Application Report
SPAA006A

PCI ADSL Adapter Using the Texas Instruments TNETD2000P Chipset

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Abstract

This application report is intended for PC and modem OEMs who wish to develop a PCI ADSL adapter using the Texas Instruments (TI™) TNETD2000P™ chipset and reference design. The PCI ADSL adapter can be installed inside one of the available expansion slots of a PC. This application report covers the following topics:

- TNETD2000P ADSL chipset
- Reference design
- Windows client OS support with NDIS miniport driver
- Software features
- Initialization, configuration and operation
- Diagnostics
- Supported encapsulation over ATM backbone
- T1.413 issue 2 and UAWG Splitterless operation
- Typical applications
- Additional information

This application report assumes that the reader is familiar with the following topics:

- ADSL modem terminology and features such as echo cancellation, rate adaptation, Multi-Dimensional Trellis Coding and Reed Solomon Coding. The application report from Texas Instruments titled “DSP solutions for Voiceband and ADSL Modems” provides background information on these topics.
- General principles of developing miniport drivers for the Windows operating systems. The reader is referred to Microsoft documentation for details on topics such as miniport drivers and Network Driver Interface Specification (NDIS).
- Networking protocols and standards such as PPP and ATM.

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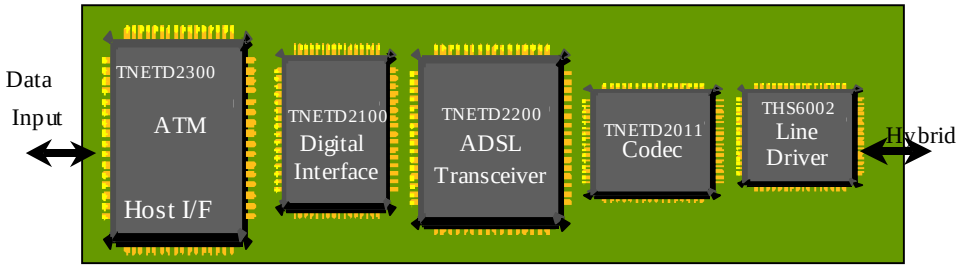
TNETD2000P ADSL Chipset

Texas Instruments has leveraged their expertise in voiceband modems, DSP, and Amati ADSL technology to develop the TNETD2000P ADSL chipset shown in Figure 1. This is a fifth generation chipset that incorporates improvements from successful field trials.

Figure 1. Texas Instruments TNETD2000P ADSL Chipset



The following is a brief description of each of the devices in the chipset:

- The TNETD2300 Host Interface device handles all ATM, SAR, AAL5 (1024 VCI address range) and PCI bus[1] control functions for efficient host bus utilization. In addition, its advanced traffic shaping features ensures optimum network bandwidth utilization.
- The TNETD2100 Digital Interface has programmable serial interfaces to provide simple and clean standards-compliant data interfaces to the chipset.
- The TNETD2200 ADSL Transceiver is based on the high-performance C6x core DSP technology. This fully programmable ADSL transceiver provides the necessary computationally intensive digital signal processing required for ADSL operation. It implements the following:
  - Full ADSL Data Rate of 800 Kbps upstream and 8 Mbps downstream
  - Echo cancellation
  - Reed-Solomon Forward Error Correction
  - Multi-dimensional (4D) Trellis Coding
  - Rate adaptation
- The TNETD2011 Codec is a high precision mixed-signal device that provides the analog-to-digital (A/D) and digital-to-analog (D/A) conversions and associated filtering required for ANSI T1.413 Issue 2 modems.
- The THS6002 Line Driver provides the necessary high-speed line drivers and receives circuitry to drive the ADSL line. It is available in TI's patented PowerPad™ package, reducing the die size and greatly improving thermal dissipation characteristics.
- Windows software drivers for seamless integration with Windows dial-up networking and support for standard encapsulations over ATM. Texas Instruments has partnered with Efficient Networks on NDIS WAN PPP over ATM miniport driver development. The drivers leverage Efficient Networks' core competence in software driver development, ATM, and networking expertise.

