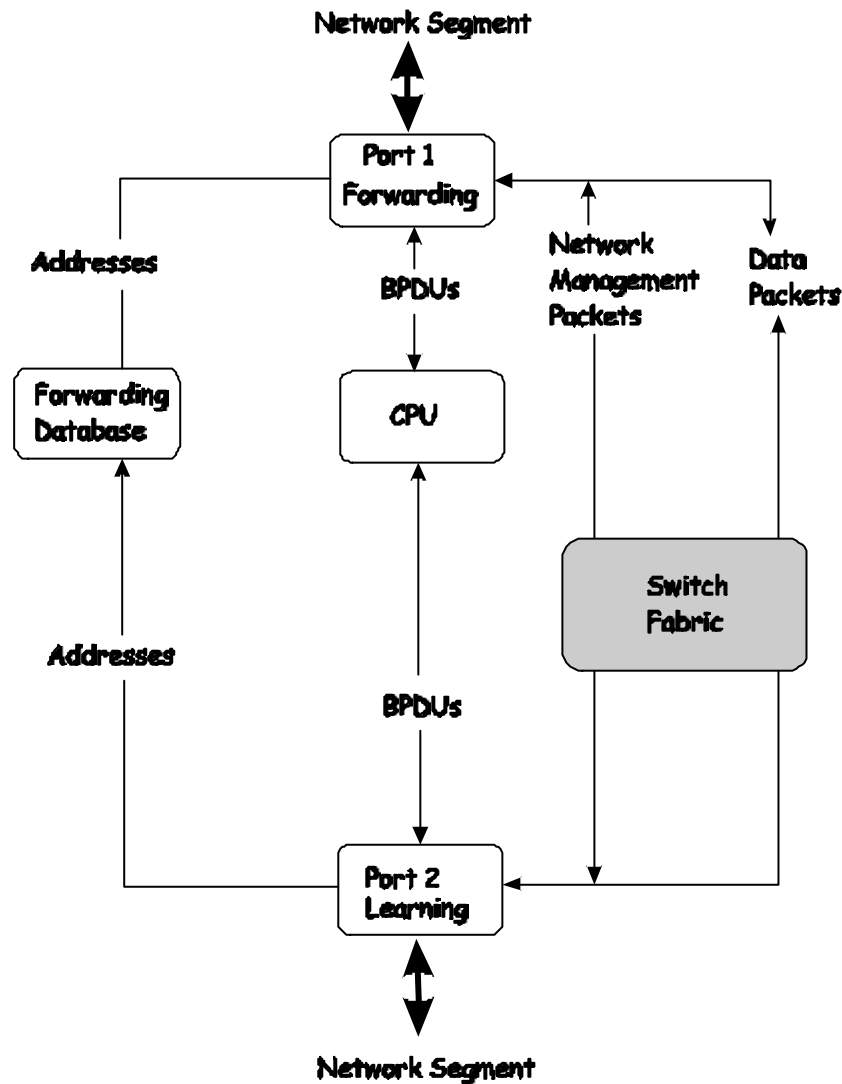


Forwarding State

A port in the forwarding state forwards packets. The port enters the forwarding state from the learning state when the forward delay timer expires.

A port in the forwarding state does the following:

- Forwards packets received from the network segment to which it is attached.
- Forwards packets sent from another port on the switch for forwarding.
- Incorporates station location information into its address database.
- Receives BPDUs and directs them to the system CPU.
- Receives and responds to network management messages.

