PPPoE Ethernet to Single/Dual DS3/E3 Network Extender

March 1st, 2015

Operating Information

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E3Switch LLC
412 N Main St Ste 100
Buffalo, WY 82834 U.S.A.
http://www.ds3switch.com, support@ds3switch.com
TEL: +1-650-241-9941

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1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

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Attention:
This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

International Electrotechnical Commission (IEC) Statement

TABLE OF CONTENTS

Chapter 1: Description and Requirements

The E3Switch converters described herein are used individually to connect a customer's Ethernet LAN to an ISP offering PPP over full or fractional/subrate DS3. The LAN interface is PPPoE RJ45 100/1000BaseTX copper or SFP 1000BaseX fiber optic. The telecom link must be point-to-point and may support either framed or unframed data. For point-to-point links without the overhead of PPPoE, consult our other product documentation.

For ease of installation, the converter requires only minimal configuration setup via HTTP – typically setting the CRC-length and scrambling state – and will then work immediately upon connection of LAN and telecom cables.

The hot-swappable converter card draws a minimal amount of power and may be purchased in a variety of chassis. Standalone, single units ship in high-reliability, fan-free 1U chassis with rackmount brackets and are available in a 100-240VAC or a ±35-75 volt DC models. NEBS-III, redundant-power multicard chassis are available in 6-slot/1U and 20-slot/3U versions.

The converter contains both an 8P8C(RJ45) LAN port and an SFP LAN port, allowing either optical or copper LAN connectivity and HTTP or SNMP management of the converter either in-band or out-of-band.

Remote firmware upgrade to a converter is possible through either the LAN or DS3/E3.

The converter will buffer data, and implements flow-control and quality-of-service mechanisms to eliminate data loss.

The converter can generate its own DS3/E3 transmit clock or use the incoming DS3/E3 received clock.

The converter will pass all PPPoE error-free packets unaltered which do not exceed 9600 bytes in length. This included stacked-VLAN, QinQ frames and all modern router protocols.

The converter has been designed with attention paid to maximum throughput, minimum latency and minimal packet loss. The converter is often both a cost-effective and bandwidth-efficient alternative to routers. Even when connected to a LAN port from a router, eliminating a router telecom card can free up expensive, limited, router backplane bandwidth .

The converter is plug-and-play and can often be installed in several minutes. Network topologies and configuration settings of equipment connected to the converter can be complex, however, so additional time should be allocated to achieve a properly functioning system.

Chapter 2: Quick Set-up

- Attach E3Switch converter to DS3 BNC cable from ISP.
- Set CRC-length, scrambling-on/off, framing-type, DS3-rate via the HTTP LAN interface.
- Connect the PPPoE LAN-port of your equipment to either LAN port of the converter.

A connection from your PPPoE equipment to the ISP via username/password login **with a blank session name** should now be possible.

In detail:

Attach the converter to a power source. The front panel lights should illuminate. Green is normal; orange indicates an error.

Attach an Ethernet UTP5 cable from the PPPoE LAN port on your equipment to the RJ-45 LAN Port 2 of the converter. The converter can perform automatic cross-over vs straight-through cable adaptation. The LAN 2 light will change from orange to green if a properly negotiated Ethernet link has been established, but does not indicate PPPoE connection status. **The network equipment attached to the LAN port of the converter should be set for autonegotiation mode in order to allow the converter to negotiate a 100Mbit full-duplex connection.** Disabling autonegotiation or using old LAN equipment may result in the attached LAN equipment configuring to half-duplex mode, resulting in CRC errors and packet loss. Refer to the interoperability section of this document for more information. **To support PPPoE packets greater than 1500-bytes, the LAN connection must be GbE/GigE/1000BaseTX rate.**

Typically, set the PPPoE LAN port speed to GigE 1000Mbit/s to allow packet-lengths greater than 1500-bytes and up to 9600 bytes. **Set the management LAN port speed to 100BASE-TX to avoid DMA underflow/overflow errors of the converter**.

Attach two 75-ohm coaxial cables from either the Port 1 or Port 2 BNC connectors of the converter to the input and output connectors of your E3 or DS3 link. Once each converter is receiving a valid signal from the remote partner, the DS3/E3 Port LED will change from orange to green. This indicates that the converter has achieved proper sync lock with the remote ISP, but **does not indicate PPP session status or proper settings of CRC-length or scrambling or framing**.

Log in to the HTTP interface of the unit and set the CRC-length, scrambling, framing-type for the DS3 link. Refer to the management chapter of this manual for HTTP connection instructions. If these values have not been provided by the ISP, simply trying different combinations and monitoring the HTTP or SNMP error status counters of the unit will typically suffice.

At the bottom of the administration page, decide which LAN ports you intend for PPPoE data and which for HTTP/SNMP management of the converter and set appropriately. This is not mandatory, but you will see some management packets on the PPPoE LAN if that LAN port is not set for PPPoE only.

Connect the PPPoE LAN port of your local host or router to the E3Switch converter. The user-name and password for your PPPoE are provided by the ISP and are not relevant to the converter; however **the session-name for the PPPoE connection must be blank or empty**.

The HTTP status screen of the converter will indicate whether the PPPoE connection is active or unconnected. PPPoE packet exchange is indicated in the log found at the bottom of the HTTP settings screen. If the packet exchange appears valid but the link is terminated shortly thereafter, ensure that your PPPoE equipment's setting for username, password and IP address (fixed vs. DHCP) are correct. All can terminate a PPPoE session shortly after initiation. A valid PPPoE connection handshake appears as follows:

```
        Event age, most recent first...
           days   h:m:s     event
        Age    0d   0:00:02> DS3/E3 Ports OK
        Age    0d   0:00:03> PPP is UP - session ID 0xa1b5
        Age    0d   0:00:03>     Sending PADS session confirmation
        Age    0d   0:00:03> PPP PADR msg received from 00:13:46:88:09:3e
        Age    0d   0:00:03>     Sending PADO offer on 8P8C LAN Port2
        Age    0d   0:00:03> PPP PADI msg received from 00:13:46:88:09:3e
        Age    0d   0:00:03> SFP LAN Port1: UP
        Age    0d   0:00:04> 8P8C LAN Port2: UP
```

Refer to the management chapter of this manual if HTTP or SNMP operating statistics are desired or to change the default administrator password. **Changing the default password is highly recommended to allow ongoing configuration changes. When the password has not been changed from default, configuration changes are prohibited for security reasons after 5 minutes after any new power cycle. Simply power cycle again to change the password – if the unit is still in your possession and the link is not passing important data.**

There is no further configuration or setup required for the converter.

Chapter 3: Front Panel

Front Panel Indicators
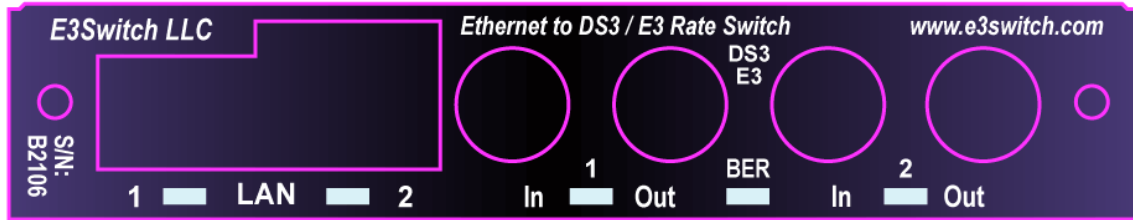
All Indicators:	Green indicates normal operation.
	Orange indicates an error condition.
	Black indicates a disabled port.