This chipset and reference design offer the following benefits:

- ANSI T1.413 Issue 2 standard compliance.

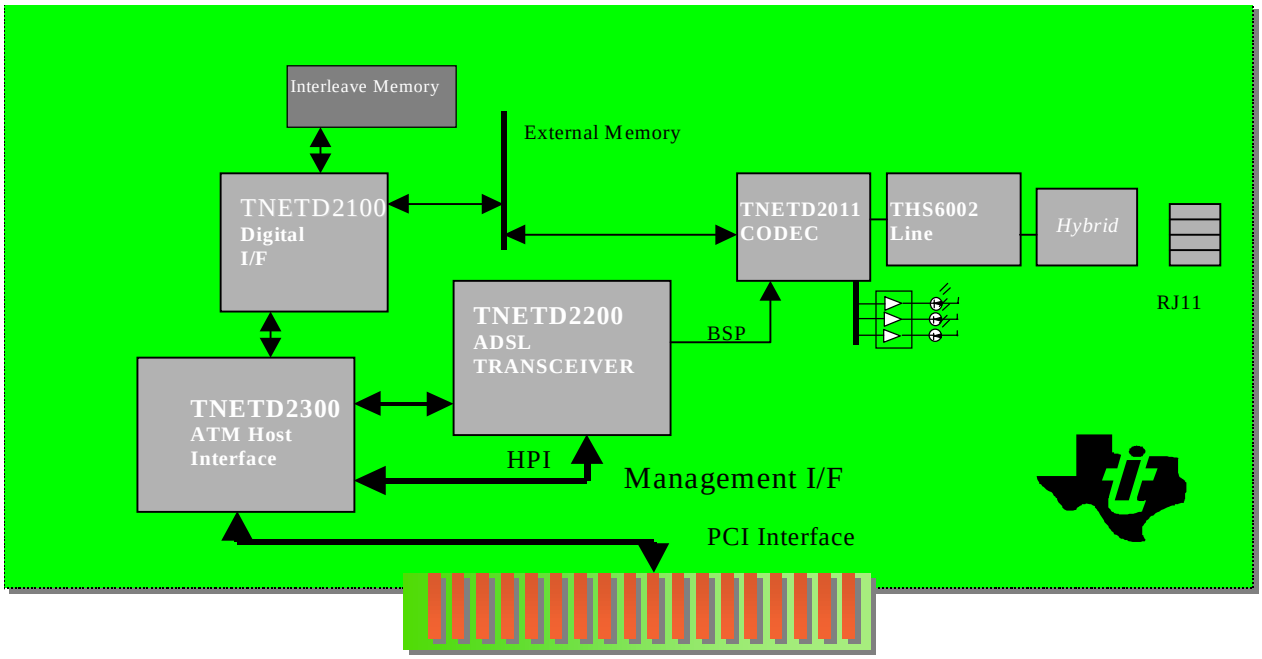
[1] PCI 2.1 compliant interface and Bus Master capability with DMA bursting

- UAWG/Splitterless framework document compliance, with software upgradability to G.lite
- All the devices have been optimized to work together to ensure maximum possible reach and data rate under varying line conditions.
- A programmable architecture facilitates quick and easy software upgrades, interoperability enhancements and future standard implementations such as the proposed G.lite standard.
- Interoperability with major central office (CO) equipment technology suppliers.
- A scalable architecture that supports a variety of data rates. This allows manufactures to build universal single board platforms that can be software upgraded.

Reference Design

Figure 2 shows a block diagram of a reference design for an internal ½ size PCI ADSL adapter using the TNETD2000P chipset.

