TigerAccess™ EE

6-Band VDSL2 Switch

- ◆ 16 VDSL Downlink Ports (1 RJ-21 Connector)
- ◆ 2 Gigabit Ethernet Combination Ports (RJ-45/SFP)
- ◆ 1 Fast Ethernet Management Port (RJ-45)
- ◆ Non-blocking switching architecture
- ◆ Spanning Tree Protocol, RSTP, and MSTP
- ◆ Up to 12 LACP or static 8-port trunks
- ◆ Layer 2/3/4 CoS support through eight priority queues
- ◆ Layer 3/4 traffic priority with IP Precedence and IP DSCP
- ◆ Full support for VLANs with GVRP
- ◆ IGMP multicast filtering and snooping
- ◆ Manageable via console, Web, SNMP/RMON
- ◆ Security features: ACL, RADIUS, 802.1x
- ◆ VDSL line configuration using Long-Reach Ethernet (LRE) commands, line profiles, and alarm profiles

SMC
N e t w o r k s®

Installation Guide

SMC7816M/VSW

TigerAccess™ EE Installation Guide

From SMC's Tiger line of feature-rich workgroup LAN solutions

SMC® **Networks**

Trademarks:

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* SMC will provide warranty service for one year following discontinuance from the active SMC price list. Under the limited lifetime warranty, internal and external power supplies, fans, and cables are covered by a standard one-year warranty from date of purchase.

COMPLIANCES

FCC - Class A

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

You may use unshielded twisted-pair (UTP) for RJ-45 connections - Category 3 or better for 10 Mbps connections, Category 5 or better for 100 Mbps connections, Category 5, 5e, or 6 for 1000 Mbps connections. For fiber optic connections, you may use 50/125 or 62.5/125 micron multimode fiber or 9/125 micron single-mode fiber.

FCC - Part 68

This equipment complies with Part 68 of FCC Rules. On the base unit of this equipment is a label that contains, among other information, the FCC Registration Number and Ringer Equivalence Number (REN) for this equipment. If requested, this information must be given to the telephone company.

This equipment uses the following USOC jacks: RJ-21.

The REN is useful to determine the quantity of devices you may connect to your telephone line and still have those entire devices ring when your telephone number is called. In most, but not all areas, the sum of the REN of all devices connected to one line should not exceed five (5.0). To be certain of the number of devices you may connect to you line, as determined by the REN, you should contact your local telephone company to determine the maximum REN for your calling area.

If your equipment causes harm to the telephone network, the telephone company may discontinue your service temporarily. If possible, they will notify you in advance. But if advance notice is not practical, you will be notified as soon as possible. You will be informed of your right to file a complaint with the FCC. Your telephone company may make changes in its facilities, equipment, operations or procedures that could affect the proper functioning of your equipment. If they do, you will be notified in advance to give you an opportunity to maintain uninterrupted telephone service.

If you experience trouble with this telephone equipment, please contact please contact our company at the numbers shown on back of this manual for information on obtaining service or repairs. The telephone company may ask that you disconnect this equipment from the

network until the problem has been corrected or until you are sure that the equipment is not malfunctioning.

This equipment may not be used on coin service provided by the telephone company. Connection to party lines is subject to state tariffs.

Industry Canada - Class A

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus as set out in the interference-causing equipment standard entitled "Digital Apparatus," ICES-003 of the Department of Communications.

Cet appareil numérique respecte les limites de bruits radioélectriques applicables aux appareils numériques de Classe A prescrites dans la norme sur le matériel brouilleur: "Appareils Numériques," NMB-003 édictée par le ministère des Communications.

CE Mark Declaration of Conformance for EMI and Safety (EEC)

SMC contact for these products in Europe is:

> SMC Networks Europe,
> Edificio Conata II,
> Calle Fructuós Gelabert 6-8, 2º, 4ª,
> 08970 - Sant Joan Despí, Barcelona, Spain.

This information technology equipment complies with the requirements of the Council Directive 89/336/EEC on the Approximation of the laws of the Member States relating to Electromagnetic Compatibility and 73/23/EEC for electrical equipment used within certain voltage limits and the Amendment Directive 93/68/EEC. For the evaluation of the compliance with these Directives, the following standards were applied:

RFI Emission:	• Limit class A according to EN 55022:1998
	• Limit class A for harmonic current emission according to EN 61000-3-2/1995
	• Limitation of voltage fluctuation and flicker in low-voltage supply system according to EN 61000-3-3/1995
Immunity:	• Product family standard according to EN 55024:1998
	• Electrostatic Discharge according to EN 61000-4-2:1995 (Contact Discharge: ±4 kV, Air Discharge: ±8 kV)
	• Radio-frequency electromagnetic field according to EN 61000-4-3:1996 (80 - 1000 MHz with 1 kHz AM 80% Modulation: 3 V/m)
	• Electrical fast transient/burst according to EN 61000-4-4:1995 (AC/DC power supply: ±1 kV, Data/Signal lines: ±0.5 kV)

- Surge immunity test according to EN 61000-4-5:1995
  (AC/DC Line to Line: ±1 kV, AC/DC Line to Earth: ±2 kV)

- Immunity to conducted disturbances, Induced by radio-frequency
  fields: EN 61000-4-6:1996 (0.15 - 80 MHz with
  1 kHz AM 80% Modulation: 3 V/m)

- Power frequency magnetic field immunity test according to
  EN 61000-4-8:1993 (1 A/m at frequency 50 Hz)

- Voltage dips, short interruptions and voltage variations immunity test
  according to EN 61000-4-11:1994 (>95% Reduction @10 ms, 30%
  Reduction @500 ms, >95% Reduction @5000 ms)

LVD: • EN 60950-1:2001

Warning: Do not plug a phone jack connector in the RJ-45 port. This may damage this device.

Attention: Les raccordeurs ne sont pas utilisés pour le système téléphonique!

Safety Compliance

Warning: Fiber Optic Port Safety

| CLASS I |
| LASER DEVICE |

When using a fiber optic port, never look at the transmit laser while it is powered on. Also, never look directly at the fiber TX port and fiber cable ends when they are powered on.

Avertissment: Ports pour fibres optiques - sécurité sur le plan optique

| DISPOSITIF LASER |
| DE CLASSE I |

Ne regardez jamais le laser tant qu'il est sous tension. Ne regardez jamais directement le port TX (Transmission) à fibres optiques et les embouts de câbles à fibres optiques tant qu'ils sont sous tension.

Warnhinweis: Faseroptikanschlüsse - Optische Sicherheit

| LASERGERÄT |
| DER KLASSE I |

Niemals ein Übertragungslaser betrachten, während dieses eingeschaltet ist. Niemals direkt auf den Faser-TX-Anschluß und auf die Faserkabelenden schauen, während diese eingeschaltet sind.

PSE Alarm

本製品に同梱いたしております電源コードセットは、
本製品専用です。本電源コードセットは、本製品以外の
製品並びに他の用途でご使用いただくことは出来ません。
製品本体に同梱された電源コードセットを利用し、他製品
の電源コードセットを使用しないで下さい。

Power Cord Safety

Please read the following safety information carefully before installing the switch:

Warning: Installation and removal of the unit must be carried out by qualified personnel only.

- The unit must be connected to an earthed (grounded) outlet to comply with international safety standards.
- Do not connect the unit to an A.C. outlet (power supply) without an earth (ground) connection.
- The appliance coupler (the connector to the unit and not the wall plug) must have a configuration for mating with an EN 60320/IEC 320 appliance inlet.
- The socket outlet must be near to the unit and easily accessible. You can only remove power from the unit by disconnecting the power cord from the outlet.
- This unit operates under SELV (Safety Extra Low Voltage) conditions according to IEC 60950. The conditions are only maintained if the equipment to which it is connected also operates under SELV conditions.

France and Peru only

This unit cannot be powered from IT† supplies. If your supplies are of IT type, this unit must be powered by 230 V (2P+T) via an isolation transformer ratio 1:1, with the secondary connection point labelled Neutral, connected directly to earth (ground).

† Impédance à la terre

Important! Before making connections, make sure you have the correct cord set. Check it (read the label on the cable) against the following:

Power Cord Set	
U.S.A. and Canada	The cord set must be UL-approved and CSA certified.
	The minimum specifications for the flexible cord are: - No. 18 AWG - not longer than 2 meters, or 16 AWG. - Type SV or SJ - 3-conductor
	The cord set must have a rated current capacity of at least 10 A
	The attachment plug must be an earth-grounding type with NEMA 5-15P (15 A, 125 V) or NEMA 6-15P (15 A, 250 V) configuration.
Denmark	The supply plug must comply with Section 107-2-D1, Standard DK2-1a or DK2-5a.
Switzerland	The supply plug must comply with SEV/ASE 1011.
U.K.	The supply plug must comply with BS1363 (3-pin 13 A) and be fitted with a 5 A fuse which complies with BS1362.
	The mains cord must be <HAR> or <BASEC> marked and be of type HO3VVF3GO.75 (minimum).

Power Cord Set (Continued)	
Europe	The supply plug must comply with CEE7/7 ("SCHUKO").
	The mains cord must be <HAR> or <BASEC> marked and be of type HO3VVF3GO.75 (minimum).
	IEC-320 receptacle.

Veuillez lire à fond l'information de la sécurité suivante avant d'installer le Switch:

AVERTISSEMENT: L'installation et la dépose de ce groupe doivent être confiés à un personnel qualifié.

• Ne branchez pas votre appareil sur une prise secteur (alimentation électrique) lorsqu'il n'y a pas de connexion de mise à la terre (mise à la masse).
• Vous devez raccorder ce groupe à une sortie mise à la terre (mise à la masse) afin de respecter les normes internationales de sécurité.
• Le coupleur d'appareil (le connecteur du groupe et non pas la prise murale) doit respecter une configuration qui permet un branchement sur une entrée d'appareil EN 60320/IEC 320.
• La prise secteur doit se trouver à proximité de l'appareil et son accès doit être facile. Vous ne pouvez mettre l'appareil hors circuit qu'en débranchant son cordon électrique au niveau de cette prise.
• L'appareil fonctionne à une tension extrêmement basse de sécurité qui est conforme à la norme IEC 60950. Ces conditions ne sont maintenues que si l'équipement auquel il est raccordé fonctionne dans les mêmes conditions.

France et Pérou uniquement:

Ce groupe ne peut pas être alimenté par un dispositif à impédance à la terre. Si vos alimentations sont du type impédance à la terre, ce groupe doit être alimenté par une tension de 230 V (2 P+T) par le biais d'un transformateur d'isolement à rapport 1:1, avec un point secondaire de connexion portant l'appellation Neutre et avec raccordement direct à la terre (masse).

Cordon électrique - Il doit être agréé dans le pays d'utilisation	
Etats-Unis et Canada:	Le cordon doit avoir reçu l'homologation des UL et un certificat de la CSA.
	Les spécifications minimales pour un cable flexible sont AWG No. 18, ouAWG No. 16 pour un cable de longueur inférieure à 2 métres. - type SV ou SJ - 3 conducteurs
	Le cordon doit être en mesure d'acheminer un courant nominal d'au moins 10 A.
	La prise femelle de branchement doit être du type à mise à la terre (mise à la masse) et respecter la configuration NEMA 5-15P (15 A, 125 V) ou NEMA 6-15P (15 A, 250 V).
Danemark:	La prise mâle d'alimentation doit respecter la section 107-2 D1 de la norme DK2 1a ou DK2 5a.
Suisse:	La prise mâle d'alimentation doit respecter la norme SEV/ASE 1011.
Europe	La prise secteur doit être conforme aux normes CEE 7/7 ("SCHUKO") LE cordon secteur doit porter la mention <HAR> ou <BASEC> et doit être de type HO3VVF3GO.75 (minimum).

Bitte unbedingt vor dem Einbauen des Switches die folgenden Sicherheitsanweisungen durchlesen:

WARNUNG: Die Installation und der Ausbau des Geräts darf nur durch Fachpersonal erfolgen.