DS3/E3 1/2:   Green if the unit has synchronized to a valid carrier signal pattern from the remote unit and data can be transferred on the link. **Does not indicate PPP or PPPoE session status.**
Flashes black each time a packet is received on this port.
Orange indicates no valid connection or loss of receive sync with remote unit.
Flashes orange/green if incoming signal is OK but either looped back or PPP session down..
Flashes orange/black if link is OK but waiting in a configured return-to-service delay period.

BER: Green if OK.
Orange flash for each BPV bit error.
Orange steady for absence of DS3/E3 receive signal, loss of frame lock onto receive bit-stream, drive-level fault on transmit cable, or excessive receive bit errors.
Note: In a dual DS3/E3 unit, the BER will reflect the status of the operational link if one fails.

LAN1/2:   Green when a properly negotiated 100/1000BaseTX Full-Duplex or SFP LAN connection exists. **Does not indicate PPPoE session status.**
Flashes black each time a packet is received on this port.
Orange indicates no valid connection.
Flashes orange/black if in a configured "down if telecom down" mode.

Chapter 4: Remote Management HTTP and SNMP

Unit's IP/MAC Address

The source Ethernet MAC address of E3Switch converters is 00:50:C2:6F:xx:xx. The converter's current IP and MAC addresses are always both shown at the HTTP management screen.

The unit's management interface can be initially contacted at either its automatic link-local IP address e3switch.local as described below or at its initial numeric IP address described below. Note that after initial setup, an operator may have changed the contact IP address to a new value and the initial addresses below may not work. Prior to operator reconfiguration the unit will respond to HTTP, SNMP and ping requests to its initial IP address.

For initial communication with the converter, it may be necessary to set the network address of the host port communicating with the converter to 169.254.xxx.xxx with subnet mask 255.255.0.0. For security, routers are advised not to forward packets with these link-local IP addresses, so a direct connection is advised. Once initial contact has been established with the HTTP management interface of the converter, the converter's IP address can be set to a new, static value if desired.

If a unit's operator-configured IP address is lost or forgotten, it can be recovered as described later in this chapter.

Other than the e3switch.local addresses described below, all IP addresses used within the converter's management interface must be in xxx.xxx.xxx.xxx numeric format rather than a human-readable DNS-resolvable hostname.

Automatic Link-Local IP Address

E3Switch converters are shipped with an initial IP address that conforms to recent zero-configuration link-local standards. This allows multiple E3Switch converters on the same IP network to initialize with unique IP addresses without conflict and allows simple ping/HTTP/SNMP access to the converters using hostnames e3switch.local or e3switch-2.local,... provided that the free ZeroConf mDNS software has been installed on the machine attempting to communicate with the converter. **Do not prefix www.** prior to e3switch.local. www.e3switch.local will not work.

The converters negotiate between themselves to determine which converter is assigned name e3switch.local and which receives e3switch-2.local and so on. Since the assigned name will not necessarily be fixed to a particular converter after power cycles, the system manager will probably want to use/set the converter's numeric IP address sometime during or after initial installation.

Web descriptions are available for ZeroConf mDNS and Link-local IPV4LL ip addresses. Free ZeroConf software such as Bonjour for Windows or Avahi is available for Windows/Linux/Unix machines.

Initial Numeric IP Address

When received from the factory, the converter can also be contacted at its initial default IP numeric address which always takes the form 169.254.aa.bbb. Units can be initially contacted at this IP address where aa.bbb matches the serial number listed on the front label.

The converter's current IP and MAC addresses are both shown at the HTTP management screen.

Unknown IP Address Recovery

The following methods may be used to determine a converter's IP address if lost or forgotten. Note that once determined, management communication may only be possible from the same IP network if the converter's default router address is invalid.

Unplug all LAN and BNC cables from the converter and power cycle the unit. 30 seconds after power-up, the converter will begin blinking out its IP address on the leftmost LED. Each digit is counted up as an orange blink with a pause between digits and a short blink for a 0. A decimal in the IP address is indicated with a green blink. For example, <orange><orange><pause><short-orange><pause><green>... would be an IP address that begins "20."

For those with access to packet sniffers, upon power-up, the converter will broadcast several gratuitous ARP packets on its network ports which can be examined with a sniffer or packet monitoring software to determine a unit's IP address. The source Ethernet MAC address of such packets and E3Switch converters is 00:50:C2:6F:xx:xx. Tcpdump or Wireshark are two readily available software packages to examine network packets.

Additionally, examination of the MAC address table of an attached LAN switch or router may provide the IP address if the E3Switch MAC address prefix (00:50:C2:6F:xx:xx) can be located.

Management Passwords

The HTTP management statistics page is initially accessible without a password. The HTTP settings page is initially accessible within the first several minutes after power-up with username *admin* and no password. If the unit has not had its default password changed, after several minutes the settings page will be locked for security reasons. It is desirable to change the default password of the unit. For security reasons, changing the default password of the unit must be done within the first several minutes of power-up. If the HTTP management password is lost or forgotten, it may be reset by accessing the HTTP management settings within the first minute after power-up and with no BNC cables attached to the unit.

SNMP statistics may initially be accessed using the read-only community name *public*. Write-community names and variable access authorization may be set through the HTTP management interface.

Security

Please also refer to the password section above.

HTTP Interface Security

Access to the HTTP management interface statistics and settings pages can be selectively limited to users knowing the HTTP management password, which is transmitted securely on the network using MD5 encoding. New values of management settings, or modifications of the administrator password are not encrypted and are visible to users monitoring network packets, as is statistical data requested by an MD5 authorized user or any information visible on a HTTP page.

When logging out from any secure webpage, the browser window should always be closed! Browsers typically continue to send administrator credentials continuously even after apparent logout.

SNMP Security

The converter implements SNMPv2c, which is inherently an insecure protocol; however, the converter enhances security by implementing view-based access management (VACM), which can restrict read or write access to specific management settings and statistics. When shipped, the converter allows read access to "safe" SNMP statistics and prohibits read and write access to statistics and settings which could allow determination of network topology or interfere with normal link traffic. The VACM configuration can be updated through the HTTP management interface to meet the user's needs, and most SNMP variables can also be set through the HTTP management interface in a more secure manner than SNMP allows.

– SNMP VACM Security Warning –
As shipped, the default "safe_ro_view" is secure but not private.
View based access model VACM for SNMPv2c provides good restriction
of access to only specified statistics but no data privacy and
minimal user authentication. When a specific variable is enabled
for reading or writing, from a security perspective it should
be considered either public for reading or public for writing.
Alternatively, most configuration parameters can be set through
the HTTP password-protected interface which is secure.
Viewing snmpd.conf exposes it and community names to visibility by
3rd party network sniffers. All SNMPv2c data on the network
is visible. All community names can be "guessed" and, when used,
become visible to sniffers. Source IP addresses of requests
can be forged. Enabling a write community should be considered
insecure with respect to the specific view variables enabled.
Variables in the groups: interface, ds3, dot3 & mau, control the
link datapath; allowing write access allows disabling the link.
Specific variables disabled for all write users are secure.
Specific statistics disabled for all read users are invisible
and secure.