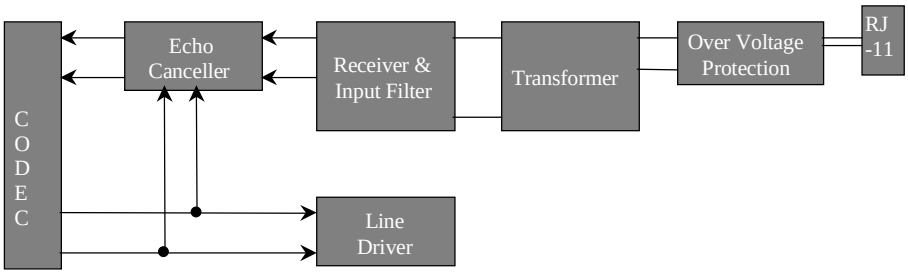
Figure 2. Internal PCI ADSL Adapter Block Diagram



Texas Instruments provides a complete package as part of its reference design. This includes all the hardware and software drivers, chipset device data sheets, bill of materials, assembly drawings, performance reports and schematic diagrams required to quickly bring a product to market.

Figure 3 provides additional details about the AFE section, which includes the CODEC, Line Driver, a Lightning/Surge Protector, and a Pre-echo Canceller.

Figure 3. AFE Details



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PCI ADSL Adapter Modes of Operation

The PCI ADSL Adapter reference design is based on the programmability of the TNETD 2200 ADSL transceiver. This allows implementation of designs for the following modes of operation:

1. T1.413 Issue 2 compliant operation has the following characteristics:
   - POTS splitter installed at the customer premises.
   - Full rate operation with scalable performance levels depending on the code load.
2. UAWG Splitterless operation with the concurrent operation of POTS and ADSL on the wire: Functionality includes support for Splitterless operation, 1.54Mbps/512Kbps, fast retrain and power management. The solution is also software upgradable to G.lite and can operate in either of the following installation scenarios:
   - With no splitter – i.e. “pure splitterless”
   - A distributed splitter, i.e. low cost in-line low pass filters (LPFs) placed at each phone in the customer premises with a high pass filter built into the ADSL modem. The LPFs prevent the interference of ADSL into POTS frequencies.
   - With a Splitter installed at the customer premise

Texas Instruments provides additional information on splitterless ADSL on a white paper titled “Universal DSL deployment of G.lite Issues and Solutions”.

Windows Client OS Support with NDIS Miniport Driver

Figure 4. WAN Miniport Driver Interface

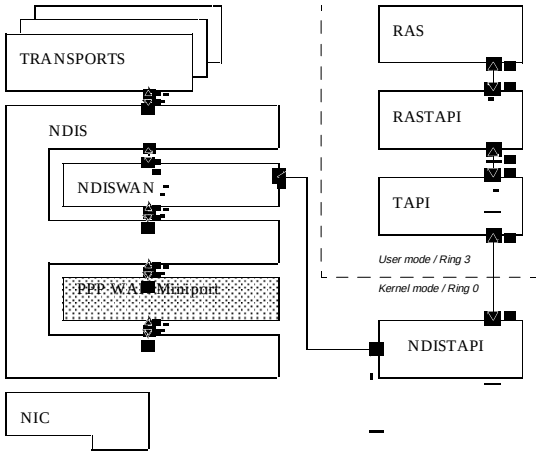


Figure 4 shows the NDIS WAN miniport driver interface for Windows 95. This interface is similar to other WAN miniports. The NDIS wrapper provides the upper layer interface into the transport layer, and lower layer mapping to the hardware via the miniport. Support for Windows 98 and NT 5.0 is provided through a NDIS 5.0 miniport.

Software Features

The PCI ADSL adapter reference design supports the following software features:

- Windows client OS support with Plug and Play installation
- Peak/Aggregate Cell Rate controls for each VC that allows tuning of the network. Total rate control for all active VCs prevents data loss on slower upstream links.
- Support for PPP over ATM data encapsulation format.
- Software upgradable. Some example software upgrades include standard compliant code updates; feature set additions, interoperability code patches, and new standards support (e.g., the proposed G.lite standard).