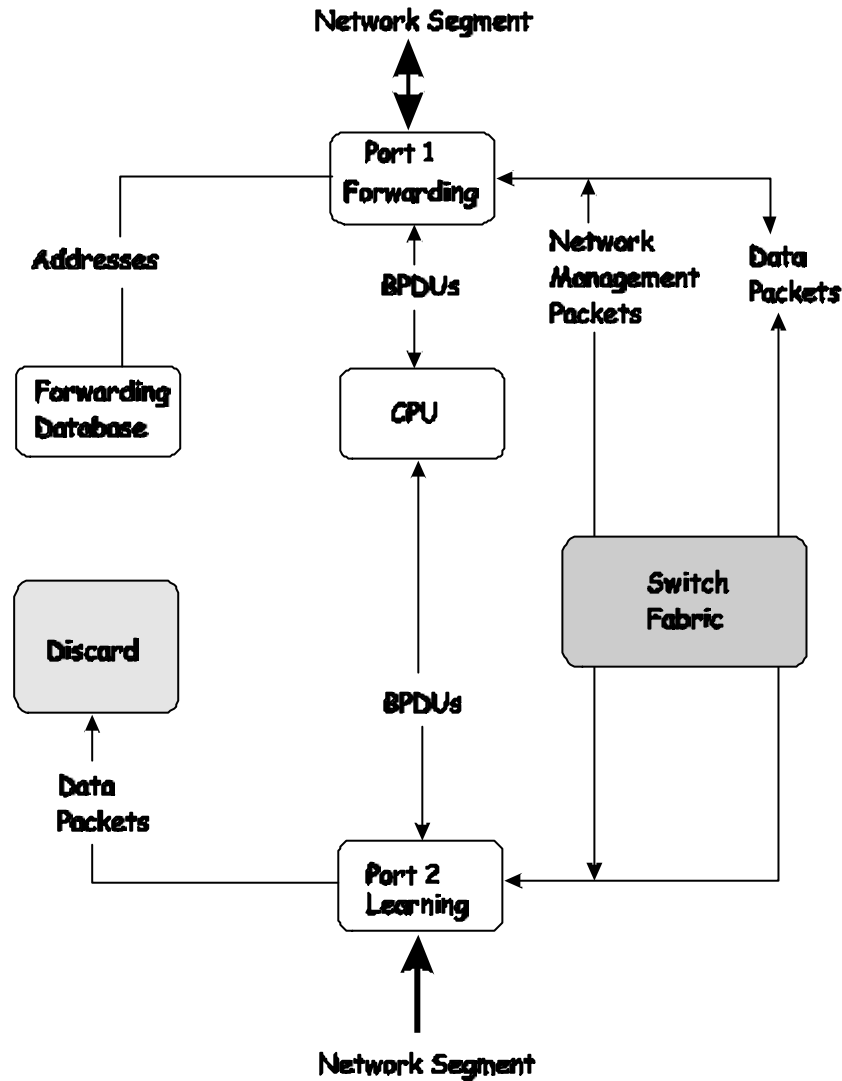
**Disabled State**

A port in the disabled state does not participate in frame forwarding or STP. A port in the disabled state is virtually non-operational.

A disabled port does the following:

- Discards packets received from the network segment to which it is attached.
- Discards packets sent from another port on the switch for forwarding.

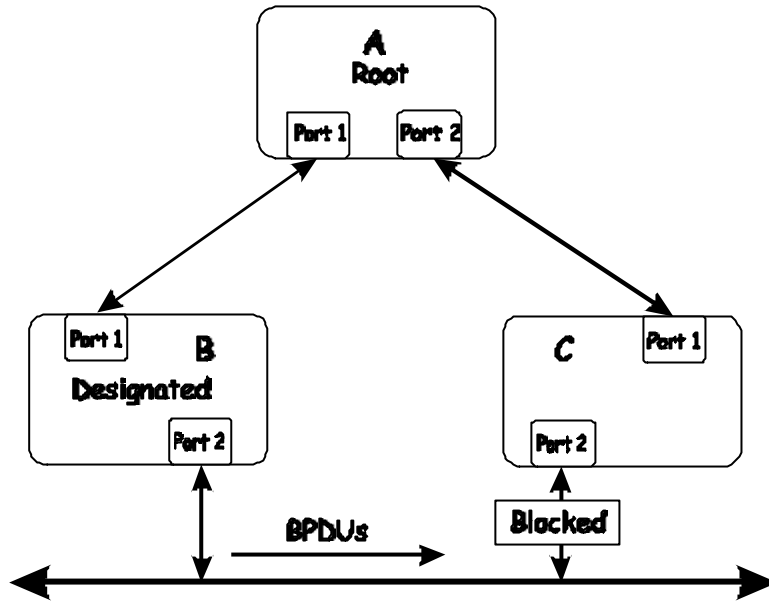
- Does not add addresses to its forwarding database.
- Receives BPDUs, but does not direct them to the system CPU.
- Does not receive BPDUs for transmission from the system CPU.
- Receives and responds to network management messages.



Troubleshooting STP

Spanning Tree Protocol Failure

A failure in the STA generally leads to a bridging loop. A bridging loop in an STP environment comes from a port that should be in the blocking state, but is forwarding packets.