HTTP Management

The converter contains a comprehensive, user-friendly HTTP management interface which allows a manager to monitor bit-error-rates on the DS3/E3 link, lost packets, and user-friendly status messages at a single, color-coded HTTP screen. A screenshot is available at www.e3switch.com. Most settings that can be modified via SNMP can also be set through the HTTP interface in a more user-friendly manner.

Refer to the configuration section of this document for guidance on specific settings.

Event Log File

A timestamped log of operating status and events may be accessed at the HTTP management administration page.

Resetting

Two options for resetting the converter may be accomplished at the HTTP management administration page. A management software reset will reset counters, statistics, MIB variables, and management software of the converter without interrupting data flow across the link. A hardware reset will temporarily interrupt link data flow as if the converter had experienced a power cycle. For new functionality to take effect, a hardware reset is required after upgrading firmware but need not be initiated immediately. A software reset is not appropriate after upgrading firmware, as only the management CPU would be reset while the packet transfer CPU would be operating with the older, incompatible version of firmware.

SNMP

The converter contains an SNMP agent which can respond to version 1 and version 2c requests for network statistics from remote SNMP clients. The agent can also generate notifications of important network events such as when network ports go up/down or experience high error rates. These trap notifications can be sent to multiple hosts if desired, and using free or commercial software, the receiving hosts can log the notifications or even generate email or pager messages for network managers.

SNMPv2c is inherently an insecure protocol, so the converter implements VACM to restrict access to "safe" statistics and settings. Please refer to the security discussion section of this document.

SNMP configuration of various parameters such as community names and trap destinations is accessed through the HTTP management interface and is implemented as a configuration file having an snmpd.conf structure. Snmpd.conf is described by third parties in publicly available documents.

Statistics and settings accessible via SNMP are called MIB-variables and are organized in a hierarchical tree topology. The MIB variable trees implemented by the converter include recent versions of the DS3/E3, interface, MAU, dot3, and many of the typical IP-network MIB trees. The full list of MIB trees available is listed by viewing the system.sysORTable of the converter. As mentioned earlier, access to certain trees or variables is initially disabled for security reasons, but can be set as the user wishes through the VACM settings. The converter can typically return 1000 MIB variables per second in bulk requests and support SNMP response message sizes up to 5000 bytes.

Upgrading Firmware

For activation of additional capabilities of the converter, see the "Feature Activation" section. Feature upgrades do not necessarily require a firmware upgrade.

Firmware upgrades may be transferred to the converter via the LAN port. A hardware reset, which will interrupt link data flow for several seconds, will be required at some point after the transfer in order to begin using the new firmware. Instructions for performing the TFTP transfer are included with all firmware shipments. The most common source of problems when performing upgrades is attempting a TFTP transfer in ASCII or text mode rather than binary or image mode, resulting in a "too large" or "out of room" type TFTP error.

Feature Activation/Upgrade

For activation of additional capabilities of the converter after initial purchase, supply the factory with the serial number from the *front* of your converter (also shown at the HTTP management page for recent firmware) and purchase an alphanumeric "factory upgrade key" which is entered at the HTTP management screen.

Chapter 5: Operating Modes and Configuration

Telecom

There are several, low-level configuration settings for telecom ports:
- CRC-length (16bit, 32bit, or none)
- Scrambling (on or off)
- Rate (typically full rather than a sub-rate or fractional rate)
- E3 vs DS3
- cable length (for long DS3 runs only)
- M13 vs C-Bit (for DS3 only)
- Circuit ID message (for C-Bit only)
- Transmit clock source

Use a "DS3" configuration setting typically for North America, Japan, and South Korea; otherwise, "E3" speed.

Incorrect WAN settings will typically manifest in the errored-packet counts shown at the HTTP management screen of the converter.

The cable length setting will transmit a slightly stronger signal on long DS3 coax runs. The M13/C-Bit setting sets the AIC bit in DS3 frames to either 0 or 1. This bit is typically ignored by the DS3 carrier; however DS3 carrier equipment set to auto-sense the incoming DS3 framing type will need this setting to be correct.

Clock Source

The transmit clock source is typically "local" for both units. Certain DS3/E3 carrier equipment or optical converters require the same transmit clock in each direction; this may manifest itself as frame-slip errors. In such a case, set *one* unit to "loop" clock source. In very rare cases the carrier DS3/E3 equipment will generate the clock for the entire path, and each unit should be set to "loop". Setting both units to "loop" is typically inappropriate and can result in transmission failure if a master clock is not being generated by carrier equipment. Without a master clock, two units set in "loop" mode will wander to an unspecified clock speed, which is unlikely to meet DS3/E3 specifications.

Dual-channel DS3/E3 units allow Port 2 transmit clock speed to be derived from incoming Port 1 clock speed. This is an uncommon configuration requirement and should typically be avoided.

In the event of incoming clock loss, the transmit clock will automatically switch to a locally generated DS3/E3 clock source.

The receive clock speeds are shown at the bottom of the unit's HTTP management statistics page to assist timing diagnosis.

DS3 Circuit ID PMDL

DS3 Path Maintenance Data Link (PMDL) identification messages associated with C-Bit framed DS3 links can be received and transmitted if desired. Circuit ID messages convey human-readable, configurable, physical location information of the DS3 source equipment. These messages are transmitted in the C-Bits of the frame and do not decrease bandwidth available for data. PMDL Circuit ID messages facilitate confirmation of the data source when presented with a pair of unlabeled BNC cables.

Packet Flow

Port to Port Packet Flow

LAN-to-LAN

Certain firmware versions allow LAN-to-LAN packet flow to be enabled, if desired, in units where the second SFP/LAN port has been enabled/purchased. LAN-to-LAN unidirectional flow for monitoring may also be configured if desired.

LAN-to-LAN flow can result in dropped packets if the destination LAN port bandwidth setting is too low. An example would be 2x 44Mbit/s traffic from a dual-DS3 and > 12Mbit/s traffic from the other LAN port exceeding 100Mbit/s of a 100Base-TX LAN port which was receiving both DS3 and LAN-to-LAN traffic. The unit will attempt to preserve incoming DS3/E3 packets while dropping LAN-to-LAN packets in such an instance.

LAN-to-LAN should be used cautiously in combination with management or data-only LAN port settings. The blocking of a subset of traffic can result in network and spanning tree topologies which can be inappropriate or difficult to diagnose.

Forwarding

Once a PPPoE session is established, all PPPoE packets are passed from LAN to WAN unfiltered and unmodified. All PPP packets from the WAN are passed to the LAN likewise.