- Das Gerät sollte nicht an eine ungeerdete Wechselstromsteckdose angeschlossen werden.
- Das Gerät muß an eine geerdete Steckdose angeschlossen werden, welche die internationalen Sicherheitsnormen erfüllt.
- Der Gerätestecker (der Anschluß an das Gerät, nicht der Wandsteckdosenstecker) muß einen gemäß EN 60320/IEC 320 konfigurierten Geräteeingang haben.
- Die Netzsteckdose muß in der Nähe des Geräts und leicht zugänglich sein. Die Stromversorgung des Geräts kann nur durch Herausziehen des Gerätenetzkabels aus der Netzsteckdose unterbrochen werden.
- Der Betrieb dieses Geräts erfolgt unter den SELV-Bedingungen (Sicherheitskleinstspannung) gemäß IEC 60950. Diese Bedingungen sind nur gegeben,

wenn auch die an das Gerät angeschlossenen Geräte unter SELV-Bedingungen betrieben werden.

Stromkabel. **Dies muss von dem Land, in dem es benutzt wird geprüft werden:**	
Schweiz	Dieser Stromstecker muß die SEV/ASE 1011Bestimmungen einhalten.
Europe	Das Netzkabel muß vom Typ HO3VVF3GO.75 (Mindestanforderung) sein und die Aufschrift <HAR> oder <BASEC> tragen.
	Der Netzstecker muß die Norm CEE 7/7 erfüllen ("SCHUKO").

Warnings and Cautionary Messages

Warning: This product does not contain any serviceable user parts.

Warning: Installation and removal of the unit must be carried out by qualified personnel only.

Warning: When connecting this device to a power outlet, connect the field ground lead on the tri-pole power plug to a valid earth ground line to prevent electrical hazards.

Warning: This switch uses lasers to transmit signals over fiber optic cable. The lasers are compliant with the requirements of a Class 1 Laser Product and are inherently eye safe in normal operation. However, you should never look directly at a transmit port when it is powered on.

Caution: Wear an anti-static wrist strap or take other suitable measures to prevent electrostatic discharge when handling this equipment.

Caution: Do not plug a phone jack connector in the RJ-45 port. This may damage this device. Les raccordeurs ne sont pas utilisé pour le système téléphonique!

Caution: Use only twisted-pair cables with RJ-45 connectors that conform to FCC standards.

Warnings (in German)

Achtung: Dieses Produkt enthält keine Teile, die eine Wartung vom Benutzer benötigen.

Achtung: Installation und Deinstallation des Gerätes müssen von qualifiziertem Servicepersonal durchgeführt werden.

Achtung: Wenn das Gerät an eine Steckdose angeschlossen wird, muß der Masseanschluß am dreipoligen Netzstecker mit Schutzerde verbunden werden, um elektrische Gefahren zu vermeiden.

Achtung: Dieses Gerät nutzt Laser zur Signalübertragung über Glasfasern. Die Laser entsprechen den Anforderungen an eine Lasereinrichtung der Klasse 1 und sind durch ihre Bauart im normalen Betrieb sicher für die Augen. Trotzdem sollte niemals direkt in den einen Übertragungskanal geblickt werden, wenn er eingeschaltet ist.

Environmental Statement

The manufacturer of this product endeavours to sustain an environmentally-friendly policy throughout the entire production process. This is achieved though the following means:

• Adherence to national legislation and regulations on environmental production standards.
• Conservation of operational resources.
• Waste reduction and safe disposal of all harmful un-recyclable by-products.
• Recycling of all reusable waste content.
• Design of products to maximize recyclables at the end of the product's life span.
• Continual monitoring of safety standards.

End of Product Life Span

This product is manufactured in such a way as to allow for the recovery and disposal of all included electrical components once the product has reached the end of its life.

Manufacturing Materials

There are no hazardous nor ozone-depleting materials in this product.

Documentation

All printed documentation for this product uses biodegradable paper that originates from sustained and managed forests. The inks used in the printing process are non-toxic.

Purpose

This guide details the hardware features of the switches, including Its physical and performance-related characteristics, and how to install each switch.

Audience

This guide is for system administrators with a working knowledge of network management. You should be familiar with switching and networking concepts.

Zielgruppe Dieser Anleitung ist fuer Systemadministratoren mit Erfahrung im Netzwerkmangement. Sie sollten mit Switch- und Netzwerkkonzepten vertraut sein.

Related Publications

The following publication gives specific information on how to operate and use the management functions of the switches:

The *SMC7816M/VSW Management Guide*

Also, as part of both switches firmware, there is an online web-based help that describes all management related features.

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ABOUT THE
TIGERACCESS EE SWITCH

Overview

This Ethernet-over-VDSL system consists of end-user CPEs (Customer Premise Equipment) connected to a VDSL switch by standard telephone cable. The VDSL connection delivers an Ethernet data link while simultaneously supporting standard telephone services. The system can be deployed in any multi-dwelling/multi-tenant environment (apartment blocks, hotels, or office complex) to provide both high-speed Internet access and telephone services without any need for re-wiring.

The VDSL switch has a built-in POTS splitter that combines both the data and phone signals coming from your Internet and telephone service providers, and passes these signals directly over standard telephone wiring to multiple users in the same building. A CPE is then used to separate these signals and pass them on to a customer's computer and telephone equipment. Using the pre-defined profiles, in-building connections can operate up to 100 Mbps upstream and downstream for runs up to 200 meters (656 ft).

Note: Type-1 26 AWG (100 ohm)/0.4 mm, or Type-2 24 AWG (100 ohm)/0.5 mm cable may be installed to achieve the maximum distance. However, typically 24 AWG (100 ohm)/0.5 mm wire provides better performance than 26 AWG (100 ohm)/0.4 mm wire. Note the distance may be limited by factors such as how the cable is bundled, and the interference and noise on the link.

The VDSL switch is typically located in a wiring closet or other central location of a multi-dwelling/multi-tenant unit, campus or enterprise. An Internet connection is provided from the ISP to the customer's building over fiber optic cable, running Ethernet directly over a 1 Gbps connection. (Trunking both uplink ports together can provide a 2 Gbps connection.) This kind of WAN connection is referred to as fiber To The Building (FTTB). The data and phone signals for each user are combined in the switch, and passed over VDSL lines to individual customers.

The CPE at the other end of the VDSL line connects to any PC or Macintosh equipped with a 10/100BASE-TX network interface card. Your existing telephone, modem, or fax machine simply plugs into the CPE's phone port. There is no need for special terminators or filters. In fact, there is no need to modify your wiring at all. Since the VDSL connection is based on Ethernet, no further complex software configurations are required.

VDSL Technology

VDSL2 (Very High Bit-Rate Digital Subscriber Line) is at the high-end of all the DSL technologies, offering the best combination of fiber optic and copper to provide high-speed broadband Internet access. VDSL's primary application is in providing a broadband data service to multi-tenant residential or commercial buildings. In this implementation, fiber optic cable carries data from an Internet Service Provider to the building; then the installed telephone copper wires take the data and deliver it to individual units within that building.
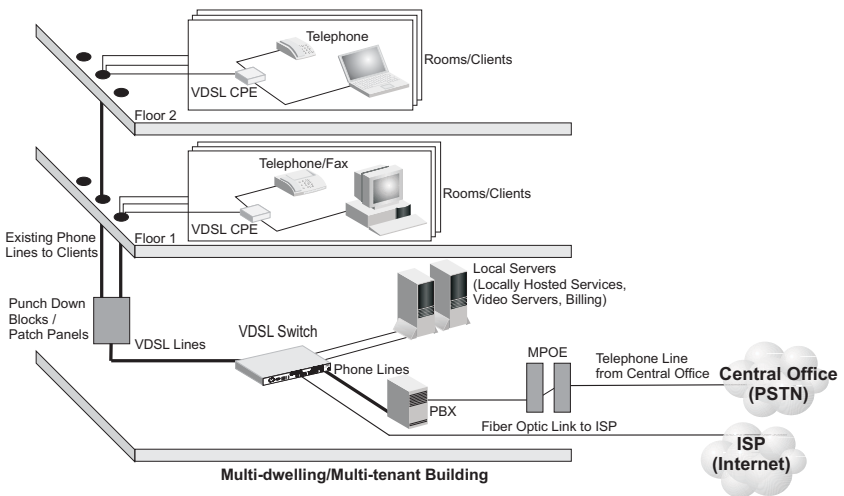
Figure 1-1 VDSL Application

VDSL provides high-speed Internet access over existing phone lines by making use of previously unused frequency bandwidth above the voice band (i.e., up to 30 MHz with VDSL2). By placing VDSL signals above the frequency of the voice signal, a VDSL service can coexist on the same line as other telephone services. VDSL can operate symmetrically, providing the same data rate in both directions, or asymmetrically, providing a higher data rate in the downstream (receive) direction than in the upstream (transmit) direction.

1-3

VDSL can deliver high-performance online applications, such as high-quality video and other switched multimedia services. This Ethernet-over-VDSL system provides robust performance, with a maximum symmetric data rate of 100 Mbps for runs up to 200 meters (656 ft). This system is based on advanced VDSL2 Multi-Carrier Modulation (MCM) technology with adaptive channel equalization that overcomes bridge taps and other line distortions. Reed-Solomon Forward Error Correction and interleaving protect against errors due to impulse noise and enable recovery from signal interruptions. Frequency Division Duplexing (FDD) separates downstream and upstream channels and allows VDSL signals to coexist with regular telephone services. A power back-off mechanism is also implemented to reduce noise from crosstalk in line bundles.

Switch Architecture

The VDSL Switch employs a wire-speed, non-blocking switching fabric. This permits simultaneous wire-speed transport of multiple packets at low latency on all ports. This switch also features full-duplex capability on all ports, which effectively doubles the bandwidth of each connection.

For communications between different VLANs, this switch uses IP routing. For communications within the same VLAN, the switch uses store-and-forward switching to ensure maximum data integrity. With store-and-forward switching, the entire packet must be received into a buffer and checked for validity before being forwarded. This prevents errors from being propagated throughout the network.

Network Management Options

This switch contains a comprehensive array of LEDs for "at-a-glance" monitoring of network and port status. It also includes a management agent that allows you to configure or monitor the switch using its embedded management software, or via SNMP applications. To manage the switch, you can make a direct connection to the console port (out-of-band), or you can manage the switch through a network

connection (in-band) using Telnet, the on-board web agent, or SNMP-based network management software.

The management port provides a dedicated management channel that operates outside of the data transport network. This makes it possible to re-configure or troubleshoot the switch over either a local or remote connection when access via the data channel is not possible or deemed insecure.

For a detailed description of the switch's advanced features, refer to the *Management Guide.*

Description of Hardware

This device is an intelligent Layer 2 VDSL2 switch with 16 VDSL ports for subscriber access to the data network, and two Gigabit Ethernet combination ports[*] for uplink traffic. The uplink ports are implemented as 10/100/1000BASE-T ports shared with SFP transceiver slots (see Figure 1-1, Ports 17-18). The switch also includes one 10/100BASE-TX port for dedicated management access (which can be operated outside the data channel).

The VDSL switch combines data and voice signals for delivery over standard telephone cable to multiple users in residential or commercial buildings. Ethernet data signals are received on the switch uplink port(s) and passed to the 16 VDSL ports on the front panel via 16 internal Ethernet ports.

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[*] If an SFP transceiver is plugged in, the corresponding RJ-45 port (17 or 18) is disabled.