Table 1 shows where various software components are implemented.

Table 1. Implementation of Software Components

Software	Where implemented
PPP	**On host processor**. Microsoft provides the PPP protocol stack components.
NDIS interface and wrapper	**On host processor**. Microsoft provides the components as part of the operating system.
Miniport driver	**On host processor**. Texas Instruments provides the miniport driver as part of reference design.
ATM	**On host interface device** – this device implements AAL5, the ATM Transmission Convergence Sub-Layer, and Cell delineation functions. Texas Instruments provides this host interface device as part of the TNETD2000P chipset to PC and modem OEMs building internal PCI adapters.
ADSL	**On ADSL transceiver** – this transceiver implements the DMT Modulation/Demodulation and Reed Solomon Coding functions on a C6x class DSP core. Texas Instruments includes the TNETD2200 ADSL transceiver as part of the TNETD2000P chipset.

Initialization, Configuration and Operation

The internal PCI ADSL adapter is installed using the standard method for installing an adapter under Windows 95. The device driver may be supplied either on a manufacturer's disk, or pre-installed on the hard drive. Once installed, the connection is configured and operated in the same way as a dial-up connection, except that the speed is much faster. This leverages the familiarity that most people have with the paradigm for connecting via a dial-up connection. Figure 5 shows a high-speed connection using Dial-Up Networking under Windows 95.

Figure 5. High-Speed Connection Using Dial-Up Networking

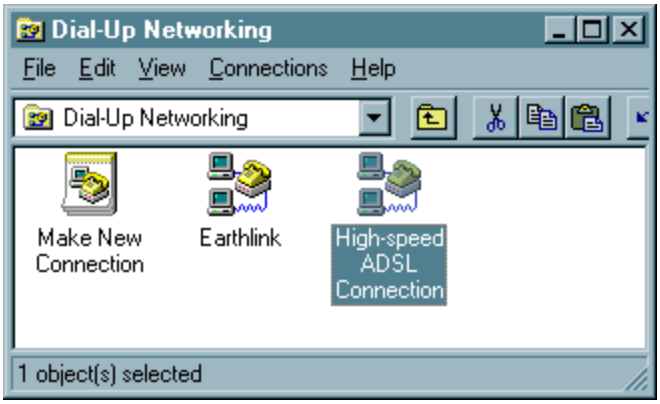
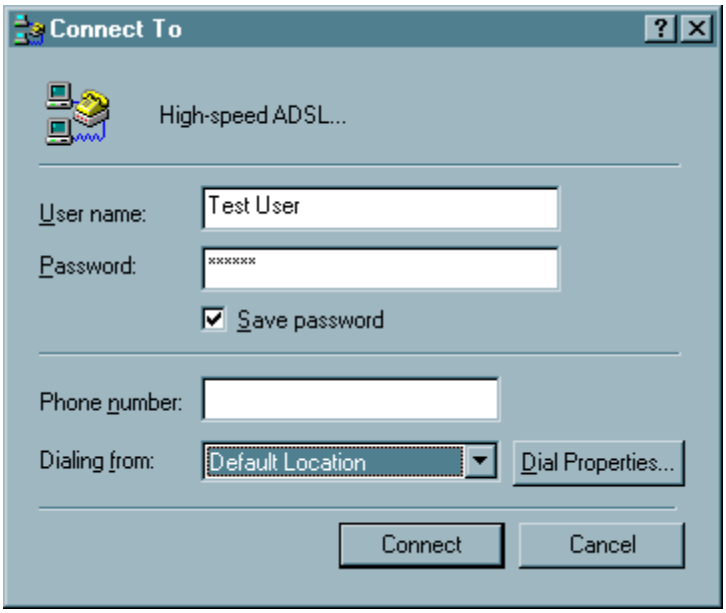


Figure 6 illustrates making a connection. The driver automatically compensates for the fact that it is not necessary to provide a telephone number with an ADSL service (ADSL modems automatically establish a connection between the premises and the Central Office).