Loopback

Certain firmware versions allow packet flow from DS3 ports to LAN to be configured to automatically halt in certain situations in which the converter is receiving loopback data. *The automatic loopback traffic disable will only occur if the local converter has requested the remote to loopback. This occurs when an SNMP request sets the local converter dsx3SendCode variable to dsx3SendLineCode, which requests the remote converter to loopback DS3 data received. DS3 loopback initiated by the carrier or any source other than described above cannot be recognized as loopback data and the setting described will be irrelevant.*

LAN Port Settings

The following hardware for the two LAN ports exist on all converters shipped:

- GbE, GigE 1000Base-T for the RJ-45 LAN port2.
- Jumbo frames (9600 bytes).
- SFP LAN Port 1 which can accept optical or copper (100/1000) SFP transceivers.
- Either LAN port can be configured as a dedicated out-of-band management port if desired.

See the "Interoperability" section of this manual for information on packet lengths and detailed port connection/autonegotiation discussion.

The autonegotiation mode of the converter must match the autonegotiation mode of attached LAN equipment. If autonegotiation is enabled on the converter it must be enabled on the attached equipment. If disabled on the converter, it must be disabled on the attached equipment. This requirement is necessary to fulfill 802.3 standards which mandate a fallback to half-duplex operation if an autonegotiation mismatch exists. The converters require full duplex to operate.

LAN Port Speed

Typically, set the PPPoE LAN port speed to GigE 1000Mbit/s to allow packet-lengths greater than 1500-bytes and up to 9600 bytes. **Set the management LAN port speed to 100BASE-TX to avoid DMA underflow/overflow errors of the converter**.

1000Mbit/s is generally preferred over 100Mbit/s **on the PPPoE port only**, though it generates significantly more power-requirements, heat, and radiated electromagnetic noise even in the absence of packet flow. 1000Mbit/s may slightly reduce path latency, as an incoming LAN packet must be fully received before being forwarded to an outgoing port. The latency savings to receive or transmit a 1500-byte packet at 1000Mbit/s vs 100Mbit/s speed is 0.108 milliseconds (1500bytes/packet x 8bits/byte / (100Mbits/s) - 1500bytes/packet x 8bits/byte / (1000Mbits/s)).

1000Mbit/s LAN port speed may be desirable when one LAN port is configured to monitor the other LAN port in addition to receiving incoming DS3/E3 data. In such a case, the data rate that the LAN port is expected to transmit (the sum of all ports that could be a data source for the LAN port) may be greater than 100Mbit/s. The HTTP management statistics screen will show overflow errors if a port's data rates are exceeded.

Setting more than one LAN port to 1000Mbit/s is not recommended and may result in underflow/overflow errors in certain high packet load, memory-intensive cases.

Autonegotiation Problems

There are rare cases with older LAN equipment in which it may be necessary to disable autonegotiation. If crc-errors or short packet errors are seen in the management statistics of the LAN port, the attached LAN equipment has probably configured itself to half-duplex mode and colliding packets are being lost. In such a case, autonegotiation should be disabled on both the converter and the attached LAN equipment, with both forced to 100BaseTX full-duplex. Autonegotiation interoperability and standards were not well understood by the industry at the inception of 100BaseTX, resulting in some older LAN equipment not understanding the converter's autonegotiation advertisement of strictly full-duplex capability.

SFP Second LAN Port

The SFP LAN Port 1 hardware exists on all converters shipped and enables out-of-band management, through either LAN port, or fiber-optic LAN connections of 10km or more. Refer to interoperability section of this document for compatible SFP transceivers.

Dedicated Management/PPPoE-Data LAN Ports

Either LAN port may be configured to pass all packets to DS3/E3 or, selectively, to pass only management or only PPPoE data packets.

If a LAN port is configured for PPPoE-only packets, the unit will drop incoming management packets destined for an E3Switch MAC address. This provides a moderate level of security. These packets and management broadcast/multicast packets may not be forwarded to the second LAN if LAN-to-LAN traffic is configured.

VLAN

As shipped, the unit will accept management packets with any VLAN tags and attempt to respond to the same. For more robust performance, specific VLAN tag settings can be configured. These settings only apply to packets to and from the converter's management entity.

VoIP / Video or High-CoS Priority Frames

In certain firmware, receive queue space is reserved in the converter to allow frames with high 802.1p class-of-service (CoS) priority settings to bypass existing frames waiting to be transmitted to the DS3/E3. This allows voice, video and other high-priority traffic to experience low-latency transmission. Firmware allows the "high" CoS level to be configured. Most VoIP traffic is tagged at CoS 5 or 6, so level 5 is typically a good setting for the high-CoS value.

Port Auto-Disable and Return-to-Service Delay

In addition to manually configuring a port as disabled, the converter has the ability to delay a DS3/E3 port's return to service for a specified period of time after it has failed or disable a LAN port if both telecom links are down.

DS3/E3 Return to Service delay

The return-to-service delay prevents network topology thrashing if a telecom link is flapping up and down.

Some telecom carriers will interrupt service for 50msec, once per day as a link test. A configurable, failure-time setting to prevent such tests from triggering a link-down, retun-to-service delay.

To exit the return-to-service delay, power-cycle the converter or click the button which appears on the configuration HTTP screen of a converter that is in configuration delay.

LAN Auto-Disable

The LAN port can be configured to automatically disable itself when no telecom link exists. This setting is useful for attached LAN equipment which requires the LAN port to go down in order to understand that the path to the remote network is no longer available. Use this setting cautiously, as management of the converter will also no longer be possible through a disabled LAN port.

To exit the LAN-port-disabled condition, power-cycle the converter, which will allow communication with the converter for approximately one minute even if telecom ports are down.

Chapter 6: Interoperability

LAN

The LAN ports of the converter support, at a minimum, all 100BaseTX Full-Duplex Ethernet connections up to maximum line lengths and are set to auto-MDI/MDIX to automatically detect/correct crossover vs straight LAN cable and auto-negotiate full-duplex and pause frame modes with the attached LAN equipment.

The converter will pass all un-errored packets which do not exceed 1650 bytes in packet length (9600 with jumbo frames enabled). This length allows QinQ, stacked VLAN, and extended packet-length router protocols to be passed without concern. The management agent accepts and responds with packets having MTU of 1350 bytes in order to automatically allow room for security protocol overheads.

Autonegotiation problems

There are rare cases with older LAN equipment in which it may be necessary to disable autonegotiation. If crc-errors or short packet errors are seen in the management statistics of the LAN port, the attached LAN equipment has probably configured itself to half-duplex mode and colliding packets are being lost. In such a case, autonegotiation should be disabled on both the converter and the attached LAN equipment with both forced to 100BaseTX full-duplex. Autonegotiation interoperability and standards were not well understood by the industry at the inception of 100BaseTX, resulting in some older LAN equipment not understanding the converter's autonegotiation advertisement of strictly full-duplex capability.

It is highly desirable to leave autonegotiation enabled so that changing attached LAN equipment does not result in the new equipment defaulting to half-duplex if set to autonegotiate.

SFP LAN Port 1

This port is designed to be compatible with inexpensive, high-quality, copper or fiber-optic, SFP transceivers from Finisar, which allows LAN connections of 10km or more. Most other industry-standard SFP transceivers will work as well; however, fiber-optic features such as temperature and optical transmit/receive power and alarms will only be available if using Finisar transceivers. Non-Finisar copper, RJ45 SFP transceivers may only operate in 1000Base-T mode, while recommended transceivers from Finisar, and possibly Avago or 3Com will operate in 100Base-TX mode as well.

