

Network Communications

This chapter presents the requirements and recommendations for network adapters and related technologies under the Microsoft Windows family of operating systems.

Version 1.1

Includes changes to items 5, 34, and References for Network Communications, as previously published in the PC 97 FAQ on <http://www.microsoft.com/hwdev/pc97.htm> and the PC 97 OnNow Requirements on <http://www.microsoft.com/hwdev/desguid/onnowpc97.htm>
See also: Network FAQs for WHQL testing on www.microsoft.com/hwtest/faqs/faq_network.stm

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Overview for Network Communications

This section presents the key PC 97 design issues for network communications devices under Microsoft Windows.

Under Microsoft Windows, the seamless integration of network software components should be supplemented by device support for Plug and Play and NDIS 4.0 capabilities, so that the user has to supply a minimal amount of information to achieve optimal configuration.

For PC 97, all network communications devices are based on the same NDIS 4.0 requirements. These are the key PC 97 design issues for network communications:

- Complete Plug and Play capabilities, with a supporting NDIS 4.0 miniport driver.
- Automatic cable sense and transceiver auto-detection capabilities, plus support for power management capabilities under the OnNow design initiative.

Tips for Selecting High-Performance Network Adapters. For PC manufacturers who want to select high-performance components, these are design features to look for in network adapters:

- Adapter supports bus mastering, especially for use with Pentium Pro-class processors.
- PCI adapter properly supports higher-level PCI commands for intelligent data transfer.
- Drivers tuned for 32-bit performance.

System Requirements for Network Communications

This section summarizes both the basic hardware design features for network communications devices and the specific features for PC 97.

1. Network adapter included in PC system

<i>Basic PC 97</i>	<i>Workstation PC 97</i>	<i>Entertainment PC 97</i>
<i>Recommended</i>	<i>Required if no modem</i>	<i>Recommended</i>

It is recognized that OEMs supply PC systems to corporations for networking purposes in situations where the customer will insert network adapters at the end-user site. If the device is present in the PC system, it must meet the minimum requirements for network adapters defined in this chapter.

Note For Workstation PC 97, the network adapter must not use the ISA bus.

2. Internal or external ISDN devices

<i>Basic PC 97</i>	<i>Workstation PC 97</i>	<i>Entertainment PC 97</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>

If the device is present in the system, it must meet the minimum requirements for ISDN devices defined in this chapter.

3. Cable modem built into PC

<i>Basic PC 97</i>	<i>Workstation PC 97</i>	<i>Entertainment PC 97</i>
<i>Optional</i>	<i>Optional</i>	<i>Optional</i>

Cable modems are not required features for any PC 97 system. If the device is present in the PC system, it must meet the minimum requirements for cable modems defined in this chapter.

4. ATM adapter built into PC

<i>Basic PC 97</i>	<i>Workstation PC 97</i>	<i>Entertainment PC 97</i>
<i>Optional</i>	<i>Optional</i>	<i>Optional</i>

Asynchronous transfer mode (ATM) adapters are not required features for any PC 97 system. If the device is present in the PC system, it must meet the minimum requirements for ATM adapters defined in this chapter.

Network Device Requirements

This section summarizes the requirements for network adapters for PC 97.

Network Adapter Basic Features

This section defines requirements for basic hardware features.

5. Support NDIS 4.0 using a miniport driver

Required

For PC 97, the driver must be an NDIS 4.0 miniport driver that is compatible with Windows NT 4.0 and Windows 95. If the device is switched WAN card (for example, ISDN, X.25, or S56), it must have an NDIS 4.0 NDIS WAN miniport driver which has a TAPI service provider compatible with Win32 TAPI applications. It must support Windows remote access or other WAN services over WAN media.

All enhancements to NDIS can be only used by miniport drivers, including all the features added in NDIS 4.0. All new media are being supported only in the miniport model, including ATM, WAN (ISDN, X.25, and so on), wireless WAN, IrDA, cable modem, ADSL, and so on.

This support also provides for dynamically starting and stopping the network adapter, and includes support for cable sense (see the following requirement). Because the operating system is performing a larger portion of the functionality in the miniport driver model, NDIS is safer, more efficient and binary compatible across operating systems than with other driver models. Writing miniport drivers is easier and requires less time and resources than drivers created under other driver models.