The following figure shows the components of the VDSL switch.
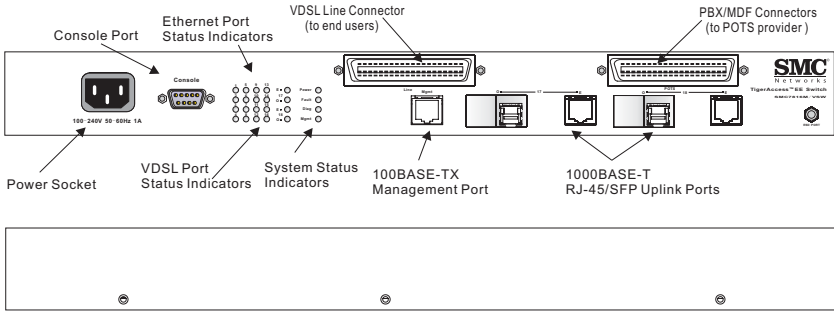
Figure 1-2 Front and Rear Panels

RJ-21 Ports

The RJ-21 ports on the switch front panel support 16 twisted-pair connections. The "Line" port connects to end-user CPEs through a punch-down box. The "POTS" port connects to the local PBX or directly to telephone lines from the CO.

1000BASE-T Ports

The switch contains two Gigabit RJ-45 ports shared with alternate Small Form Factor Pluggable (SFP) transceiver slots. The 1000BASE-T RJ-45 ports operate at 10/100 Mbps, half/full duplex, or at 1000 Mbps, full duplex. Because all of the RJ-45 ports support automatic MDI/MDI-X operation, you can use straight-through cables for all network connections to PCs or servers, or to other switches or hubs. (See "1000BASE-T Pin Assignments" on page B-3.)

Each of these ports support auto-negotiation, so the optimum transmission mode (half or full duplex), and data rate (10, 100, or 1000 Mbps) can be selected automatically. If a device connected to one of these ports does not support auto-negotiation, the communication mode of that port can be configured manually.

Each port also supports auto-negotiation of flow control, so the switch can automatically prevent port buffers from becoming saturated.

Note: If an SFP transceiver (purchased separately) is installed in a slot and has a valid link on the port, the associated RJ-45 port is disabled.

SFP Slots

The Small Form Factor Pluggable (SFP) transceiver slots are shared with RJ-45 ports (ports 17~18). In its default configuration, if an SFP transceiver (purchased separately) is installed in a slot and has a valid link on its port, the associated RJ-45 port is disabled and cannot be used. The switch can also be configured to force the use of an RJ-45 port or SFP slot, as required.

Table 1-1 Optional SFP Transceivers

1000BASE-SX (SMCBGSLCX1)
1000BASE-LX (SMCBGLLCX1)
1000BASE-ZX (SMCBGZLCX1)

Note that 1000BASE-SX transceivers use multimode duplex fiber cable, 1000BASE-LX and 1000BASE-ZX transceivers use single-mode duplex fiber cable.

Management Port

The 100BASE-TX port labeled "Mgmt" provides a dedicated management interface which is segregated from the data traffic crossing the other ports.

This port supports auto-negotiation, so the optimum data rate and transmission mode (10/100 Mbps at half/full duplex) can be selected automatically, if this feature is also supported by the attached device. However, note that the interface connection parameters of this port cannot be configured.

Console Port

The console port on the switch's front panel is a DB-9 connector that enables a connection to a terminal for performing switch monitoring and configuration functions. The terminal may be a PC or workstation running terminal emulation software, or a terminal configured as a Data Terminal Equipment (DTE) connection. A null-modem wired serial cable is supplied with the switch for connecting to this interface.

Ethernet-over-VDSL CPE (Optional Equipment)

The VDSL switch is designed to connect to the RJ-11 VDSL Line port on a CPE. The CPE provides users with a high-speed Internet connection via the RJ-45 Ethernet port and a standard telephone connection via the RJ-11 phone jack.

Port and System Status LEDs

The switch includes key system and port indicators that simplify installation and network troubleshooting. The LEDs, which are located on the front panel for easy viewing, are shown below and described in the following table.
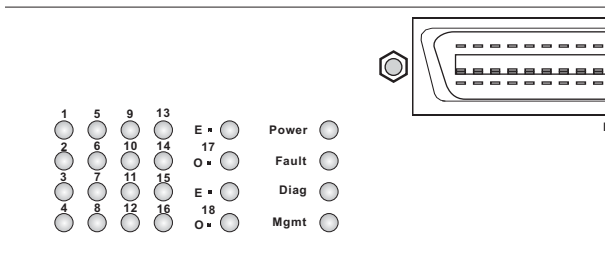
Figure 1-3 Port and System LEDs

Table 1-2 Port Status LEDs

LED	Condition	Status
VDSL Ports		
Link/Act (Port 1-16)	On Green	Port has a valid link
	Flashing Green	Flashing indicates activity on the port
	Off	The link is down, or port is disabled
Uplink Ports		
Link/Act (Port 17-18) E: RJ-45 O: SFP	On Green	Port has a valid link
	Flashing Green	Flashing indicates activity on the port
	Off	The link is down, or port is disabled
Management Port		
Mgmt (Port 19)	On Green	Port has a valid link
	Flashing Green	Flashing indicates activity on the port
	Off	The link is down, or port is disabled

Table 1-3 System Status LEDs

LED	Condition	Status
Power	On Green	Switch is receiving power
	Off	Switch is not receiving power
Fault	Amber	A fan has failed, the temperature threshold exceeded, or other hardware malfunction
Diag	Flashing Green	System diagnostic test in progress
	On Green	System diagnostic test successfully completed
	Off	System self-diagnostic test has detected a fault

Power Supply Socket

There is a power socket on the front panel of the switch for an AC power cord.
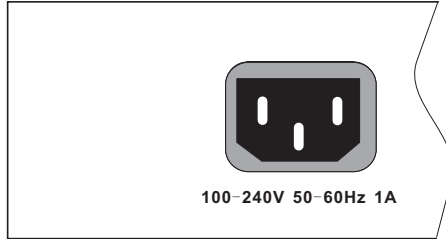
Figure 1-4 Power Supply Socket

Key Features

VDSL Features

*   High-speed Internet access over existing phone lines

*   ITU-T G.993.1/G.993.2 VDSL & VDSL2 Standard and G.993.2 Annex.C Compliant

*   Support programmable band Plan (up to 6 band) compliant with spectrum utilization up to 30MHz

*   Concurrent data and telephone services (voice/ISDN) over a single connection

*   Always-on digital connection eliminates dial-up delays, and transparent reconnection when initiating any network request

*   Supports evolving ETSI, ANSI and ITU VDSL standards for the copper local loop

*   Spectral compatibility with VDSL, VDSL2, ADSL, ADSL2+, POTS, ISDN (2B1Q/4B3T) or "Smartphone" digital PBX extensions

*   Port-to-port isolation for Ethernet

- Robust operation on severely distorted lines

- Supports power back-off algorithm that permits a mixed distance deployment

Additional VDSL2 features include:

- Fast startup for quick initialization

- Trellis coding modulation for higher performance

- Seamless rate adaptation for enhanced quality in video applications

- Variable tone spacing enables best performance for long and short reach lines

- Improved framing, overhead channel, and interleaving

Ethernet Connectivity

- 16 VDSL lines for Ethernet connections to subscribers, operating at 100 Mbps symmetric or at asymmetric rates (such as 100/50 Mbps).

- 2 1000BASE-T/SFP ports provide 4 Gbps of aggregate bandwidth for network uplink.

- Auto-negotiation enables each RJ-45 uplink port to automatically select the optimum speed and communication mode (10/100 Mbps at half/full duplex, or 1000 Mbps at full duplex) if this feature is supported by the attached device; otherwise the port can be configured manually.

- RJ-45 ports support auto MDI/MDI-X pinout selection.

- Unshielded (UTP) cable supported on all RJ-45 ports: Category 3 or better for 10 Mbps connections, Category 5 or better for 100 Mbps connections, and Category 5, 5e, 6 or better for 1000 Mbps connections.

- IEEE 802.3-2005 Ethernet, Fast Ethernet, Gigabit Ethernet compliance ensures compatibility with standards-based hubs, network cards and switches from any vendor.

1-11

Expandability

• Supports optional 1000BASE-SX, 1000BASE-LX and 1000BASE-ZX SFP transceivers

System Features

• Transparent bridging

• Aggregate switch fabric bandwidth of 8.8 Gbps

• Switching table with a total of 8K entries

• Store-and-forward switching

• Wire-speed Layer 2 switching

• Flow control, using back pressure for half duplex and IEEE 802.3x for full duplex

Management features include:

• "At-a-glance" LEDs for easy troubleshooting

• Network management agent:

    - Manages the switch in-band or out-of-band

    - Supports Telnet, SSH, SNMP v1/v2c/v3, RMON (4 groups) web-based interface

CHAPTER 2
NETWORK PLANNING

Introduction to Switching

A network switch allows simultaneous transmission of multiple packets via non-crossbar switching. This means that it can partition a network more efficiently than bridges or routers. The switch has, therefore, been recognized as one of the most important building blocks for today's networking technology.

When performance bottlenecks are caused by congestion at the network access point (such as the network card for a high-volume file server), the device experiencing congestion (server or power user) can be attached directly to a switched port. And, by using full-duplex mode, the bandwidth to the end-user can be doubled to maximize throughput.

A switch can be easily configured in any Ethernet network to significantly boost bandwidth while using conventional cabling and network cards.

Application Examples

VDSL provides significant savings on network installation, equipment and service fees. Internet services operate over existing phone cabling and a minimal amount of network equipment. The only changes require installing a VDSL CPE for each client, and a VDSL switch in the basement or wiring closet. Internet service can then be provided over a direct Ethernet connection from your ISP. For non-commercial environments, you can run the switch through a broadband router at the customer's site. This will allow you to use a single-user account and ISP sharing to significantly reduce network access charges.

This VDSL switch provides Internet connections of up to 100 Mbps symmetric, or an asymmetric 100 Mbps downstream and 50 Mbps upstream over 200 meters. Cable distances also can run up to 1.5 km at lower transmission rates. Installation is extremely economical for multiple-tenant dwellings such as apartment buildings, hotels or school dormitories, as well as commercial buildings.

VDSL provides multiple-user access to the Internet with benefits including:

- Internet services such as e-mail over faster connections than currently possible with other options such as cable modem or ADSL
- Multimedia applications such as video and virtual gaming made available to the broader public for the first time
- Access to corporate intranets at speeds close to that available in the office
- Both local network applications and Internet services are supported for commercial environments

Internet Connections

The figure below shows a VDSL switch providing a broadband data service to a multi-tenant residential or commercial building. In this implementation, fiber optic cable carries data from a telephone company's central office to the building; then the installed telephone copper wires take the data and deliver it to individual units within that building.
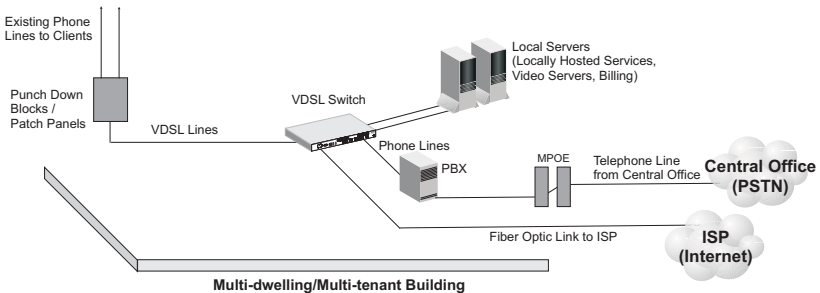
Figure 2-1 Internet Connections

Remote Connections with Fiber Cable

Fiber optic technology allows for longer cabling than any other media type. A 1000BASE-SX MMF Gigabit link can connect to a site up to 550m away, a 1000BASE-LX (SMF) link up to 10 km, and a 1000BASE-ZX link up to 70 km. This allows end-users at two sites to use the same Internet connection, share server resources, and communicate with each other.