Pause Frames

Unless disabled in the settings or through autonegotiation, the converter sends pause command frames to attached LAN equipment when the converter's incoming LAN buffers become nearly full. The converter ignores pause command frames sent to it.

VoIP / Video or High-CoS Priority Frames

In certain firmware, receive queue space is reserved in the converter to allow frames with high 802.1p class-of-service (CoS) priority settings to bypass existing frames waiting to be transmitted to the DS3/E3. This allows voice, video and other high-priority traffic to experience low-latency transmission. Firmware allows the "high" CoS level to be configured.

Telecom/WAN

The converter can transmit over a variety of E3 or T3/DS3 links (with appropriate media converters) such as fiber optic, microwave radio, laser, copper, satellite, or a combination; however, the attachment interface is always via 75-ohm copper coaxial rather than optical. The point-to-point telecom link must be unchannelized, i.e., not subdivided into T1 or E1 channels. The telecom link may be either framed or unframed and supports both M13, M23, clear-channel, C-Bit, and G.751 framing. C-Bit framing is suggested for DS3 links.

Certain firmware allows subrate/fractional WAN connectivity.

Fiber/Copper Media Converters

Transition Networks DS3/E3 Coax to Fiber Media Converter, SCSCF3014-100 has been reported to lack the ability to properly maintain separate DS3/E3 transmit clock speeds in each direction and are not recommended. This problem typically manifests itself as frame slips or loss of telecom signal lock in one direction at a rapid, consistent periodic rate, which is proportional to the difference in clock speeds of each telecom direction. If such media converters are already in use, setting the DS3/E3 transmit clock source of *one* of the WAN units to "loop" may alleviate problems.

Routers and Switches

The configuration of routing tables of the PPPoE equipment attached to the E3Switch converter is beyond the scope of this document.

Chapter 7: Telecom Connections

Framing and Physical Link

The converter can transmit the LAN data over a variety of E3, T3/DS3 links (with the appropriate media converter) such as fiber optic, microwave radio, laser, copper, satellite, or a combination. The converter may be used with a standard (i.e., M13, M23, clear-channel, C-Bit or G.751) framed or unframed, E3 or T3/DS3 link with AMI and HDB3 or B3ZS encoding. The link must be unchannelized, i.e., not subdivided into T1/E1 channels. C-Bit framing is recommended for DS3 links. Newer firmware supports PMDL Circuit ID on C-Bit links.

Certain firmware supports sub-rate/fractional WAN.

Each converter generates the timing clock of its transmitted bit-stream, within E3 and T3/DS3 standards, either locally, or locked to either port's received bit-rate. The incoming clock rates are displayed at the unit's HTTP management page.

Telecom Cabling

For the E3 or T3/DS3 connection, two 75-ohm coaxial cables (one transmit and one receive) with BNC connectors are required at each end. It is important that 75-ohm cable be used and not 50-ohm cable. For long connections or in electrically noisy environments it may be important to use a high-quality 75-ohm

cable which will have more consistent shielding and conduction. The maximum length of each cable shall be 440 meters for E3 or 300 meters for T3/DS3, but the acceptable cable lengths of equipment attached to the converter must be met as well. For lengths over 135 meters, testing in field should be used to determine whether bit error rates are acceptable. Long cable lengths also require careful selection of cable type and attention to sources of external noise.

Third-party fiber to copper media converters can be used with the E3Switch converter to implement fiber-optic DS3/E3 links; however, refer to the interoperability section of this document for vendors to avoid.

Chapter 8: LAN Connections and Performance

LAN Ports

Each LAN port implements the following features to maximize LAN compatibility and link utilization and minimize packet loss:
- Autosense/Autoconfiguration/Autonegotiation with the attached LAN.
- 100Mbit/sec or 1000Mbit/s.
- Full-duplex LAN connection.
- Data buffering.
- Upstream pause-frame flow-control messaging.
- Quality of service high-priority queuing in certain firmware.
- 1650-byte packet acceptance (1350 for mgmt and 9600 for jumbo).

These features and their ramifications are discussed below in more detail.

Autonegotiation

The network equipment attached to the LAN port of the converter should be set for autonegotiation mode in order to allow the converter to negotiate a 100Mbit full-duplex connection.

There are rare cases with older LAN equipment in which it may be necessary to disable autonegotiation. If crc-errors or short packet errors are seen in the management statistics of the LAN port, the attached LAN equipment has probably configured itself to half-duplex mode and colliding packets are being lost. In such a case, autonegotiation should be disabled on both the converter and the attached LAN equipment, with both forced to 100BaseTX full-duplex. Autonegotiation interoperability and standards were not well understood by the industry at the inception of 100BaseTX, resulting in some older LAN equipment not understanding the converter's autonegotiation advertisement of strictly full-duplex capability.

It is highly desirable to leave autonegotiation enabled so that changing attached LAN equipment does not result in the new equipment defaulting to half-duplex if set to autonegotiate. Autonegotiation must always be enabled for 1000Mbit/s links.

LAN Cabling

It is important to use the correct cabling for proper operation. Use UTP Category 5 network cable with RJ-45 connectors for the LAN ports, and do not exceed 100 meters (328 feet) in length. Either a straight-through or crossover cable may be used.

LAN Buffering, Loading and Flow Control

This converter contains approximately 500kBytes of total packet buffer. Queue utilization can be monitored at the converter's statistics HTTP page, and buffer overflow will appear as "Rx oflow" errors at the same HTTP page.

If the converter's packet memory begins to fill up, the converter applies flow control techniques to the machines connected to its LANs rather than simply dropping incoming packets. For connected 100/1000BaseTX LANs the converter uses 802.3x flow control. Flow control creates a much more

efficient network by avoiding time-out requirements for packets that would otherwise be dropped during bursts of network traffic.

Unless disabled in the settings or during autonegotiation, the converter will transmit pause frames to attached LAN equipment when its buffer has reached approximately 60% capacity. During autonegotiation, the converter indicates to the attached equipment that it will ignore received pause frames.

If overflow errors appear for a 1000Mbit/s port at the statistics management page of the converter, confirm that the pause packet counter shown there is incrementing and that the attached LAN equipment can accept pause packets. If the overflow errors disappear when the LAN port speed is reduced to 100Mbit/s, it is possible that the attached LAN equipment is not receiving pause packets in time to interrupt large 1000Mbit/s traffic bursts. It may be necessary to operate at 100Mbit/s in this case, if packet loss during bursts is unacceptable.

LAN Packet Priority

LAN packets may optionally contain class of service (CoS) information (802.1p information), which may be used to specify packets that are time critical. In certain firmware, queue space is reserved in the converter to allow frames with a "high" 802.1p CoS priority setting to bypass existing frames waiting to be transmitted to the DS3/E3. This allows voice and other high-priority traffic to experience low-latency transmission.