For information about NDIS and required driver support for the network adapter, see the Microsoft Windows NT 4.0 DDK and the Microsoft Windows 95 Device Driver Reference available by way of MSDN Professional membership.

Version 1.1 Clarification:

NDIS 4.0 miniports are compatible with OnNow power management in Windows 98 and Windows NT 5.0. If the hardware supports the bus power management specification, the operating system will "emulate" the D0 and D3 power states for the miniport, which will be stopped and restarted around D3. The bus driver will set the card to the D3 state using the bus interface. NDIS 5.0 miniports are required only to enable D1, D2, and wake up, which are not required capabilities for PC 97. NDIS 5.0 miniports will be required for PC 98. NDIS 5.0 miniport compliance testing is expected to begin at WHQL in 3Q1997. Also, please note that NDIS 5.0 documentation will be provided only in the Windows NT 5.0 DDK.

6. Automatically sense presence of link or carrier to the network

Required

The network adapter must be capable of determining whether it is connected to a functional network. If the adapter is on an expansion card not used as a boot device, the presence of the cable can be determined by device drivers. If a cable is not attached, the miniport driver must provide appropriate NDIS status indication, using support for cable sense in NDIS 4.0. For information about NDIS Status codes and indication mechanism, see the Microsoft Windows NT 4.0 DDK.

No time durations are specified for the required detection or status indication.

7. Automatically sense transceiver type (TP, AUI, BNC)

Required

Network adapters that support multiple transceivers must be capable of automatically detecting which transceiver is connected to the network and then use that transceiver automatically. In all cases, the user must not be required to set jumpers or manually enter information to inform the operating system of the transceiver type.

8. Support quad-word buffer alignment or better for receive and support byte buffer alignment for send

Required

Recommended: byte alignment. All allocated memory will be quad-word alignment so the receive buffers must be quad-word aligned or better (can be byte

or word aligned). For the send buffer, it must be capable of handling byte-aligned buffers. The network adapter must have minimal buffer alignment restrictions. This refers to the allowed offset addresses (boundaries) where packets can begin and end. Byte alignment is recommended, because it imposes fewer limitations on overlying software components.

9. Adapter communicates with driver across any bridge

Required

If the adapter uses a bridge, all communications must be free of errors across any bridge such as a PCI bridge adapter.

ISDN Basic Features

This section summarizes the design features for ISDN devices. ISDN is a new area for requirements. For PC 97, ISDN is a recommended but not required device for high-speed connections. If it is implemented, ISDN in a PC 97 system must meet the requirements defined in this chapter. For basic requirements for Plug and Play, power management, and driver support, see the “PC 97 Design for Network Communications” section later in this chapter.

An internal ISDN adapter plugs into the internal PC bus and appears to the operating system as a network adapter. An external ISDN adapter connects to an asynchronous port such as a serial port or USB and appears as a COM device to the operating system.

10. Support PC 97 requirements for network adapters

Required

The following requirements must be met, as defined in the “Network Adapter Basic Features” section earlier in this chapter:

- Support NDIS 4.0 using a miniport driver
- Automatically sense whether a cable is connected
- Support quad-word buffer alignment or better
- Adapter communicates with driver across any bridge

11. Synchronous HDLC framing for internal ISDN device

Required

HDLC framing is a standard for sending synchronous data.

12. AT command set for external ISDN device: TIA-602

Required

TIA-602 is a subset of ITU V.25ter. This can be implemented in the device or in the communications driver.

13. Async-to-sync conversion for external ISDN device

Required

Because ISDN is a synchronous service and an external ISDN device connects to an asynchronous port on the PC, the external device must provide some means of converting asynchronous data to synchronous data.

14. Built-in NT-1*Recommended*

An NT-1 (*network terminator*) splits the duplexed transmit and receive signals from the ISDN line into separate transmit and receive components. An ISDN device with a built-in NT-1 can connect directly to the ISDN line. However, doing so prevents other devices from being attached to the ISDN line (only one NT-1 can be connected to an ISDN line).

For this recommendation, it is recognized the NT-1 applies only for the United States.

15. Multilink PPP (RFC 1717) for external ISDN device*Recommended*

Multilink PPP combines several ISDN B channels to increase the bandwidth of PPP links.