In the figure below, a 1000BASE-SX port on the switch in Building 1 is providing 1000 Mbps connectivity to the switch in Building 2.
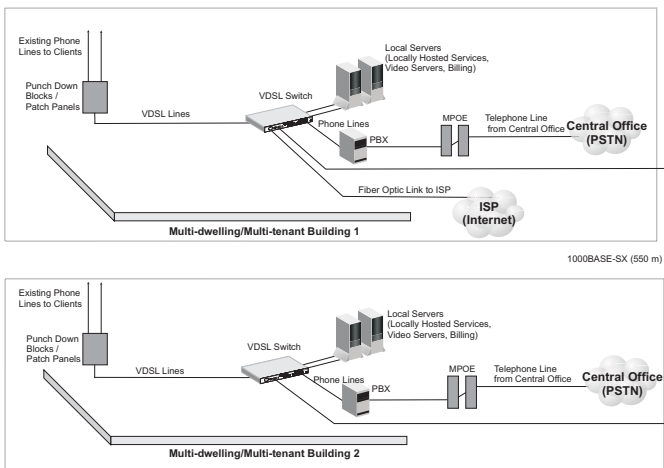
Figure 2-2 Remote Connections with Fiber Cable

Making VLAN Connections

This switch supports VLANs which can be used to organize any group of network nodes into separate broadcast domains. VLANs confine broadcast traffic to the originating group, and can eliminate broadcast storms in large networks. This provides a more secure and cleaner network environment.

VLANs can be based on untagged port groups, or traffic can be explicitly tagged to identify the VLAN group to which it belongs. Untagged VLANs

2-3

can be used for small networks attached to a single switch. However, tagged VLANs should be used for larger networks, and all the VLANs assigned to the inter-switch links.

This switch also has a Private VLAN feature. This allows modification of the default VLAN to provide port-based security and isolation between ports within the VLAN. Data traffic on these ports can only be forwarded to, and from, the uplink port. Private VLANs and normal VLANs can exist simultaneously within the same switch.

In the figure below, ports 1-5 are connected to four end users and a server in a normal VLAN configuration. The remaining ports are configured into a private VLAN.
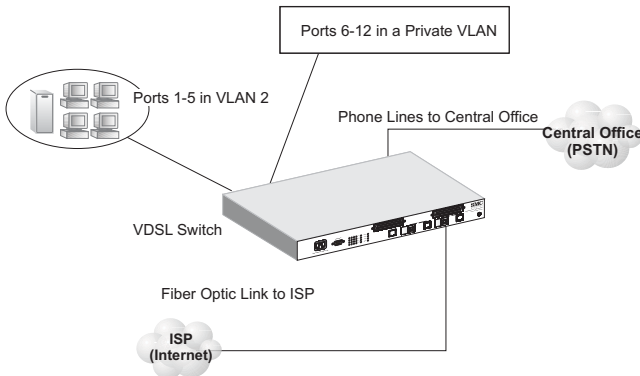
Figure 2-3 Making VLAN Connections

Note: When connecting to a switch that does not support IEEE 802.1Q VLAN tags, use untagged ports.

Application Notes

1. Full-duplex operation only applies to point-to-point access (such as when a switch is attached to a workstation, server or another switch). When the switch is connected to a hub, both devices must operate in half-duplex mode.

2. To interconnect distinct VLANs or IP subnets, you can attach the switch to a standard Layer 3 router. For network applications that require routing between dissimilar network types, you can attach the switch directly to a router.

3. As a general rule the length of fiber optic cable for a single switched link should not exceed:

   • 1000BASE-SX: 550 m (1805 ft) for multimode fiber.

   • 1000BASE-LX: 5 km (3.2 miles) for single-mode fiber.

   • 1000BASE-ZX: 70 km (43 miles) for single-mode fiber.

   However, power budget constraints must also be considered when calculating the maximum cable length for your specific environment.

CHAPTER 3
INSTALLING THE SWITCH

Preparing the Site for VDSL/POTS Connections

In multi-tenant buildings, phone lines from the service provider enter the site and are terminated at a location referred to as the MPOE (Minimum Point of Entry). The MPOE is the "demarcation" point where the service provider's cables end and that of the building's owner/customer begins.

An MPOE typically consists of two sets of punch-down blocks; one from the service provider, and the other from the customer. The customer's punch-down blocks are connected to PBX or MDF equipment in the building. A PBX may have either analog or digital cards that provide the phone lines to individual end users. The PBX lines are usually connected to the end users through another set of punch-down blocks or patch panels. The following figure displays the normal wiring before installing the VDSL switch.
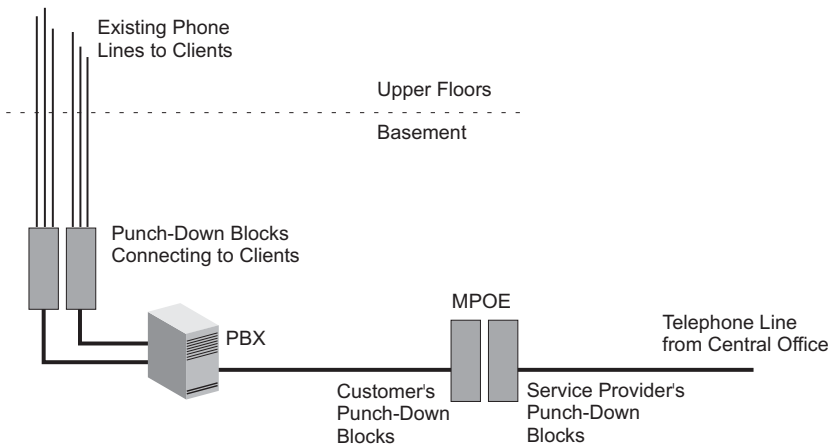
Figure 3-1 Wiring before VDSL Switch Installation

Installing Additional Equipment

The VDSL switch should be installed close to the PBX, punch-down blocks, and patch panels, usually in the basement or wiring closet. You may also want to install a rack for distribution equipment (switches, routers etc.), and extra punch-down blocks or patch panels for flexibility and future applications or expansion.

An optional patch panel can be used to connect the circuits between the switch and the punch-down blocks. If a patch panel is not used, the switch connects directly to the PBX for the incoming phone lines and the punch-down block used for the VDSL lines running up to the end users. In this case, the punch-down blocks must have an RJ-21 connector.

Figure 3-2 Wiring after Switch Installation

Verifying Site Requirement

Before you start installing the switch, make sure you can provide the right operating environment, including power requirements, sufficient physical space, and proximity to other network devices that are to be connected. Be sure to follow the guidelines below when choosing a location.

- The site should:

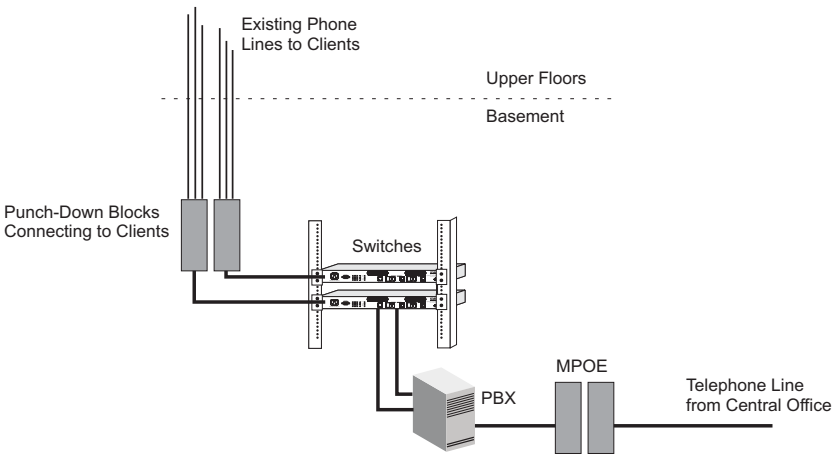 - be at the center of all the devices you want to link and near a power outlet.

  - be out of direct sunlight, and away from heat sources or areas with a high amount of electromagnetic interference. The temperature should be within 0 to 50 °C (32 to 122 °F) and its humidity within 5% to 95%, non-condensing.

  - be located in a cool dry place, and have adequate space (approximately ten centimeters or four inches) on all sides for proper air flow

  - be accessible for installing, cabling and maintaining the devices

  - allow the status LEDs to be clearly visible

- Make sure twisted-pair cable is always routed away from power lines, fluorescent lighting fixtures and other sources of electrical interference, such as radios and transmitters.

- Make sure that the unit is connected to a separate grounded power outlet that provides 100 to 240 VAC (± 10%), 50 to 60 Hz (± 3Hz), is within 2 m (6.6 feet) of each device and is powered from an independent circuit breaker. As with any equipment, using a filter or surge suppressor is recommended.

Installing Ethernet Cabling

To ensure proper operation when installing switches into a network, make sure that the current cables are suitable for 10BASE-T, 100BASE-TX or 1000BASE-T operation. Check the following criteria against the current installation of your network:

- Cable type should be unshielded twisted pair (UTP) or shielded twisted pair (STP) cables with RJ-45 connectors; Category 3 or better for 10BASE-T, Category 5 or better for 100BASE-TX, and Category 5, 5e or 6 for 1000BASE-T.

- Protection from radio frequency interference emissions

- Electrical surge suppression

- Separation of electrical wires (switch related or other) and electromagnetic fields from data based network wiring

- Safe connections with no damaged cables, connectors or shields
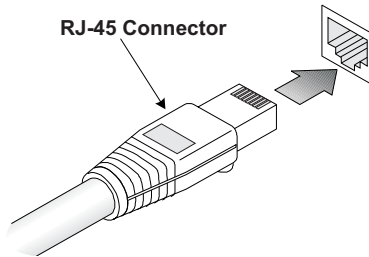
Figure 3-3 RJ-45 Connections

Equipment Checklist

After unpacking the switch, check the contents to be sure you have received all the components. If any of the items are missing or damaged, contact your local distributor. Also, be sure you have all the necessary tools and cabling before installing the switch.

Package Contents

- TigerAccess EE Switch (SMC7816M/VSW)
- Four adhesive foot pads
- Bracket Mounting Kit containing two brackets and four screws for attaching the brackets to the switch
- Power cord—either US, Continental Europe or UK
- Two RJ-21 cables
- This Installation Guide
- Management Guide CD

If possible, retain the carton, including the original packing materials. Use them again to repack the product in case there is a need to return it for repair.

Optional Rack-Mounting Equipment

If you plan to rack-mount the switch, be sure to have the following equipment available:

• Four mounting screws for each device you plan to install in a rack—these are not included

• A screwdriver (Phillips or flathead, depending on the type of screws used)

Mounting

The switch may be mounted on any flat surface, such as a shelf, or in a rack. Mounting instructions for each type of site follow.

Rack Mounting

Before rack mounting the switch, pay particular attention to the following factors:

• Temperature: Since the temperature within a rack assembly may be higher than the ambient room temperature, check that the rack-environment temperature is within the specified operating temperature range. (See page C-2.)

• Mechanical Loading: Do not place any equipment on top of a rack-mounted unit.

• Circuit Overloading: Be sure that the supply circuit to the rack assembly is not overloaded.

• Grounding: Rack-mounted equipment should be properly grounded. Particular attention should be given to supply connections other than direct connections to the mains.