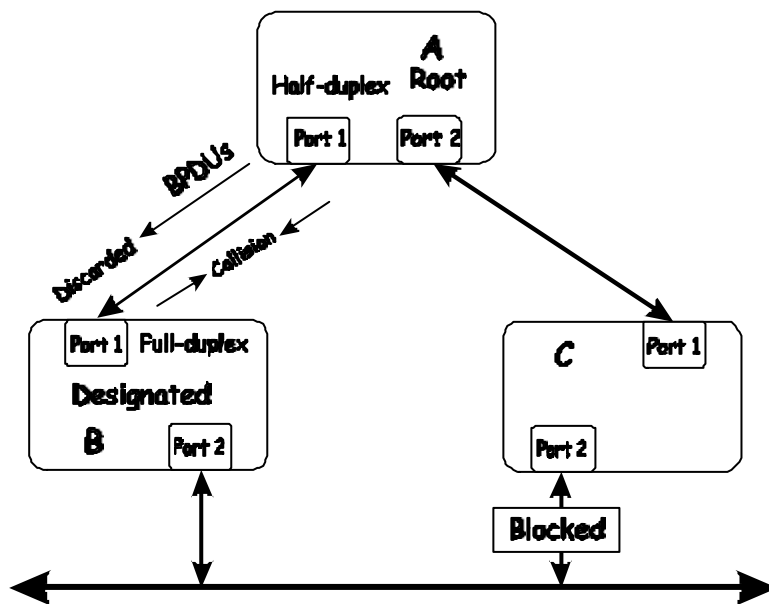
In this example, B has been elected as the designated bridge and port 2 on C is in the blocking state. The election of B as the designated bridge is determined by the exchange of BPDUs between B and C. B had a better BPDU than C. B continues sending BPDUs advertising its superiority over the other bridges on this LAN. Should C fail to receive these BPDUs for longer than the MAX AGE (default of 20 seconds), it could start to transition its port 2 from the blocking state to the forwarding state.

It should be noted: A port must continue to receive BPDUs advertising superior paths to remain in the blocking state.

There are a number of circumstances in which the STA can fail – mostly related to the loss of a large number of BPDUs. These situations will cause a port in the blocking state to transition to the forwarding state.

Full/Half Duplex Mismatch

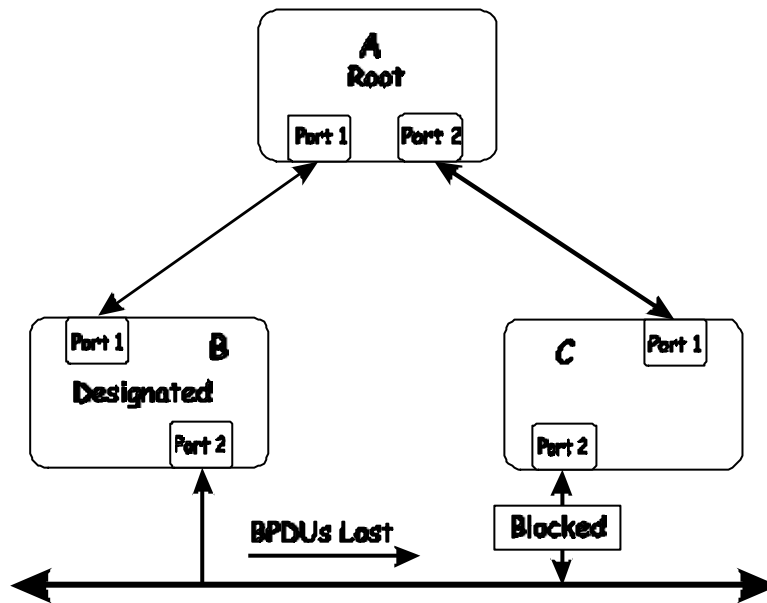
A mismatch in the duplex state of two ports is a very common configuration error for a point-to-point link. If one port is configured as a full duplex, and the other port is left in auto-negotiation mode, the second port will end up in half-duplex because ports configured as half- or full-duplex do not negotiate.



In the above example, port 1 on B is configured as a full-duplex port and port 1 on A is either configured as a half-duplex port, or left in auto-negotiation mode. Because port 1 on B is configured as a full-duplex port, it does not do the carrier sense when accessing the link. B will then start sending packets even if A is using the link. A will then detect collisions and begin to run the flow control algorithm. If there is enough traffic between B and A, all packets (including BPDUs) will be dropped. If the BPDUs sent from A to B are dropped for longer than the MAX AGE, B will lose its connection to the root (A) and will unblock its connection to C. This will lead to a data loop.