Figure 6. Making a High-Speed Connection



Diagnostics

Driver and connection status information can be obtained through the standard interfaces provided by Microsoft in Windows 95 – the Dial-Up Networking Monitor and Device Manager.

The diagnostic information available through the Microsoft interface includes:

- Driver load failure
- Connect time
- Connect (downstream) rate
- Bytes transmitted
- Bytes received.

The power-up diagnostics provided by the driver includes:

- EEPROM verification
- SAR memory data-line test
- SAR memory address line test
- AAL5 PDU loopback

Supported Encapsulations over ATM Backbone

Encapsulation is a generic term that describes how the higher layer data is transported across an ATM backbone. The PCI ADSL adapter reference design supports the following encapsulation.

- PPP over ATM

  This method is gaining a lot of popularity in the industry. The IETF is expected to approve the draft standard in 1998. The advantage of this method is that it leverages the existing procedures for example, for user authentication and dynamic IP address assignment. This method is the most compatible with the dial-up networking paradigm used today.

The PCI ADSL adapter hardware can support the following encapsulation methods through software and additional operating system support, which could be obtained through various third party sources. The PCI ADSL reference design software does not support these additional methods.

- Native ATM

  Microsoft is building native ATM support into future versions of its operating systems – Windows 98 and Windows NT 5.0. Applications written directly to the native ATM stack can utilize the benefits of low latency and high throughput afforded by an ATM transport.

- RFC 1483

  This refers to a mechanism of encapsulating Ethernet frames into AAL5 PDUs that are then transported across the ATM network using PVCs. This method allows for migration of the existing installed base of Ethernet equipment to an ATM backbone.

- RFC 1577

  This refers to a mechanism of transporting IP packets over ATM in AAL5 PDUs. This is referred to as Classical IP over ATM. This method is widely supported in many ATM products.

NOTE:
In the protocol diagrams below, the PPP over ATM encapsulation is used as an example, since this is the preferred industry direction for ADSL deployment.

Typical Applications

Two of the ways in which an internal PCI ADSL adapter may be used are (a) in a standalone PC or (b) in a PC acting as a router.

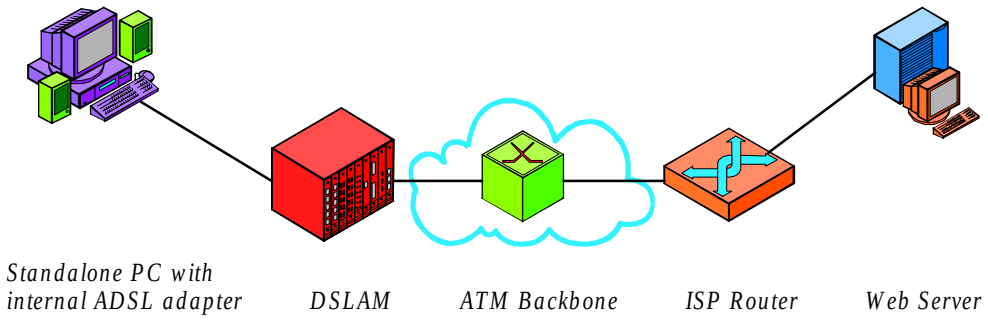
ADSL Adapter in a Standalone PC

As shown in Figure 7, this configuration is very simple. The ADSL Adapter offers several advantages:

- Unlike an external adapter, an internal adapter does not require additional cost for packaging, power supply, and additional components such as memory.

- All of the necessary software components for connectivity run within the PC itself (either on the host CPU or on the ADSL transceiver). This greatly simplifies the protocol stacks and enables native ATM support.
- Internal adapters are easy to manage using standard network management protocols.
- Easy to setup, configure and use. The paradigm for use is essentially the same as today's Dial-Up Networking supported under Windows 95.
- Enables end to end ATM support, which allows traffic management and QoS.