To rack-mount devices:

1. Attach the brackets to the device using the screws provided in the
    Bracket Mounting Kit.
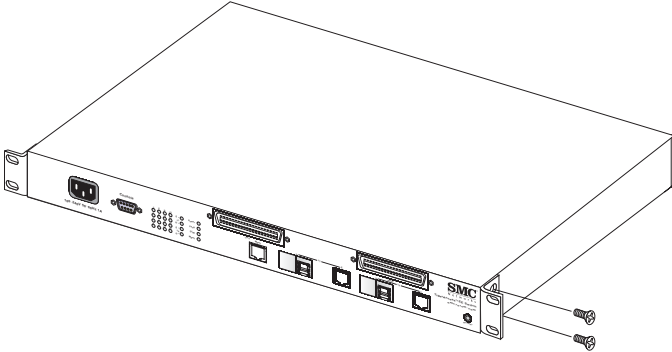
Figure 3-4 Attaching the Brackets

2. Mount the device in the rack, using four rack-mounting screws (not
    provided).
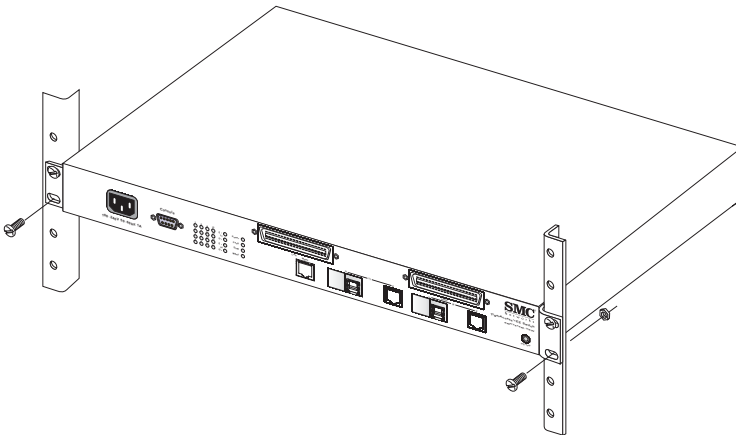
Figure 3-5 Installing the Switch in a Rack

3.   If installing a single switch only, turn to Connecting to a Power Source on page 3-7.

4.   If installing multiple switches, mount them in the rack, one below the other, in any order.

Desktop or Shelf Mounting

1.   Attach the four adhesive feet to the bottom of the first switch.

Figure 3-6 Attaching the Adhesive Feet

2.   Set the device on a flat surface near an AC power source, making sure there are at least four inches of space on all sides for proper air flow.

3.   If installing a single switch only, go to Connecting to a Power Source at the end of this chapter.

4.   If installing multiple switches, attach four adhesive feet to each one. Place each device squarely on top of the one below, in any order.

Installing an Optional SFP Transceiver

Figure 3-7 Inserting an SFP Transceiver into a Slot

The switch support the following optional transceivers:

Table 3-1 Optional SFP Transceivers

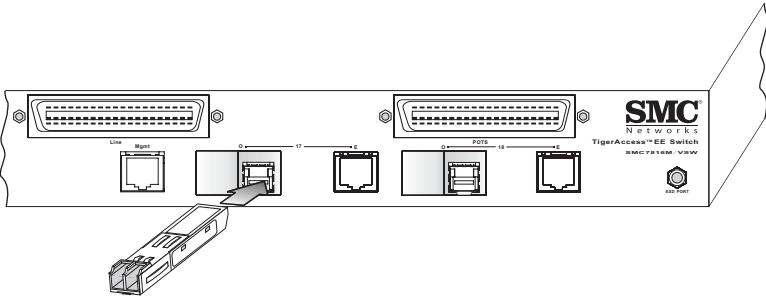| |
|---|
| 1000BASE-SX (SMCBGSLCX1) |
| 1000BASE-LX (SMCBGLLCX1) |
| 1000BASE-ZX (SMCBGZLCX1) |

To install an SFP transceiver, do the following:

1. Consider network and cabling requirements to select an appropriate SFP transceiver type.

2. Insert the transceiver with the optical connector facing outward and the slot connector facing down. Note that SFP transceivers are keyed so they can only be installed in the correct orientation.

3. Slide the SFP transceiver into the slot until it clicks into place.

Note: SFP transceivers are hot-swappable. The switch does not need to be powered off before installing or removing a transceiver. However, always first disconnect the network cable before removing a transceiver.

Note: SFP transceivers are not provided in the switch package.

Connecting to a Power Source

To connect a device to a power source:

1. First verify that the external AC power supply can provide 100 to 240 VAC, 50-60 Hz, 1 A minimum.

2. Plug the power cable into a grounded, 3-pin, AC power source.

   Note: For international use, you may need to change the AC line cord. You must use a line cord set that has been approved for the socket type in your country.

3. Insert the plug on the other end of the power directly into the socket located on the front of the switch.
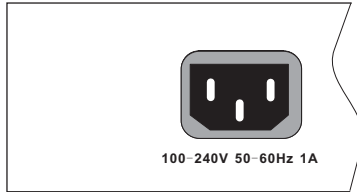
Figure 3-8 Power Socket

4. Check the front-panel LEDs as the switch is powered on to be sure the Power LED is lit. If not, check that the power cable is correctly plugged in. The switch will automatically select the setting that matches the connected input voltage. Therefore, no additional adjustments are necessary when connecting it to any input voltage within the range marked on the front panel.

Notes: 1. The switch performs a self-diagnostic test upon power-on.

   2. The unit supports a "hot remove" feature which permits you to connect or disconnect network cables without powering off the unit

and without disrupting the operation of the devices attached to the unit.

Connecting to the Console Port

The RJ-45 serial port on the switch's front panel is used to connect to the switch for out-of-band console configuration. The on-board configuration program can be accessed from a terminal or a PC running a terminal emulation program. The pin assignments used to connect to the serial port are provided in the following table.
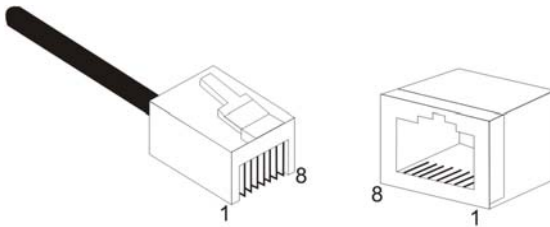
Figure 3-9 Serial Port (RJ-45) Pin-Out

Wiring Map for Serial Cable

Table 3-2 Wiring Map for Serial Cable

Switch's 8-Pin Serial Port	Null Modem	PC's 9-Pin DTE Port
6 RXD (receive data)	<-----------------------------	3 TXD (transmit data)
3 TXD (transmit data)	----------------------------->	2 RXD (receive data)
5 SGND (signal ground)	-----------------------------	5 SGND (signal ground)

No other pins are used.

The serial port's configuration requirements are as follows:

- Default Baud rate—9,600 bps

- Character Size—8 Characters

- Parity—None

- Stop bit—One

- Data bits—8

- Flow control—none

See "Console Port Pin Assignments" on page B-9 for more detailed information on attaching various connector types to the console port.

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CHAPTER 4
MAKING NETWORK
CONNECTIONS

The TigerAccess EE Switch is designed to connect subscriber ports via VDSL lines, and uplink to the service provider's network via twisted-pair or fiber optic cabling. The uplink ports can be connected to network cards in PCs and servers, as well as to hubs, switches or routers. The dedicated management port is designed for local configuration access outside of the data network.

Connecting RJ-21 Cables

For incoming phone lines, a switch can connect directly to a PBX or can be connected via a punch-down block or patch panel. The particular connection method used will depend on the type of connectors and cables supported on the PBX, and on the existing cabling in the building.

The RJ-21 cables from the switch are connected to the punch-down block that connects the phone lines and run up to the end users.

For all connections to the switch, cables with standard Telco RJ-21 connectors must be used. Some punch-down blocks and panels can be pre-wired with an RJ-21 connector, making the connection simple. Otherwise, a cable with an RJ-21 on one end and free wiring on the other end will be required.

Note: RJ-21 Cable is Type-1 26 AWG (100 ohm)/0.4 mm, or Type-2 24 AWG (100 ohm)/0.5 mm cable with male RJ-21 connectors at

each end. Typically 24 AWG (100 ohm)/0.5 mm wire provides better performance than 26 AWG (100 ohm)/0.5 mm wire.

Connecting to the Punch-down Blocks

The switch connects directly to the PBX and building's phone-line punch-down block with RJ-21 connectors. Follow the steps listed below to connect the switch.

1. Connect one RJ-21 cable from the PBX/MDF to the RJ-21 connector on the rear of the switch labeled "POTS."
2. Connect another RJ-21 cable from the punch-down block to the RJ-21 connector on the rear of the switch labeled "VDSL." Note that the connection to the punch down block usually requires punching down the free wires from the RJ-21 cable.

The RJ-21 ports on punch-down blocks must be wired to match the pin assignments of ports on the back of the switch. To ensure that your cables are properly wired, refer to "RJ-21 Port Pin Assignments" on page B-8.

Note: If you are using a patch panel, connect the RJ-21 ports on the back of the switch directly to the corresponding ports on the patch panel, and then manually wire each pair (up to 16) from the patch panel to the punch-down blocks.
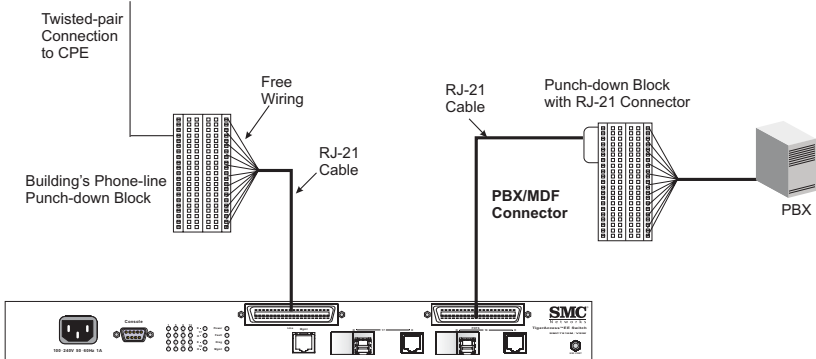

Figure 4-1 Connecting to the Punch-down Blocks

Using Patch Panels

Follow the steps below to connect a VDSL switch to a building's phone-line system using a patch panel:

1. Connect an RJ-21 cable from the patch panel to the RJ-21 connectors on the rear of the switch labeled "VDSL." If connecting to a pre-wired patch-panel with an RJ-21 connector, use a cable with RJ-21 connectors on both ends, otherwise a cable with free wires at one end will have to be punched down to the back of the patch panel.

2. Connect each port on the front of the patch panel to one end-user phone-line connection. This connection can be direct to the building's phone-line punch-down block or via another patch-panel.
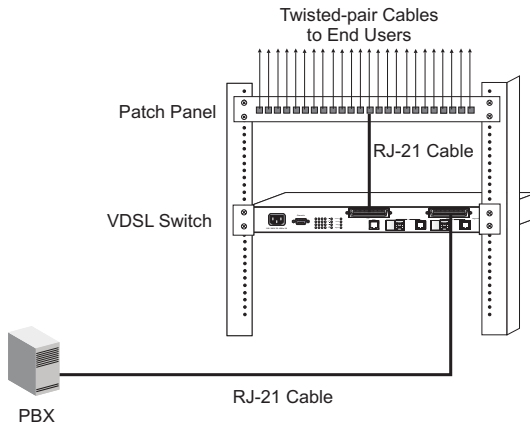
3. Label the cables to simplify future troubleshooting.

Figure 4-2 Using Patch Panels

Connecting Twisted-Pair Devices

Each device requires an unshielded twisted-pair (UTP) cable with RJ-45 connectors at both ends. Use Category 5, 5e or 6 cable for 1000BASE-T connections, Category 5 or better for 100BASE-TX connections, and Category 3 or better for 10BASE-T connections.

Cabling Guidelines

The RJ-45 ports on the switch support automatic MDI/MDI-X pinout configuration, so you can use standard straight-through twisted-pair cables to connect to any other network device (PCs, servers, switches, routers, or hubs). See Appendix B for further information on cabling.

Caution: Do not plug a phone jack connector into an RJ-45 port. This will damage the switch. Use only twisted-pair cables with RJ-45 connectors that conform to FCC standards.