TCP/IP and General Performance Tuning

In a TCP/IP environment, maximum performance across the E3, T3/DS3 link will be achieved by adjusting TCP/IP communication parameters of all LAN equipment attached to the converter including equipment attached indirectly via hubs, switches or bridges. It should be possible to achieve TCP/IP transfer rates within 5% of the theoretical maximum of 44Mbit/s for T3/DS3 or 34 Mbit/s for E3. The most important parameter to adjust for maximum performance is the TCP window size. A valuable TCP/IP performance testing tool called IPERF or JPERF (graphical version) and many excellent documents for setting TCP parameters are available online.

Chapter 9: DS3 Packets and Link Topology

Link Bit-Errors

The converters at each end of the link will maintain synchronization with each other even at very high DS3 bit-error rates. The converter will count and drop packets with FCS/CRC and length errors.

Chapter 10: Troubleshooting

General

Check the front panel lights and the HTTP log entries at the settings management web page of the unit. Check for orange status messages at the top of the HTTP status management web page of the unit and associated orange errored-packet counters.

A great deal of diagnostic information is available by accessing the HTTP management interface of the converter. Refer to the management section of this document for additional information.

The converter's *front panel lights can provide useful information* but are often under-utilized. They are simple to read and can indicate where a data connection is being lost. It can be very helpful to learn their meaning and monitor flashes as a packet is received at each port.

Incoming Circuit ID is shown at the top of the converter's HTTP management page for C-Bit DS3 links, facilitating confirmation of the remote data transmitter when presented with a pair of unlabeled BNC cables.

The Ethernet networks to which the converter connects are complex and may contain thousands of devices, each of which requires proper configuration and performance. As such, network configuration and topology issues dominate when problems arise. When troubleshooting, solutions can be reached more rapidly by remembering that *the most frequent cause of problems arises from improper network configurations*.

The next most frequent source of problems can arise from the E3, T3/DS3 *link configurations* or faults – in other words, the microwave radio or fiber optic link or the interface and associated configuration settings between such equipment and the converter. It is important that the telecom link is operating in unchannelized mode and that the circuit provider has not mixed C-Bit with M13 or auto-detect framing among the various intermediate pieces of equipment.

The next most frequent source of problems generally arises from *faulty cabling or connectors* or incorrect cable type. Cabling must be UTP5 or better for LAN and 75-Ohm rather than 50-Ohm for telecom. If long telecom cable runs or an electrically noisy environment exists, high-quality coaxial cable will be required.

Loopback of DS3

The converters have the ability to loopback DS3 data in several ways, including responding to SNMP requests and responding to FEAC loopback requests from intermediate carrier equipment. Remote loopback is supported. Local loopback is not implemented – being of limited utility.

Terminology

- *Remote Loopback*: A DS3 signal received at the "In" port of the converter is duplicated onto the converter's "Out" port. In this case the DS3 signal has traversed the entire link in both directions.
- *Local Loopback*: The DS3 signal being sent at the converter's "Out" port is duplicated in internal circuitry as if it is also being received at the "In" port.
- *FEAC Loopback Request*: FEAC command bits in a C-Bit-framed DS3 can instruct equipment receiving the DS3 signal to enter or leave remote loopback.

Limitations

Loopback is typically not the best way to diagnose or confirm a DS3 connection and can be misleading. Typically, the web management screen or SNMP interface of the converter provides a less misleading and more informative, sophisticated, detailed and user-friendly mechanism than a loopback test. Loopback testing is most useful for a carrier who has few other tools at their disposal and simply wants to see if sending a FEAC loopback request to something at the end of the line results in a loopback signal initiation. The carrier, however, doesn't even know if they are actually connected to an E3Switch unit in such a case – whether the loopback succeeds or fails.

- *Remote Loopback*: A carrier or test equipment requesting loopback of a remote device does not know what device they are connected to. The loopback may succeed or fail, but the carrier may not even be on the correct DS3 line. Little information is gained. If the carrier is receiving the E3Switch's PMDL ID signal, then the carrier has a better idea that they are on the correct receive DS3 line, but is the converter connected to the correct DS3 cable in the other direction? This can be better determined by examining the receive signal of the web status screen, including the PMDL section, of the remote converter.
- *Local Loopback*: This would mainly diagnose a broken receive DS3 path on the local converter board. Such failures are extremely rare. A much better test would be a physical local loopback using a short DS3 cable, since connectors and cables are a much more likely source of problems.
- *FEAC Loopback Requests*: All intermediate equipment on the DS3 path and the converter must be in C-Bit mode for a FEAC request to be forwarded and acted upon.

Alternatives to Loopback

Loopback is not typically the best way to diagnose or confirm a DS3 connection. Here are some alternatives:

- *Web Management*: User-friendly status messages will appear at the top of the converter's web management status page. Errors are highlighted in orange. Sophisticated error detection status, such as frame-slip, is only available through this interface mechanism.
- *SNMP Management*: 24 hours of historical DS3 operational data is maintained in the standard DS3 MIB-variable of the converter and can be accessed via any common SNMP client program.
- *Circuit ID*: For units/paths configured as a C-Bit-framed DS3, the incoming DS3 circuit ID of the remote sender is shown at the top of the web management status screen and details the remote equipment type, geographical location, IP address, location in rack, and whatever text the operator wishes to configure in the web management configuration settings of the remote unit. This confirms that a valid, framed receive DS3 signal from the correct remote equipment is being received.
- *Alarm Signals*: Standard telco alarm signals are shown in orange at the top of the web management status screen and indicate: loss of signal, loss of framing, remote loss of signal, in loopback mode. Some alarms are also available through the standard DS3 MIB-variables.
- *Bit Errors*: Both bit error rate and individual C-bit/P-bit and line-code error counts are shown at the top of the web management status screen to indicate a flaky link, even if alarm signals are OK. The error counts are also available through the standard DS3 MIB-variables. For a sophisticated user, these counts indicate where in the path the error is occurring.
- *Packet Audit*: The ingress/egress of every packet as it passes through the converter (or is dropped due to an error condition) is detailed at the top of the web management status screen. The "Clear Statistics" button zeros the values and allows a quick determination of where a link is failing – whether configuration or physical.
- *Clock Frequency*: High accuracy ingress/egress clock frequency statistics are shown at the bottom of the web management status screen.
- *SFP Optical LAN*: Receive and transmit power levels, alarms, warnings and temperature of SFP optical modules in the SFP LAN port of the converter are displayed at the bottom of the web management status screen. Finisar SFP transceivers are recommended as one source capable of reporting detailed operating statistics.