Figure 7. ADSL Adapter in a Standalone PC



A typical protocol diagram for the connection is shown in Figure 8.

Figure 8. Typical Protocol Diagram for Standalone PC

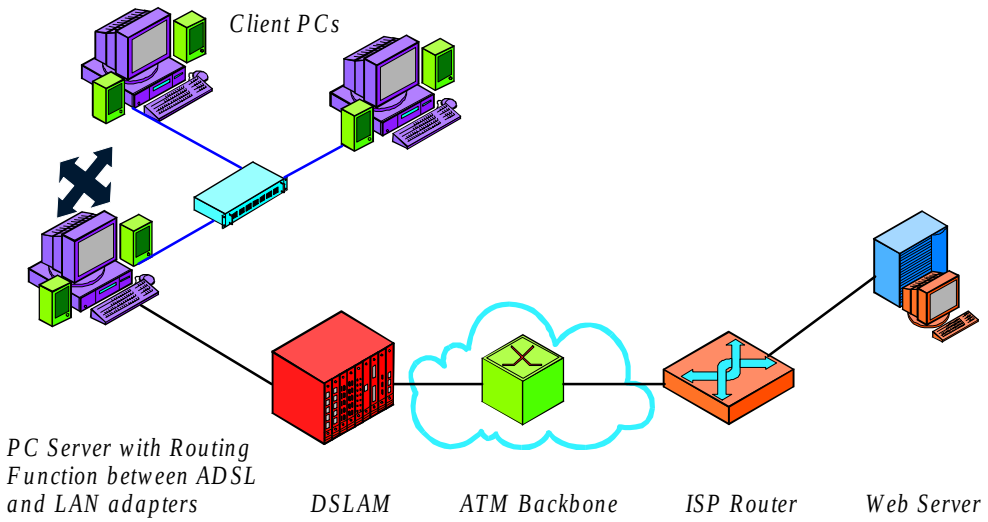
Client PC	DSLAM		ATM Backbone		ISP ROUTER		WEB SERVER
HTTP	ATM Multiplexing Function		ATM Switching Function		IP Routing Function		HTTP
TCP							TCP
IP					IP	IP	IP
PPP					PPP	LAN or WAN Media	LAN or WAN Media
ATM	ATM	ATM	ATM	ATM	ATM		
ADSL	ADSL	OC-3	OC-3	OC-3	OC-3		

ADSL Adapter in a PC Acting as a Router

As shown in Figure 9, this configuration is slightly more complex than a standalone PC, but still easy to setup. The ADSL Adapter installed on a PC configured as a router offers several advantages.

- The cost of the adapter, the ADSL line and service is spread across all client PCs on the LAN. It also offers cost savings over an external modem.
- All of the necessary software components for connectivity and routing run within the PC itself (either on the host CPU or on the ADSL transceiver). This greatly simplifies the protocol stacks and enables native ATM support.
- Internal adapters are easy to manage using standard network management protocols.

Figure 9. ADSL Adapter in a PC Acting as a Router



A typical protocol diagram for the connection is shown in Figure 10.

Figure 10. Typical Protocol Diagram for PC Acting as a Router

Client PC	PC Server with Routing Function		DSLAM		Backbone		ISP Router		Web Server
HTTP	IP Routing Function		ATM Multiplexing Function		ATM Switching Function		IP Routing Function		HTTP
TCP									TCP
IP	IP	IP					IP	IP	IP
		PPP					PPP	LAN or WAN Media	LAN or WAN Media
		ATM	ATM	ATM	ATM	ATM	ATM		
Ethernet	Ethernet	ADSL	ADSL	OC-3	OC-3	OC-3	OC-3		

Additional Information

This application report provides basic information on developing a PCI ADSL adapter using the Texas Instruments TNETD2000P chipset under the Windows client operating systems. For additional information, please contact your Texas Instruments Sales Representative, or visit the web site at www.ti.com/sc/access.

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TI Number	-800-800-1450
Korea	080-551-2804
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