Network Wiring Connections

Attach one end of a twisted-pair cable to an available uplink port on the switch in the wiring closet, and the other end to the Internet Service Provider's network equipment.
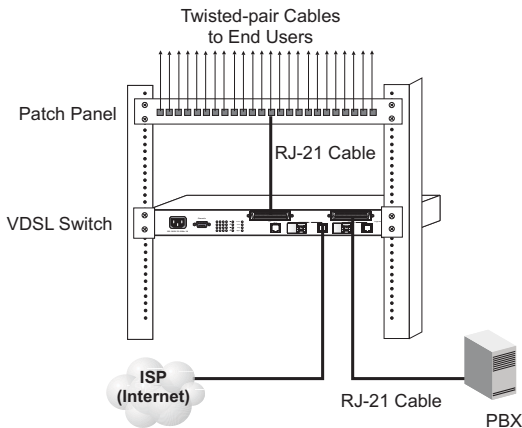

Figure 4-3 Network Wiring Connections

Connecting to PCs, Servers, Hubs and Switches

Depending on the wiring configuration used at the customer's site, separate wall jacks may be used for telephone and VDSL services. Otherwise, you will need to connect the telephone and computer directly to a CPE similar to that shown below. For detailed information on installing and operating the CPE, refer to the relevant user guide.

Figure 4-4 Customer Premises Connections
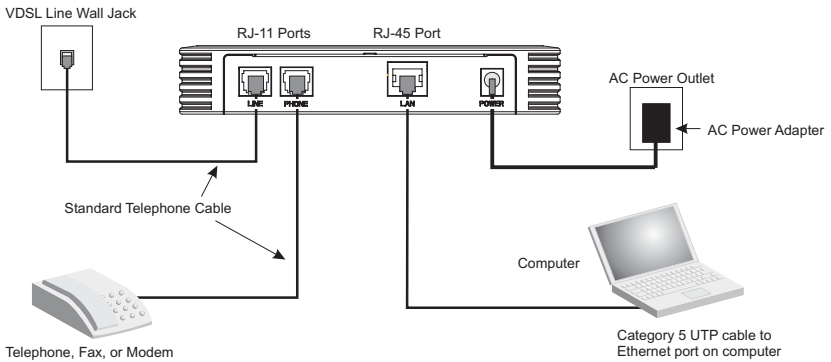
1. Attach one end of a twisted-pair cable segment to the CPE's RJ-45 connector.

2. Attach the other end of the cable segment to to your PC or other network equipment. Make sure the twisted pair cable does not exceed 100 meters (328 ft) in length.

3. As each connection is made, the corresponding Link LED (on the CPE) should light up to indicate that the connection is valid.

Connecting Fiber Optic Devices

An optional SFP transceiver (1000BASE-SX, 1000BASE-LX or 1000BASE-ZX) can be used for a backbone connection to your Internet Service Provider, or for connecting to a high-speed server.

Each single-mode fiber port requires 9/125 micron single-mode fiber optic cable with an LC connector at both ends. Each multimode fiber optic port requires 50/125 or 62.5/125 micron multimode fiber optic cabling with an LC connector at both ends. 1000BASE-SX/LX/ZX uses duplex fiber, operating at a frequency of 1310 nm for both transmit and receive signals.

Warning: This switch uses lasers to transmit signals over fiber optic cable. The lasers are compliant with the requirements of a Class 1 Laser Product and are inherently eye safe in normal operation. However, you should never look directly at a transmit port when it is powered on.

Note: When selecting a fiber SFP device, considering safety, please make sure that it can function at a temperature that is not less than the recommended maximum operational temperature of the product. You must also use an approved Laser Class 1 SFP transceiver.

1. Remove and keep the LC port's rubber cover. When not connected to a fiber cable, the rubber cover should be replaced to protect the optics.

2. Check that the fiber terminators are clean. You can clean the cable plugs by wiping them gently with a clean tissue or cotton ball moistened with a little ethanol. Dirty fiber terminators on fiber cables will impair the quality of the light transmitted through the cable and lead to degraded performance on the port.

3. Connect one end of the cable to the LC port on the switch and the other end to the LC port on the other device. Since LC connectors are keyed, the cable can be attached in only one orientation.
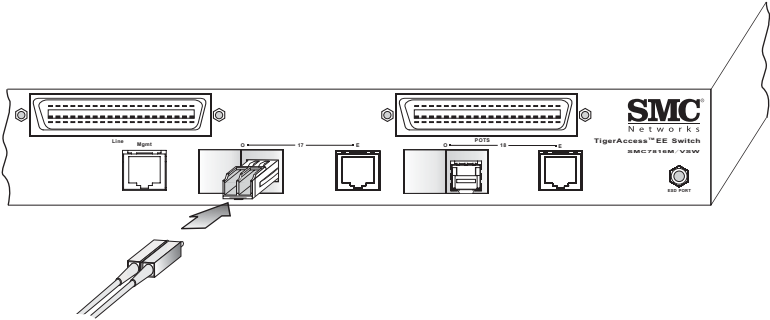

Figure 4-5 Making LC Port Connections

4. As a connection is made, check the Link LED on the switch corresponding to the port to be sure that the connection is valid.

The 1000BASE-SX, 1000BASE-LX and 1000BASE-ZX fiber optic ports operate at 1 Gbps full duplex. All of these SFP modules also support auto-negotiation of flow control. The maximum length for fiber optic cable depends on the fiber type as listed under "1000 Mbps Gigabit Ethernet Cable Lengths" on page 4-8.

Connectivity Rules

When adding hubs (repeaters) to your network, please follow the connectivity rules listed in the manuals for these products. However, note that because switches break up the path for connected devices into separate collision domains, you should not include the switch or connected cabling in your calculations for cascade length involving other devices.

1000BASE-T Cable Requirements

All Category 5 UTP cables that are used for 100BASE-TX connections should also work for 1000BASE-T, providing that all four wire pairs are connected. However, it is recommended that for all critical connections, or any new cable installations, Category 5e (enhanced Category 5) or Category 6 cable should be used. The Category 5e specification includes test parameters that are only recommendations for Category 5. Therefore, the first step in preparing existing Category 5 cabling for running 1000BASE-T is a simple test of the cable installation to be sure that it complies with the IEEE 802.3-2005 standards.

1000 Mbps Gigabit Ethernet Cable Lengths

Table 4-1 Maximum 1000BASE-T Gigabit Ethernet Cable Length

Cable Type	Maximum Cable Length	Connector
Category 5, 5e, 6 100-ohm UTP or STP	100 m (328 ft)	RJ-45

Table 4-2 Maximum 1000BASE-SX Gigabit Ethernet Cable Length

Fiber Size	Fiber Bandwidth	Maximum Cable Length	Connector
62.5/125 micron multimode fiber	160 MHz/km	2-220 m (7-722 ft)	LC
	200 MHz/km	2-275 m (7-902 ft)	LC
50/125 micron multimode fiber	400 MHz/km	2-500 m (7-1641 ft)	LC
	500 MHz/km	2-550 m (7-1805 ft)	LC

Table 4-3 Maximum 1000BASE-LX Gigabit Ethernet Cable Length

Fiber Size	Fiber Bandwidth	Maximum Cable Length	Connector
9/125 micron single-mode fiber	N/A	2 m - 10 km (7 ft - 6.2 miles)	LC

Table 4-4 Maximum 1000BASE-ZX Gigabit Ethernet Cable Length

Fiber Size	Fiber Bandwidth	Maximum Cable Length	Connector
9/125 micron single-mode fiber	N/A	70* - 100 km (43.5 - 62.1 miles)	LC

* For link spans exceeding 70 km, you may need to use premium single mode fiber or dispersion shifted single mode fiber

100 Mbps Fast Ethernet Cable Lengths

Table 4-5 Maximum Fast Ethernet Cable Length

Type	Cable Type	Max. Cable Length	Connector
100BASE-TX	Category 5 or better 100-ohm UTP or STP	100 m (328 ft)	RJ-45

10 Mbps Ethernet Cable Lengths

Table 4-6 Maximum Ethernet Cable Length

Type	Cable Type	Maximum Length	Connector
100ASE-T	Categories 3, 4, 5 or better 100-ohm UTP	100 m (328 ft)	RJ-45

Cable Labeling and Connection Records

When planning a network installation, it is essential to label the opposing ends of cables and to record where each cable is connected. Doing so will enable you to easily locate inter-connected devices, isolate faults and change your topology without need for unnecessary time consumption.

To best manage the physical implementations of your network, follow these guidelines:

• Clearly label the opposing ends of each cable.

• Using your building's floor plans, draw a map of the location of all network-connected equipment. For each piece of equipment, identify the devices to which it is connected.

• Note the length of each cable and the maximum cable length supported by the switch ports.

• For ease of understanding, use a location-based key when assigning prefixes to your cable labeling.

• Use sequential numbers for cables that originate from the same equipment.

• Differentiate between racks by naming accordingly.

• Label each separate piece of equipment.

• Display a copy of your equipment map, including keys to all abbreviations at each equipment rack.

APPENDIX A
TROUBLESHOOTING

Diagnosing Switch Indicators

This switch can be easily monitored through panel indicators to identify problems. The table below describes common problems you may encounter and possible solutions.

Table A-1 Diagnosing Switch Indicators

Symptom	Possible Cause	Action
Power indicator does not light up after power on.	Power outlet, power cord, or internal power supply may be defective.	• Check the power outlet by plugging in another device that is functioning properly. • Check the power cord with another device. • If these measures fail to resolve the problem, have the unit's power supply replaced by a qualified distributor.
Diag LED is off	Boot-up diagnostic program has detected a problem.	• Power cycle the switch to try and clear the condition. • If the condition does not clear, contact your local dealer for assistance.

Table A-1 Diagnosing Switch Indicators

Symptom	Possible Cause	Action
Ethernet port **Link** indicator does not light up after making a connection.	Network cable or Ethernet device attached to this port may be defective.	• Verify that the switch and attached device are powered on. • Be sure an Ethernet cable is plugged into both the switch and attached device. • Verify that the proper cable type is used and its length does not exceed specified limits. • Check the network cable connections for possible defects. Replace the defective cable if necessary.
VDSL port **LINK** indicator does not light up after making a connection.	VDSL switch, cabling, or VDSL switch ports may be defective.	• Verify that the VDSL switch and attached CPE are powered on. • Be sure the RJ-21 cables are plugged into the VDSL switch and the VDSL punch-down block/patch panel. • Verify that the cable length does not exceed specified limits. • Check the cable connections on the VDSL switch, punch-down block/patch panel, and the VDSL CPE for possible defects. Replace the defective cable if necessary.
Fault is on amber.	Fan failure, temperature threshold exceeded, or other hardware malfunction	• Have the switch replaced.

Power and Cooling Problems

If the power indicator does not turn on when the power cord is plugged in, you may have a problem with the power outlet, power cord, or internal power supply. However, if the unit powers off after running for a while, check for loose power connections, power losses or surges at the power outlet, and verify that the fans on the unit are unobstructed and running prior to shutdown. If you still cannot isolate the problem, then the internal power supply may be defective.

Installation

Verify that all system components have been properly installed. If one or more components appear to be malfunctioning (such as the power cord or network cabling), test them in an alternate environment where you are sure that all the other components are functioning properly.

In-Band Access

You can access the management agent in the switch from anywhere within the attached network using Telnet, Secure Shell, a web browser, or other network management software such as SMC EliteView. However, you must first configure the switch with a valid IP address, subnet mask, and default gateway. If you have trouble establishing a link to the management agent, check to see if you have a valid network connection. Then verify that you entered the correct IP address. Also, be sure the port through which you are connecting to the switch has not been disabled. If it has not been disabled, then check the network cabling that runs between your remote location and the switch.

Also, note that the switch may be configured to prevent management access from a connection through the data ports (1-16). Refer to the *Management Guide* for detailed information on this configuration option.

Note: The switch can accept up to four simultaneous Telnet sessions. If the maximum number of sessions already exists, an additional Telnet connection will not be able to log into the system.

APPENDIX B
CABLES

Twisted-Pair Cable and Pin Assignments

For 10BASE-T/100BASE-TX connections, a twisted-pair cable must have two pairs of wires. For 1000BASE-T connections the twisted-pair cable must have four pairs of wires. Each wire pair is identified by two different colors. For example, one wire might be green and the other, green with white stripes. Also, an RJ-45 connector must be attached to both ends of the cable.