Initiating Loopback

- *FEAC Code Initiation*: A converter that is configured for DS3 C-Bit framing will respond to FEAC loopback commands that it receives from the incoming DS3 line. FEAC loopback requests can be generated by a carrier's intermediate DS3 equipment or by commanding the source converter to send a FEAC loopback request via an SNMP command as detailed below.
- *SNMP Direct Initiation*: First, write-access to the DS3 MIB, using VACM settings, must be enabled as described below. RFC3896 details the DS3 MIB configuration and status values available. The SNMP requests are issued by commonly available text or GUI SNMP-client programs which send requests to the converter's internal SNMP agent. An SNMP request can set the local converter's dsx3LoopbackConfig variable to dsx3LineLoop. The following sample SNMP command might be used to set DS3 Port 2 into remote loopback:
  - snmpset -v 1 -c public <ip-address-of-unit> .1.3.6.1.2.1.10.30.5.1.9.6 i 3
    (.6 is DS3 Port 2; .5 is DS3 Port 1, matching SNMP MIB-variable interface ID values)
  - snmpset -v 1 -c public <ip-address-of-unit> .1.3.6.1.2.1.10.30.5.1.9.6 i 1
    (terminates loopback as in dsx3NoLoop(1))
  - snmpget -v 1 -c public <ip-address-of-unit> .1.3.6.1.2.1.10.30.5.1.9.6
    (returns current loopback value of DS3 Port 2)
- *SNMP FEAC Initiation*: See above for VACM MIB write-access description first. An SNMP request can set the local converter's dsx3SendCode variable to dsx3SendLineCode, which requests the remote converter to loopback DS3 data received. The following sample SNMP

command could instruct a converter configured in C-Bit DS3 framing mode to send FEAC loopback commands to a remote converter:

- ▪ snmpset -v 1 -c public <ip-address-of-unit> .1.3.6.1.2.1.10.30.5.1.7.6 i 2
  (.6 is DS3 Port 2; .5 would be DS3 Port 1; dsx3SendLineCode(2) initiates FEAC loop cmd)
- ▪ snmpset -v 1 -c public <ip-address-of-unit> .1.3.6.1.2.1.10.30.5.1.7.6 i 4
  (sends FEAC disable loopback as in dsx3SendResetCode(4) NOT dsx3SendNoCode(1))
- ▪ snmpset -v 1 -c public <ip-address-of-unit> .1.3.6.1.2.1.10.30.5.1.7.6 i 1
  (Does nothing! Dsx3SendNoCode(1) will not terminate a loopback set up with a FEAC loopback request, just stop sending a request to begin one. Use dsx3SendResetCode(4))
- ▪ snmpget -v 1 -c public <ip-address-of-unit> .1.3.6.1.2.1.10.30.5.1.7.6
  (returns current value for DS3 Port 2)

- Upon successful loopback initiation, the web management status screen of the converter will also indicate that a DS3 line is in loopback and testing administrative mode.

- *VACM Settings for SNMP DS3 MIB access*: The SNMP area of the web management configuration screen of the converter allows an operator to grant write-access to specific SNMP MIB variables. Press "Login to view sensitive SNMP community/security information" then add the following line exactly (or a more secure one):
  authcommunity read,write public default .1.3.6.1.2.1.10.30.5.1
  to the "Access Rights – snmpd.conf " section, submit changes, and confirm error-free in the "Status – snmpd.conf " section. Remember to remove this line when done testing to maintain a completely secure system. This enables the configuration and loopback sections of the DS3 MIB using community name public for all IP hosts.

Performance

Performance issues are addressed in the previous chapter.

Interoperability

The interoperability section of this manual should be reviewed to ensure that appropriate equipment is connected to the converter. Connected LAN equipment should adhere to 802.3 standards, and connected telecom equipment should be in unchannelized mode, i.e., not broken into T1 or E1 channels.

Laboratory Testing

The PPPoE connection to a converter may be tested before introducing a complicated E3 or T3/DS3 link. The DS3 link does not have to be present to confirm a successful PPPoE connection via the LAN port and the status and log messages of the converter's HTTP interface.

Pinging

Ping is not reliable. The protocol which ping programs use does not guarantee delivery of the data packets. **Ping programs from major software and hardware corporations are known to contain bugs, both in packet content and function**. Generally, however, nearly all of the ping packets on a test network that is not over-loaded should get through; if fewer are received, there is probably a problem.

The ping program is a useful, simple test for a TCP/IP Ethernet network. It is a program that sends a data packet from a source machine to a destination machine, which then returns a response packet. There is a plethora of information about ping and the free public-domain ping utilities available. Ping is often supplied as a standard operating system utility, and often the command "ping" followed by the destination machine's IP address or hostname is all that is required to be typed at the source machine's command line.

The default ping generates approximately one 64-byte packet per second. This is not a robust test. If convenient, locate a ping program or set command line parameters to generate perhaps 50 pings per second and try both small packets and large 1400-byte packets. Be aware that packets larger than 1400 bytes sometimes uncover bugs in the software of ping programs.

Step-by-Step Diagnosis

This section assumes that communication between two machines at opposite ends of the E3, T3/DS3 link (herein the link) is failing. If this is a test in the laboratory or without a telecom link present, be sure to read the previous "Laboratory Testing" section first.

1. If access to the HTTP management interface of the converter is possible, many useful status messages will be displayed. Typically, any message highlighted in orange should be of concern. Error counters are of lesser concern if they are not incrementing, and some link errors would be normal as link cables are initially connected.

2. *The DS3/E3* **BER** *light of the converter should be illuminated and green*. This indicates that a valid, DS3/E3 waveshape is being received without bit errors and with proper framing. Refer to the front panel section of this document for other light colors.

    The DS3/E3 **port** *light of the converter should be illuminated and green*. This indicates that a valid, framed carrier signal and sync is being received from a remote E3Switch converter. Refer to the front panel section of this document for other light colors.

    If orange, data will not be received by the local converter and the loss of data is occurring on the link between the converters. Check that the incoming circuit ID shown at the top of the converter's HTTP management page matches the circuit ID being transmitted by the remote converter as shown at the remote converter's HTTP management settings page (only applies if framing is C-Bit DS3 and firmware since November 2009 exists in units at each end of the link).

    If flashing orange/green, the link may be in loopback as indicated by the HTTP management status page.

3. If the ISP indicates it is not receiving a valid DS3 from the E3Switch unit, check the TX path starting at the local unit. Ensure the carrier believes the link is set up in unchannelized mode (not subdivided into T1 or E1 channels). Either M13 or C-Bit framing is fine but the configuration page setting of each converter should match and the carrier should have consistent framing settings on intermediate equipment – not mixed among M13 and C-Bit or autoconfigure.

    If flashing orange/black, the link is in a configured return-to-service delay mode as discussed elsewhere.

4. CRC-length, scrambling, subrate/fractional settings must be consistent between the E3Switch and the ISP. Inconsistent settings will not show up as DS3 line errors at the HTTP status screen of the converter, but may show up as CRC, or length packet errors at the status screen, and may result in an apparently successful PPPoE session initiation being terminated shortly thereafter when PPP logon or IP address negotiation fails between the PPPoE user-equipment and the ISP.

5. The user-name and password for your PPPoE are provided by the ISP and are not relevant to the converter; however **the session-name for the PPPoE connection must be blank or empty**.

    The HTTP status screen of the converter will indicate whether the PPPoE connection is active or unconnected. PPPoE packet exchange is indicated in the log found at the bottom of the HTTP settings screen. If the packet exchange appears valid but the link is terminated shortly thereafter, ensure that your PPPoE equipment's setting for username, password and IP address (fixed vs. DHCP) are correct. All can terminate a PPPoE session shortly after initiation. A valid PPPoE connection handshake appears as follows:

```
Event age, most recent first...
    days   h:m:s     event
Age   0d  0:00:02> DS3/E3 Ports OK
Age   0d  0:00:03> PPP is UP - session ID 0xa1b5
Age   0d  0:00:03>     Sending PADS session confirmation
Age   0d  0:00:03> PPP PADR msg received from 00:13:46:88:09:3e
Age   0d  0:00:03>     Sending PADO offer on 8P8C LAN Port2
Age   0d  0:00:03> PPP PADI msg received from 00:13:46:88:09:3e
Age   0d  0:00:03> SFP LAN Port1: UP
Age   0d  0:00:04> 8P8C LAN Port2: UP
```

6. *Ensure a proper LAN cable is being used*. Straight-through or crossover cabling is acceptable. The LAN light of the converter port to which any LAN is attached should be illuminated and green. If not, ensure that the attached equipment is set for autonegotiation and can accept 100BaseTX Full-Duplex links. Refer to front panel section of this document for other LAN light colors.