This requirement is for external devices only. NDIS WAN miniport drivers for internal devices benefit from the built-in multilink support provided by the remote access services of the operating system and do not need to provide multilink PPP support.

16. External ISDN device uses high-speed port*Recommended*

Because of speed limitations inherent in the COM ports on the PC, the connection for external ISDN devices should use a high-speed connection such as USB.

17. NDIS WAN miniport for internal ISDN device*Required*

The device must have an NDIS WAN miniport driver to support Windows remote access over ISDN. For information, see the Windows NT 4.0 DDK.

18. Binary compatibility between Windows 95 and Windows NT for ISDN drivers*Recommended*

Drivers should not make calls to specific functions for either Windows 95 or Windows NT.

Cable Modem Basic Features

Cable modems are neither required nor recommended for PC 97, but if a cable modem is implemented in a PC 97 system, it must meet the requirements defined in this section. For basic requirements for Plug and Play, power management, and driver requirements, see the “PC 97 Design for Network Communications” section later in this chapter.

Cable modems connected to a PC are one component in a system that cable TV operators use to deliver High Speed Cable Data Services (HSCDS) to cable TV customers. HSCDS provides two-way services (data flows both “downstream” from the cable operator’s head end and “upstream” from the customer’s PC).

Ideally, two-way HSCDS is delivered over 450-MHz and 550-MHz hybrid fiber-coax (HFC) cable TV distribution networks. Most of the current cable TV distribution network in the U.S. is 300-MHz, 350-MHz, and 400-MHz coax branch and tree networks.

In 1996, HSCDS delivery has primarily been confined to trial projects. In these trials, the cable modems used on customer premises are typically external to the PC with their own power supply. These cable modems are essentially IP routers. The cable modem’s upstream connection is either a standard “F” coax interface or an ATM interface. The cable modem connection to the PC uses a 10BaseT interface (RJ45) to connect a twisted pair to a standard Ethernet network adapter.

For the next several years, it is expected that external cable modems will be included as part of the HSCDS service by the cable operator, much like set top boxes. In light of that, along with the absence of standards for cable modems, few PC vendors are expected to bundle cable modem hardware with their systems.

PC platform vendors can build PCs that are capable of using external cable modems by including a standard Ethernet network adapter in their PC systems. The PC platform should also have Microsoft TCP/IP software pre-installed.

HSCDS upstream data flow can be implemented on the predominant 300-MHz, 350-MHz, and 400-MHz coax branch and tree cable TV distribution networks by using telephone circuits for the upstream channel. This is a design alternative used today to accomplish HSCDS field trials with existing cable TV networks until more HFC networks are built.

There are a great number of design issues for cable operators as they upgrade their cable TV distribution networks to HFC and begin to deliver HSCDS. Even operators who have existing HFC networks must add equipment to that network in order to begin offering HSDCS. The speeds at which cable TV operators resolve these issues will determine the requirements for cable modems in homes and businesses in two years. Although HSDCS is primarily only in trials today, a majority of the cable operators in the U.S. are working on business plans for delivering HSCDS within the next two years.

PC platform makers must track the rate at which cable TV operators are resolving these issues and what are the best methods. The key design issues for cable modems for PC platform makers are cost, standards, and the evolution of cable modems from external to internal models.

Some cable modem vendors plan to implement the new IEEE 802.14 protocol when it becomes available. It should be well suited to the distances, data rates, and physical plant scenarios for HSCDS on cable TV distribution networks.

For basic requirements for Plug and Play, power management, and driver support, see the “PC 97 Design for Network Communications” section later in this chapter.

19. Support PC 97 requirements for network adapters

Required

The following requirements must be met, as defined in the “Network Adapter Basic Features” section earlier in this chapter:

- Support NDIS 4.0 using a miniport driver
- Automatically sense whether a network cable is connected
- Automatically sense transceiver type
- Support quad-word buffer alignment or better
- Adapter communicates with driver across any bridge

20. Provide platform support for external cable modems

Recommended

Plan to support external cable modems by supplying a low-cost Ethernet network adapter as part of a PC until a low-cost internal cable modem becomes available.

21. Provide Ethernet card solution

Recommended

PC platform makers providing a standard Ethernet card to connect to an external cable modem can contribute to a low-cost solution at the customer’s end for the HSCDS service today.