Caution: Each wire pair must be attached to the RJ-45 connectors in a specific orientation.

Caution: DO NOT plug an RJ-11 connector into any RJ-45 port. Use only twisted-pair cables with RJ-45 connectors that conform with FCC standards.

Figure B-1 illustrates how the pins on the RJ-45 connector are numbered. Be sure to hold the connectors in the same orientation when attaching the wires to the pins.
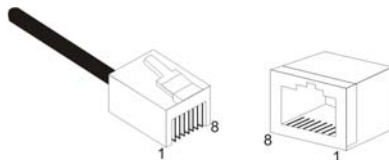

Figure B-1 RJ-45 Connector Pin Numbers

10BASE-T/100BASE-TX Pin Assignments

Use unshielded twisted-pair (UTP) or shielded twisted-pair (STP) cable for RJ-45 connections: 100-ohm Category 3 or better cable for 10 Mbps connections, or 100-ohm Category 5 or better cable for 100 Mbps connections. Also be sure that the length of any twisted-pair connection does not exceed 100 meters (328 feet)

All RJ-45 ports on this switch support automatic MDI/MDI-X operation, so you can use straight-through cables for all network connections to PCs or servers, or to other switches or hubs. In straight-through cable, pins 1, 2, 3, and 6, at one end of the cable, are connected straight through to pins 1, 2, 3 and 6 at the other end of the cable. When using any RJ-45 port on this switch, you can use either straight-through or crossover cable.

Table B-1 10/100BASE-TX MDI and MDI-X Port Pinouts

| Pin	MDI Signal Name	MDI-X Signal Name
1	Transmit Data plus (TD+)	Receive Data plus (RD+)
2	Transmit Data minus (TD-)	Receive Data minus (RD-)
3	Receive Data plus (RD+)	Transmit Data plus (TD+)
6	Receive Data minus (RD-)	Transmit Data minus (TD-)
4,5,7,8	Not used	Not used

Note: The "+" and "-" signs represent the polarity of the wires that make up each wire pair.

Note: Auto-negotiation must be enabled for automatic MDI/MDI-X pinout configuration.

Straight-Through Wiring

If the twisted-pair cable is to join two ports and only one of the ports has an internal crossover (MDI-X), the two pairs of wires must be straight-through. (When auto-negotiation is enabled for any RJ-45 port on this switch, you can use either straight-through or crossover cable to connect to any device type.)

You must connect all four wire pairs as shown in the following diagram to support Gigabit Ethernet connections.

EIA/TIA 568B RJ-45 Wiring Standard
10/100BASE-TX Straight-through Cable

Figure B-2 Straight-through Wiring
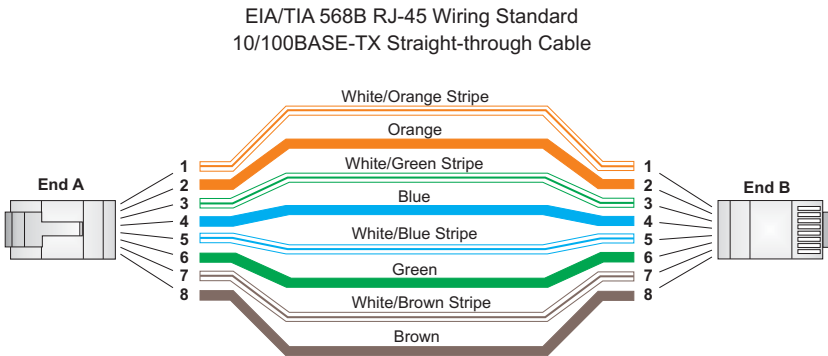
Crossover Wiring

If the twisted-pair cable is to join two ports and either both ports are labeled with an "X" (indicating MDI-X) or neither port is labeled with an "X" (which indicates MDI), a crossover must be implemented in the wiring. (When auto-negotiation is enabled for any RJ-45 port on this switch, you can use either straight-through or crossover cable to connect to any device type.)

You must connect all four wire pairs as shown in the following diagram to support Gigabit Ethernet connections.
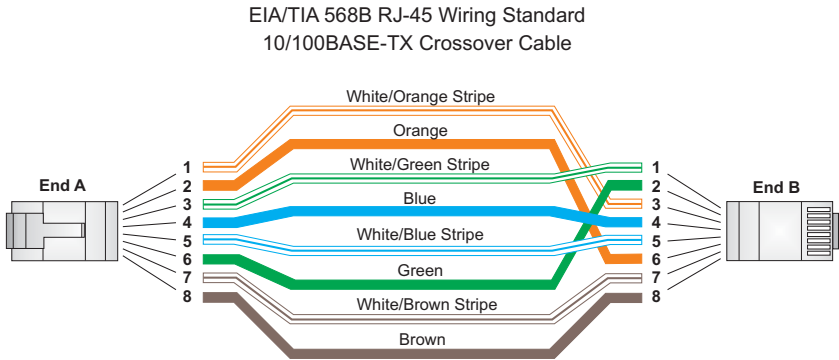
EIA/TIA 568B RJ-45 Wiring Standard
10/100BASE-TX Crossover Cable

Figure B-3 Crossover Wiring

1000BASE-T Pin Assignments

1000BASE-T ports switch support automatic MDI/MDI-X operation, so you can use straight-through cables for all network connections to PCs or servers, or to other switches or hubs.

The table below shows the 1000BASE-T MDI and MDI-X port pinouts. These ports require that all four pairs of wires be connected. Note that for 1000BASE-T operation, all four pairs of wires are used for both transmit and receive.

Use 100-ohm Category 5, 5e, or better unshielded twisted-pair (UTP) or shielded twisted-pair (STP) cable for 1000BASE-T connections. Also be sure that the length of any twisted-pair connection does not exceed 100 meters (328 feet).

Table B-2 1000BASE-T MDI and MDI-X Port Pinouts

Pin	MDI Signal Name	MDI-X Signal Name
1	Bi-directional Data One Plus (BI_D1+)	Bi-directional Data Two Plus (BI_D2+)
2	Bi-directional Data One Minus (BI_D1-)	Bi-directional Data Two Minus (BI_D2-)
3	Bi-directional Data Two Plus (BI_D2+)	Bi-directional Data One Plus (BI_D1+)
4	Bi-directional Data Three Plus (BI_D3+)	Bi-directional Data Four Plus (BI_D4+)
5	Bi-directional Data Three Minus (BI_D3-)	Bi-directional Data Four Minus (BI_D4-)
6	Bi-directional Data Two Minus (BI_D2-)	Bi-directional Data One Minus (BI_D1-)
7	Bi-directional Data Four Plus (BI_D4+)	Bi-directional Data Three Plus (BI_D3+)
8	Bi-directional Data Four Minus (BI_D4-)	Bi-directional Data Three Minus (BI_D3-)

1000BASE-T Cable Requirements

All Category 5 UTP cables that are used for 100BASE-TX connections should also work for 1000BASE-T, providing that all four wire pairs are connected. However, it is recommended that for all critical connections, or any new cable installations, Category 5e (enhanced Category 5) or Category 6 cable should be used. The Category 5e specification includes test parameters that are only recommendations for Category 5. Therefore, the first step in preparing existing Category 5 cabling for running 1000BASE-T is a simple test of the cable installation to be sure that it complies with the IEEE 802.3ab standards.

Cable Testing for Existing Category 5 Cable

Installed Category 5 cabling must pass tests for Attenuation, Near-End Crosstalk (NEXT), and Far-End Crosstalk (FEXT). This cable testing information is specified in the ANSI/TIA/EIA-TSB-67 standard. Additionally, cables must also pass test parameters for Return Loss and Equal-Level Far-End Crosstalk (ELFEXT). These tests are specified in the ANSI/TIA/EIA-TSB-95 Bulletin, "The Additional Transmission Performance Guidelines for 100 Ohm 4-Pair Category 5 Cabling."

Note that when testing your cable installation, be sure to include all patch cables between switches and end devices.

Adjusting Existing Category 5 Cabling to Run 1000BASE-T

If your existing Category 5 installation does not meet one of the test parameters for 1000BASE-T, there are basically three measures that can be applied to try and correct the problem:

1. Replace any Category 5 patch cables with high-performance Category 5e or Category 6 cables.

2. Reduce the number of connectors used in the link.

3. Reconnect some of the connectors in the link.

Fiber Standards

The current TIA (Telecommunications Industry Association) 568-A specification on optical fiber cabling consists of one recognized cable type for horizontal subsystems and two cable types for backbone subsystems.

Horizontal 62.5/125 micron multimode (two fibers per outlet).
Backbone 62.5/125 micron multimode or single mode.

TIA 568-B will allow the use of 50/125 micron multimode optical fiber in both the horizontal and backbone in addition to the types listed above. All optical fiber components and installation practices must meet applicable building and safety codes.

RJ-21 Port Pin Assignments

The RJ-21 ports are designed to aggregate 24 POTS/VDSL lines, although only 16 lines are implemented for this switch. Each wire pair must be attached to the RJ-21 connector in a specific orientation detailed below. The following tables show the pin assignments.
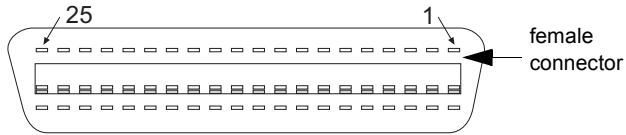

Figure B-4 RJ-21 Port Pins

Table B-3 RJ-21 Port Pin Assignments (PBX/MDF connector)

Pins	Circuit	Pins	Circuit	Pins	Circuit	Pins	Circuit
48,49	1, Ring/Tip	42,43	5, Ring/Tip	36,37	9, Ring/Tip	30,31	13, Ring/Tip
22,23	2, Ring/Tip	16,17	6, Ring/Tip	10,11	10, Ring/Tip	4,5	14, Ring/Tip
45,46	3, Ring/Tip	39,40	7, Ring/Tip	33,34	11, Ring/Tip	27,28	15, Ring/Tip
19,20	4, Ring/Tip	13,14	8, Ring/Tip	7,8	12, Ring/Tip	1,2	16, Ring/Tip

The VDSL Line connector is designed to aggregate 16 VDSL ports. The following table shows the pin assignments.

Table B-4 RJ-21 Port Pin Assignments (VDSL Line connector)

Pins	Circuit	Pins	Circuit	Pins	Circuit	Pins	Circuit
48,49	Port 1	42,43	Port 5	36,37	Port 9	30,31	Port 13
22,23	Port 2	16,17	Port 6	10,11	Port 10	4,5	Port 14
45,46	Port 3	39,40	Port 7	33,34	Port 11	27,28	Port 15
19,20	Port 4	13,14	Port 8	7,8	Port 12	1,2	Port 16

Console Port Pin Assignments

The DB-9 serial port on the switch's front panel is used to connect to the switch for out-of-band console configuration. The on-board command-line configuration program can be accessed from a terminal or a PC running a terminal emulation program. The pin assignments used to connect to the serial port are provided in the following tables.
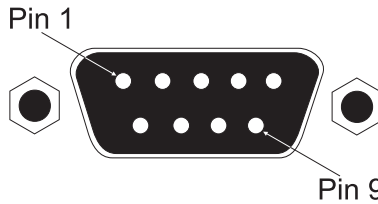

Figure B-5 DB-9 Console Port Pin Numbers

DB-9 Port Pin Assignments

Table B-5 DB-9 Port Pin Assignments

EIA Circuit	CCITT Signal	Description	Switch's DB9 DTE Pin #	PC DB9 DTE Pin #	PC DB25 DTE Pin #
BB	104	**RxD** (Received Data)	2	2	3
BA	103	**TxD** (Transmitted Data)	3	3	2
AB	102	**SG** (Signal Ground)	5	5	7

No other pins are used.