7. The network equipment attached to the LAN port of the converter should be set for autonegotiation mode in order to allow the converter to negotiate a 100Mbit full-duplex connection. Forcing either the converter's or attached equipment's LAN port to 100Mbit full-duplex may not allow the proper autonegotiation and LAN connection to occur. There are rare cases with older LAN equipment in which it may be necessary to disable autonegotiation. **If crc-errors or short packet errors are seen in the management statistics of the LAN port, the attached LAN equipment has probably configured itself to half-duplex mode and colliding packets are being lost**. In such a case, autonegotiation should be disabled on **both** the converter and the attached LAN equipment with both forced to 100BaseTX full-duplex. Autonegotiation interoperability and standards were not well understood by the industry at the inception of 100BaseTX, resulting in some older LAN equipment not understanding the converter's autonegotiation advertisement of strictly full-duplex capability.

8. If ping is available, ping from the local machine to a machine on the same local LAN. Then ping to the machine or router, on the same local LAN, that is directly connected to the converter. Then ping to the machine or router, on the remote LAN, that is directly connected to the remote converter. Then ping to another machine on the remote LAN. During pinging, attempt to generate high traffic loading on the network.

9. Try different types of communication with the remote machine. Some examples might be a ping, a file transfer, a telnet connection if appropriate, a HTTP page viewing if appropriate, a "find" remote computer if appropriate. If some work and some do not but those that do, work consistently, there is possibly a network configuration issue.

10. Monitor lights during packet transmission:
    - With LANs attached, verify, perhaps using pings, that data packets generated by a local machine cause the converter's light of the connected LAN port to blink. If not, determine if there is an intermediate router or piece of equipment that is not properly forwarding the data packets to the converter. Examine the Link/Activity light on the source machine and any intermediate machines to ensure they behave properly (usually flicker) as well.
    - If the local LAN light blinks with each packet, next verify that the packet traverses the link by monitoring the DS3 Port light at the remote converter. If the remote DS3 Port light does not blink, there is either a link malfunction or an interface configuration problem or failure between the converter and the link. Perhaps change 75-ohm cables. Ensure the link is delivering unchannelized AMI HDB3 or B3ZS data to the converter. Ensure this configuration is proper at **both** ends of the link.
    - If the remote DS3 Port light blinks, attempt to locate the Link/Activity light on the destination machine. Ensure that it flickers. If not, the problem may be with an intermediate router or hub or converter intercepting the packet.

11. Perform the prior examinations but in the reverse direction – from the remote machine back to the local machine.

12. Enlist the aid of a sniffer program to view at the source and destination machines exactly what data packets are being sent and received. Free public-domain programs such as Wireshark are readily available.

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Chapter 12: Technical Specifications and Standards

General

E3Switch often provides custom hardware and software solutions to meet requirements not shown below.

Indicators:	LED – LAN Status/Rx; Telcom Status/Rx; Bit Error.
User Data Rate:	Single: DS3/T3: **43.4 Mbit/s**; E3: **33.2 Mbit/s**.
Aggregate Data Rate:	DS3/T3: 44.736 Mbit/s; E3: 34.368 Mbit/s.
Management:	**SNMP**v2c with VACM View-Based Access Control; **HTTP** comprehensive web interface; **in-band** through any port or **out-of-band**.
LAN:	100Base-TX to 1650 bytes (9600 byte and 1000Base-T options) – VLAN QinQ – 1/2MByte buffers, SFP copper/optical available
VoIP/Video:	In certain firmware, **Dedicated VoIP queue** for low-latency high-CoS 802.1p VoIP/video processing
Firmware Upgrades:	

Network/Link

Total Path Latency:	Through a single unit: 0.035ms/0.180ms (60/1518-bytes GbE) – 0.080ms/0.230ms (100Base-TX)
Path Throughput:	39,300 packets/sec simultaneously each direction, or 78,600 in asymmetric unidirectional use.
DS3/E3 Frame Format:	C-Bit / M13 / M23 / G.751 – HDB3/B3ZS – Unchannelized (no T1/DS1/E1) or unframed. PMDL Circuit ID for C-Bit links. Subrate/fractional in some firmware.
DS3/E3 Waveshape Compliance:	ANSI T1.102-1993, Telcordia TR-NWT-000499 and GR-253-CORE, ITU-T G.703.
DS3/E3 Cabling:	DS3/T3: 300 meters; E3: 480 meters to radio/CSU; BNC – 75ohm one rx, one tx.
DS3/E3 Frame Lock:	250ms typical lock time. Lock maintained up to 10^{-2} BER typically.
LAN Layer-1:	100/1000BaseTX full duplex – Autoneg/Auto-MDIX correction; 1000Base-X optical or copper SFP
LAN Layer-2:	802.3x flow-control; 802.1p CoS/priority for VoIP; 1650-byte packets (9600 for jumbo option); Transparent VLAN; QinQ.
Packet Priority:	Separate high-priority queue for 802.1p priority packets (i.e. VoIP/video) in some firmware.

Mechanical/Electrical

Dimensions (WxLxH):	Standalone: 4.75" wide 1U with 19" rackmount brackets (120mm x 215mm x 38mm (4.75" x 8.5" x 1.5"); 6-slot/1U and 20-slot/3U NEBS-III redundant power chassis available.
Weight:	1 kg / 2 lbs.
Power:	100-240VAC or ±35-75VDC – 6 Watts. **Redundant power** chassis available.
Power Connector:	VAC: IEC connector. VDC: Screw terminal.
LAN Connectors:	RJ-45 and SFP port.
DS3/E3 Connectors:	Two 75-ohm BNC – one rx, one tx; Second optional T3/E3/DS3 channel.

Environmental

Operating Temperature:	0° C to 50° C (30° F to 122° F); Storage Temperature: -20° C to 70° C (-4° F to 158° F)
Operating Humidity:	10% to 90% – Non-Condensing; Storage Humidity: 5% to 95% – Non-Condensing

Regulations

RFI/EMI/RoHS:	FCC Part 15, Class A; EMC Directive (89/336/EEC) (CE Mark); EN55022, Class A; EN55082-1; AS/NZS 3548 (C-Tick Mark); ICES-003, Class A; VCCI, Class A; RoHS Compliant and others.

For More Information:

UNITED STATES (Worldwide):	**E3Switch LLC**	**http://www.e3switch.com**
	412 N Main St Ste 100	**specs@e3switch.com**
	Buffalo, WY 82834, U.S.A.	**Tel: +1-650-241-9941**