Unidirectional Link

Unidirectional links can be caused by an undetected failure in one side of a fiber cable, or a problem with a ports transceiver. Any failure that allows a link to remain up while providing one-way communication is very dangerous for STP.



In this example, port 2 on B can receive but not transmit packets. Port 2 on C should be in the blocking state, but since it can no longer receive BPDUs from port 2 on B, it will transition to the forwarding state. If the failure exists at boot, STP will not converge and rebooting the bridges will have no effect. (Note: Rebooting would help temporarily in the previous example).

This type of failure is difficult to detect because the Link-state LEDs for Ethernet links rely on the transmit side of the cable to detect a link. If a unidirectional failure on a link is suspected, it is usually required to go to the console or other management software and look at the packets received and transmitted for the port. A unidirectional port will have many packets transmitted but none received, or vice versa, for example.

Packet Corruption

Packet corruption can lead to the same type of failure. If a link is experiencing a high rate of physical errors, a large number of consecutive BPDUs can be dropped and a port in the blocking state would transition to the forwarding state. The blocking port would have to have the BPDUs dropped for 50 seconds (at the default settings) and a single BPDU would reset the timer. If the MAX AGE is set too low, this time is reduced.

Resource Errors

The DGS-3308FG/DGS-3308TG Layer 3 switch performs its switching and routing functions primarily in hardware, using specialized ASICs. STP is implemented in software and is thus reliant upon the speed of the CPU and other factors to

converge. If the CPU is over-utilized, it is possible that BPDUs may not be sent in a timely fashion. STP is generally not very CPU intensive and is given priority over other processes, so this type of error is rare.

It can be seen that very low values for the MAX AGE and the FORWARD DELAY can result in an unstable spanning tree. The loss of BPDUs can lead to data loops. The diameter of the network can also cause problems. The default values for STP give a maximum network diameter of about seven. This means that two switches in the network cannot be more than seven hops apart. Part of this diameter restriction is the BPDU age field. As BPDUs are propagated from the root bridge to the leaves of the spanning tree, each bridge increments the age field. When this field is beyond the maximum age, the packet is discarded. For large diameter networks, STP convergence can be very slow.

Identifying a Data Loop

Broadcast storms have a very similar effect on the network to data loops, but broadcast storm controls in modern switches have (along with subnetting and other network practices) have been very effective in controlling broadcast storms. The best way to determine if a data loop exists is to capture traffic on a saturated link and check if similar packets are seen multiple times.

Generally, if all the users of a given domain are having trouble connecting to the network at the same time, a data loop can be suspected. The port utilization data in the switch's console will give unusually high values in this case.

The priority for most cases is to restore connectivity as soon as possible. The simplest remedy is to manually disable all of the ports that provide redundant links. Disabling ports one at a time, and then checking for a restoration of the user's connectivity will identify the link that is causing the problem, if time allows. Connectivity will be restored immediately after disabling a data loop.

Avoiding Trouble

Know where the root is located.

Although the STP can elect a root bridge, a well-designed network will have an identifiable root for each VLAN. Careful setup of the STP parameters will lead to the selection of this best switch as the root for each VLAN. Redundant links can then be built into the network. STP is well suited to maintaining connectivity in the event of a device failure or removal, but is poorly suited to designing networks.