Console Port to 9-Pin DTE Port on PC

Table B-6 Console Port to 9-Pin DTE Port on PC

Switch's 9-Pin Serial Port	Null Modem	PC's 9-Pin DTE Port
2 RXD	<-------- TXD ----------->	3 TXD
3 TXD	---------- RXD ---------->	2 RXD
5 SGND	<-----------SGND ---------->	5 SGND

No other pins are used.

Console to 25-Pin DTE Port on PC

Table B-7 Console to 25-Pin DTE Port on PC

Switch's 9-Pin Serial Port	Null Modem	PC's 25-Pin DTE Port
2 RXD	<-------- TXD -----------	2 TXD
3 TXD	---------- RXD ---------->	3 RXD
5 SGND	---------- SGND ----------	7 SGND

No other pins are used.

APPENDIX C
SPECIFICATIONS

Physical Characteristics

VDSL Specifications
Band Plan: Up to 6 bands
Signal Bandwidth: 25 kHz to 30MHz
Data Rate: Up to 100 Mbps / 100 Mbps (Downstream/Upstream)
Range: Up to 200 meters (656 ft)
Optional Band: US0 from 4~25 kHz (low end) to 138~276 kHz (high end)
Multi-Carrier-Modulation (MCM) - DMT modulation
Interleaving: general convolution
Tone Spacing: 8.6 kHz
Upstream Power Back-off (UPBO)
Compliance: ETSI 101/270, ANSI T1E1.4 and ITU-T G.993.2 (Plan 998)

Ports
16 VDSL lines (RJ-21 Connector)
16 POTS lines (RJ-21 Connector)
2 Gigabit Ethernet combination uplink ports (RJ-45/SFP)
1 Fast Ethernet management port (RJ-45)

Network Interface
Ports 1-16: VDSL lines, auto-negotiation
Ports 17-18: RJ-45/SFP combo port, auto-negotiation, auto MDI/X
Management Port: RJ-45 connector, auto MDI/X

  RJ-45 ports –
  10BASE-T: RJ-45 (100-ohm, UTP cable; Category 3 or better)
  100BASE-TX: RJ-45 (100-ohm, UTP cable; Category 5 or better)
  1000BASE-T: RJ-45 (100-ohm, UTP or STP cable; Category 5, 5e, or 6)
  Maximum Cable Length - 100 m (328 ft)

Buffer Architecture
16 Mbytes

Aggregate Bandwidth
8.8 Gbps

Switching Database
8K MAC address entries

LEDs
System: Power, Diag, Fault
Port: Link/Act

Weight
2.92 kg (6.44 lb)

Size
44.0 x 35.2 x 6.6 cm (17.4 x 13.9 x 2.6 in.)

Temperature
Operating: 0 to 50 °C (32 to 122 °F)
Storage: -40 to 70 °C (-40 to 158 °F)

Humidity
Operating: 5% to 90%

Power Supply
100 to 240 VAC, 50 to 60 Hz

Power Consumption
61.68 Watts maximum

Heat Dissipation
211 BTU/hr maximum

Maximum Current
0.5 A @ 110 VAC
0.25 A @ 240 VAC

Switch Features

Forwarding Mode
Store-and-forward

Throughput
Layer 2: wire speed

Flow Control
Full Duplex: IEEE 802.3x
Half Duplex: Back pressure

Management Features

In-Band Management
Web, Telnet, SSH, or SNMP manager

Out-of-Band Management
Console port (RS-232 DB-9)
Isolated management port, Gigabit Ethernet (RJ-45)

Software Loading
TFTP in-band or XModem out-of-band

Standards

Ethernet Standards
IEEE 802.3-2005 Ethernet Access
  Ethernet, Fast Ethernet, Gigabit Ethernet
  Link Aggregation Control Protocol (LACP)
  Full-duplex flow control (ISO/IEC 8802-3)
  IEEE 802.1D Spanning Tree Protocol
IEEE 802.1w Rapid Spanning Tree Protocol
IEEE 802.1s Multiple Spanning Tree Protocol
IEEE 802.1p priority tags
IEEE 802.3ac VLAN tagging
IEEE 802.1Q Virtual LAN
IEEE 802.1v Protocol-based VLANs

VDSL Standards
ANSI T1E1.4 Part 1 - VDSL Interface
ITU-T G.993.1 - VDSL
ITU-T G.993.2 - VDSL2
ITU-T G.993.2 Annex C - Band Plan for Japan
ITU-T 997 and 998 Band Plans
Other evolving ETSI, ANSI, ITU standards

Compliances

CE Mark

Emissions
FCC Class A
FCC Part 68
Industry Canada Class A
EN 61000-3-2/3
EN55022 (CISPR 22) Class A
JATE

Immunity
EN 61000-4-2/3/4/5/6/8/11

Safety
CSA/CUS (CSA 22.2. NO 60950-1 & UL60950-1)
CB (IEC60950-1)

APPENDIX D

ORDERING INFORMATION

Table D-1 TigerAccess EE Products and Accessories

Product Number	Description
SMC7816M/VSW	16-Port VDSL2 Switch with 2 combo Gigabit Ethernet uplink ports (RJ-45/SFP) and 1 dedicated Fast Ethernet management port (RJ-45)
SMC7800A/VCP	Ethernet-over-VDSL2 CPE with 1 VDSL line port, 1 POTS phone port, and 1 Fast Ethernet port
SMCBGSLCX1	1-port 1000BASE-SX Small Form Pluggable (SFP) mini-GBIC transceiver
SMCBGLLCX1	1-port 1000BASE-LX Small Form Pluggable (SFP) mini-GBIC transceiver
SMCBGZLCX1	1-port 1000BASE-ZX Small Form Pluggable (SFP) mini-GBIC transceiver

GLOSSARY

10BASE-T

IEEE 802.3 specification for 10 Mbps Ethernet over two pairs of Category 3, 4, or 5 UTP cable.

100BASE-TX

IEEE 802.3u specification for 100 Mbps Fast Ethernet over two pairs of Category 5 UTP cable.

1000BASE-LX

IEEE 802.3z specification for Gigabit Ethernet over two strands of 50/125, 62.5/125 or 9/125 micron core fiber cable.

1000BASE-SX

IEEE 802.3z specification for Gigabit Ethernet over two strands of 50/125 or
62.5/125 micron core fiber cable.

1000BASE-T

IEEE 802.3ab specification for Gigabit Ethernet over 100-ohm Category 5 or 5e twisted-pair cable (using all four wire pairs).

1000BASE-ZX

Gigabit Ethernet over two strands of 9/125 micron core fiber cable.

Auto-Negotiation

Signalling method allowing each node to select its optimum operational mode   (e.g., 10 Mbps or 100 Mbps and half or full duplex) based on the capabilities of the node to which it is connected.

Bandwidth

> The difference between the highest and lowest frequencies available for network signals. Also synonymous with wire speed, the actual speed of the data transmission along the cable.

Collision

> A condition in which packets transmitted over the cable interfere with each other. Their interference makes both signals unintelligible.

Collision Domain

> Single CSMA/CD LAN segment.

Customer Premises Equipment (CPE)

> Terminating equipment, such as terminals, phones, and routers, supplied by the phone company, installed at customer sites, and connected to the phone company network.

CSMA/CD

> CSMA/CD (Carrier Sense Multiple Access/Collision Detect) is the communication method employed by Ethernet, Fast Ethernet, or Gigabit Ethernet.

End Station

> A workstation, server, or other device that does not forward traffic.

Ethernet

> A network communication system developed and standardized by DEC, Intel, and Xerox, using baseband transmission, CSMA/CD access, logical bus topology, and coaxial cable. The successor IEEE 802.3 standard provides for integration into the OSI model and extends the physical layer and media with repeaters and implementations that operate on fiber, thin coax and twisted-pair cable.

Fast Ethernet

A 100 Mbps network communication system based on Ethernet and the CSMA/CD access method.

Fibre To The Home (FTTH)

Network where an optical fibre runs from the telephone switch to the subscriber's premises or home.

Full Duplex

Transmission method that allows two network devices to transmit and receive concurrently, effectively doubling the bandwidth of that link.

Gigabit Ethernet

A 1000 Mbps network communication system based on Ethernet and the CSMA/CD access method.

IEEE

Institute of Electrical and Electronic Engineers.

IEEE 802.3

Defines carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

IEEE 802.3ab

Defines CSMA/CD access method and physical layer specifications for 1000BASE-T Gigabit Ethernet. (Now incorporated in IEEE 802.3-2005.)

IEEE 802.3u

Defines CSMA/CD access method and physical layer specifications for 100BASE-TX Fast Ethernet. (Now incorporated in IEEE 802.3-2005.)

IEEE 802.3x

> Defines Ethernet frame start/stop requests and timers used for flow control on full-duplex links. (Now incorporated in IEEE 802.3-2005.)

IEEE 802.3z

> Defines CSMA/CD access method and physical layer specifications for 1000BASE Gigabit Ethernet. (Now incorporated in IEEE 802.3-2005.)

LAN Segment

> Separate LAN or collision domain.

Layer 2

> Data Link layer in the ISO 7-Layer Data Communications Protocol. This is related directly to the hardware interface for network devices and passes on traffic based on MAC addresses.

LED

> Light emitting diode used for monitoring a device or network condition.

Local Area Network (LAN)

> A group of interconnected computer and support devices.

Main Distribution Frame (MDF)

> The hardware at a facility where external and internal lines terminate and are cross connected.

Management Information Base (MIB)

> An acronym for Management Information Base. It is a set of database objects that contains information about the device.

Media Access Control (MAC)

A portion of the networking protocol that governs access to the transmission medium, facilitating the exchange of data between network nodes.

Modal Bandwidth

Bandwidth for multimode fiber is referred to as modal bandwidth because it varies with the modal field (or core diameter) of the fiber. Modal bandwidth is specified in units of MHz per km, which indicates the amount of bandwidth supported by the fiber for a one km distance.

MTU

Multiple Tenant Units

Plain Old Telephone Service (POTS)

One of the services using voice band. Sometimes used as a descriptor for all voice band services.

Private Branch Exchange (PBX)

A telephone exchange local to a particular organization who use, rather than provide, telephone services.

RJ-45 Connector

A connector for twisted-pair wiring.

Splitter

A filter to separate DSL signals from POTS signals to prevent mutual interference.

Switched Ports

Ports that are on separate collision domains or LAN segments.

TIA

> Telecommunications Industry Association

Transmission Control Protocol/Internet Protocol (TCP/IP)

> Protocol suite that includes TCP as the primary transport protocol, and IP as the network layer protocol.

User Datagram Protocol (UDP)

> UDP provides a datagram mode for packet-switched communications. It uses IP as the underlying transport mechanism to provide access to IP-like services. UDP packets are delivered just like IP packets – connection-less datagrams that may be discarded before reaching their targets. UDP is useful when TCP would be too complex, too slow, or just unnecessary.

UTP

> Unshielded twisted-pair cable.

Very high data rate Digital Subscriber Line (VDSL)

> A family of digital telecommunications protocols designed to allow high speed data communication at data rates from below 1 Mbps to 52.8 Mbps with corresponding maximum reach ranging from 4500 feet to 1000 feet using 24 gauge twisted pair cable over the existing copper telephone lines between end-users and service providers.

Very high data rate Digital Subscriber Line 2 (VDSL2)

> VDSL2 as defined in ITU-T Recommendation G.993.2 is an enhancement to the first VDSL standard (G.993.1). It supports transmission at a bi-directional net data rate (the sum of upstream and downstream rates) of up to 200 Mbps on twisted pair cables using a bandwidth of up to 30 MHz. VDSL2 includes many enhancements, one of which is the addition of the US0 band and methods to train echo cancellers and time domain equalizers.

Virtual LAN (VLAN)

> A Virtual LAN is a collection of network nodes that share the same collision domain regardless of their physical location or connection point in the network. A VLAN serves as a logical workgroup with no physical barriers, allowing users to share information and resources as though located on the same LAN.

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