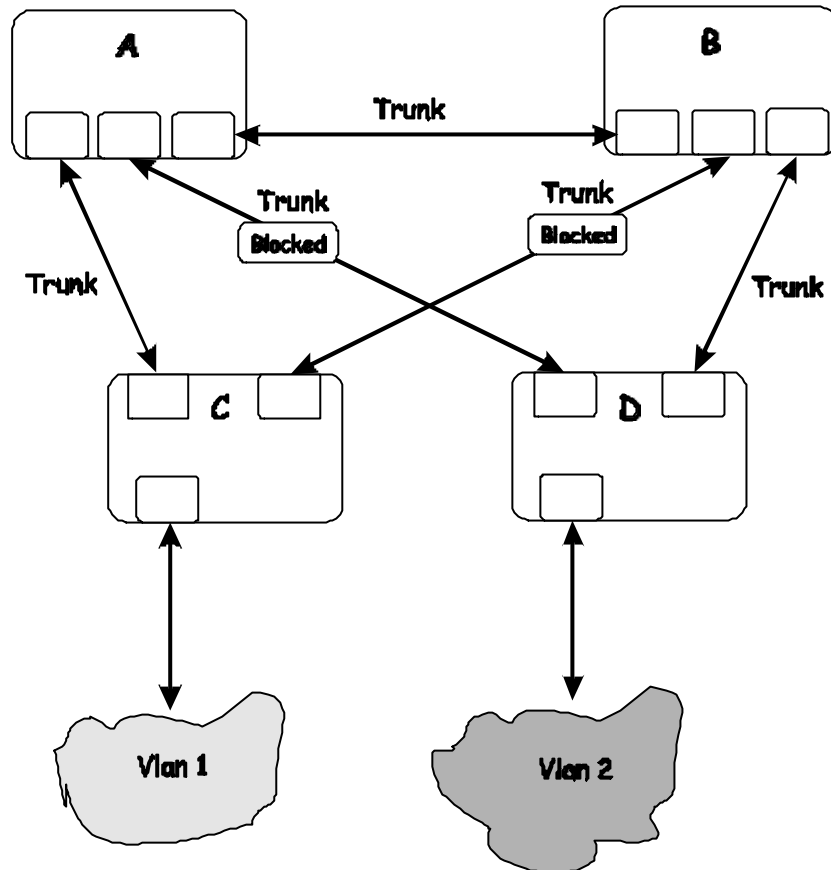
Know which links are redundant.

Organize the redundant links and tune the port cost parameter of STP to force those ports to be in the blocking state.

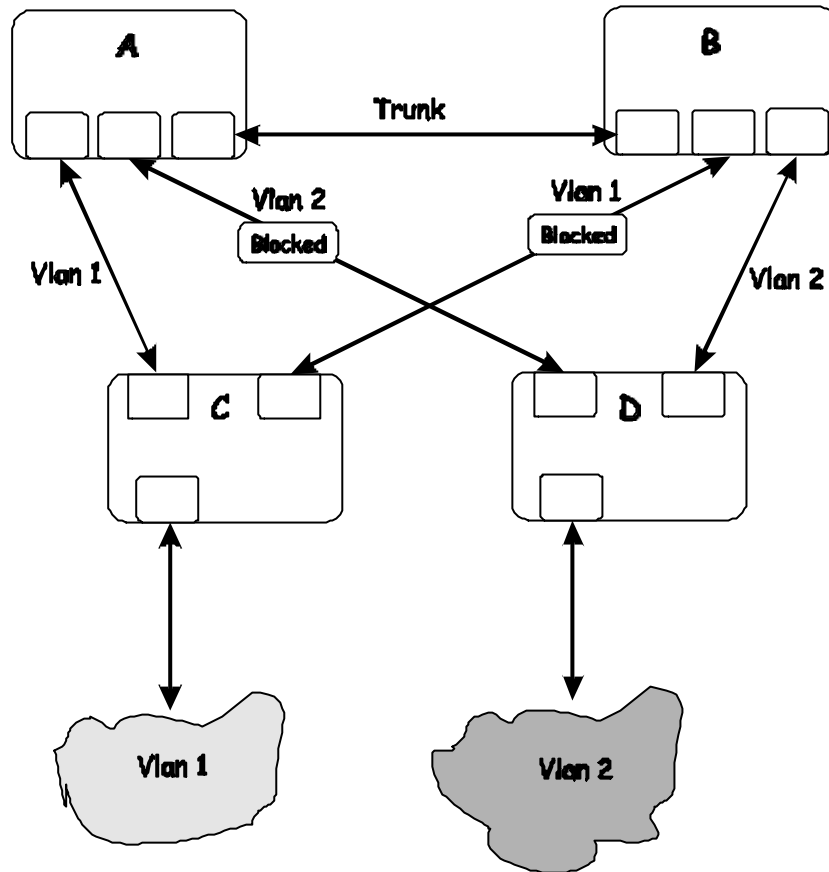
For each VLAN, know which ports should be blocking in a stable network. A network diagram that shows each physical loop in the network and which ports break which loops is extremely helpful.

Minimize the number of ports in the blocking state.

A single blocking port transitioning to the forwarding state at an inappropriate time can cause a large part of a network to fail. Limiting the number of blocked ports help to limit the risk of an inappropriate transition.



This is a common network design. The switches C and D have redundant links to the backbone switches A and B using trunks. Trunks, by default, carry all the VLAN traffic from VLAN 1 and VLAN 2. So switch C is not only receiving traffic for VLAN 1, but it is also receiving unnecessary broadcast and multicast traffic for VLAN 2. It is also blocking one port for VLAN 2. Thus, there are three redundant paths between switches A and B and two blocked ports per VLAN. This increases the chance of a data loop.



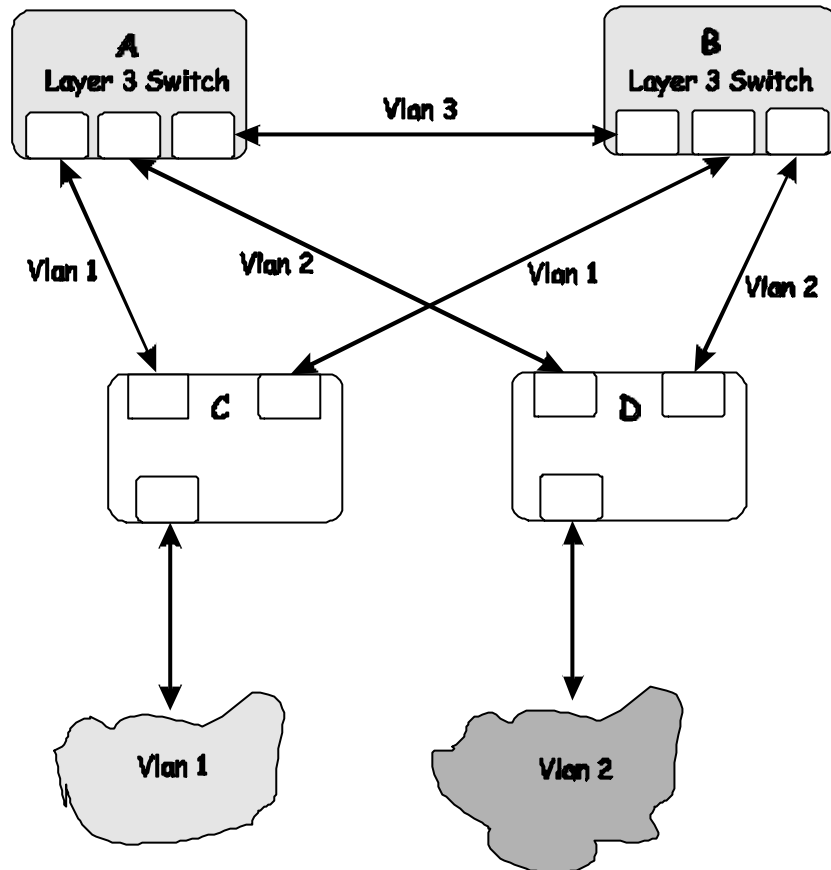
In this example, the VLAN definitions are extended to switches A and B. This gives only a single blocked port per VLAN and allows the removal of all redundant links by removing switch A or B from the network.

Impact of Layer 3 Switching.

The IP routing operational mode of the DGS-3308FG/DGS-3308TG Layer 3 switch can accomplish the following:

- Building a forwarding table, and exchanging information with its peers using routing protocols.
- Receiving packets and forwarding them to the correct interface based upon their destination address

With layer 3 switching, there is no performance penalty to introducing a routing hop and creating an additional segment of the network.



Using layer 3 switches and IP routing eliminates the need for STP port blocking because the packets are routed by destination addresses. The link redundancy remains, and relying on the routing protocols gives a faster convergence than with STP.

The drawback is that the introduction of layer 3 switching usually requires a new addressing scheme.

BRIEF REVIEW OF BITWISE LOGICAL OPERATIONS

AND

The logical AND operation compares 2 bits and if they are both "1", then the result is "1", otherwise, the result is "0".

	0	1
0	0	0
1	0	1

OR

The logical OR operation compares 2 bits and if either or both bits are "1", then the result is "1", otherwise, the result is "0".

	0	1
0	0	0
1	0	1

XOR

The logical XOR (exclusive OR) operation compares 2 bits and if exactly one of them is a "1", then the result is "1", otherwise the result is "0".

	0	1
0	0	1
1	1	0

NOT

The logical NOT operation simply changes the value of a single bit. If it is a "1", the result is "0", if it is a "0", the result is "1". This operation is carried out on a single bit.

0	1
1	0

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4. **What network operating system(s) does your organization use ?**
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5. **What network management program does your organization use ?**
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