Cable TV operators are extremely sensitive to the cost of every component it takes to deliver HSCDS over an HFC cable distribution network. For example, operators currently want the cable modem on the customer’s site to cost no more than \$500. Cable modem vendors are building devices that cost between \$395 and \$1495.

This cost sensitivity can be understood in the context of what it costs cable TV operators to upgrade their physical plant to deliver HSCDS. Estimates are that cable operators have spent over \$500 per customer to build the existing physical plant. Upgrades of coax branch and tree networks to HFC are estimated to cost another \$150 to \$400 per household.

22. Participate in developing standards*Recommended*

Microsoft encourages cable modem vendors to contact Microsoft about the devices they are designing. Microsoft wants to work with the cable TV industry in establishing standards for the use of cable modems in HSCDS delivery networks.

ATM Adapter Basic Features

ATM is a new area for requirements. Although ATM is not a required device for high speed connections, if it is implemented, it must meet these requirement.

For basic requirements for Plug and Play, power management, and driver support, see the “PC 97 Design for Network Communications” section later in this chapter. For more details about the following requirements, please refer to Section 3, “ATM Layer Specification,” in ATM User-Network Interface Specification v. 3.1.

23. Support PC 97 requirements for network adapters*Required*

The following requirements must be met, as defined in the “Network Adapter Basic Features” section earlier in this chapter:

- Support NDIS 4.0 using a miniport driver
- Automatically sense whether a network cable is connected
- Support quad-word buffer alignment or better
- Adapter communicates with driver across any bridge

24. Minimum VPI and VCI range*Required*

On servers larger Virtual Path Identifier (VPI) and Virtual Channel Identifier (VCI) ranges are needed to support larger number of connections on servers.

System type	VPI	VCI
Client system	0	0–255
Server system	0–31 (or more)	0–2048 (or more)

25. Traffic shaping*Required*

Simpler Segmentation and Re-Assembly (SAR) chips support only “Peak Rate” traffic shaping—for example, you can only specify the peak rate per Virtual Channel (VC). In the ATM Forum’s Traffic Management Specification, the Available Bit Rate (ABR) standard requires end-stations to be able to send and receive “Resource Management” (RM) cells used to control traffic in a bursty LAN-type environment. Eventually, both workstation and server PCs must be capable of supporting this.

System type	Method
Client system	Peak Rate
Server system	ABR from the ATM Forum’s Traffic Management Specification

26. Operation and maintenance (OAM) support

Recommended for Client system; required for Server system (layers F1-F5)

This feature is needed for diagnostics.

27. Buffer chaining (Tx + Rx)

Recommended for Client system; required for Server system

This feature is needed for large packets.

28. External clocking*Required*

Recommended method: ATM adapter supports both Internal and External (default) clocking. Usually, adapters can derive their transmit clocks from the switch’s Sonet frames (external clocking). Internal clocking is useful for diagnostics (connect Tx to Rx, and so on).

PC 97 Design for Network Communications

This section summarizes requirements related to the design initiatives for PC 97 defined in Part 1 of this guide.

Plug and Play and Bus Design for Network Communications

The items in this section are requirements for Plug and Play capabilities.

29. Plug and Play device identifier

Required

- For a system board device, there must be a Plug and Play device-specific ID.
- The device must provide Plug and Play device identifiers in the manner required for the bus it uses, as defined in Part 3 of this guide. For example, a PCI device must comply with PCI v. 2.1 requirements and also provide a Subsystem ID and Subsystem Vendor ID, as defined in the “PCI” chapter in Part 3 of this guide.

30. Automatic resource assignment and dynamic disable capabilities

Required

The system must be capable of automatically assigning, disabling, and relocating the resources used by this device when necessary, using the method required for the related bus class. Changing or adding this device to the system must not require changing jumpers or switches on either the adapter or the system board. In the event of an irreconcilable conflict with other devices on the system, the system must be able to disable the device to prevent the system from stalling.

31. Minimum resource requirements for non-PCI devices

Required

As for all PC 97 devices, unique 16-bit I/O address decoding is required. These are the required resource settings for non-PCI devices:

- 4 unique I/O locations
- 4 unique IRQ signals
- 3 unique memory address locations, if memory-mapped I/O is used
- 3 DMA channel selections, if DMA is used

Notice that, as for all devices, IRQ sharing for ISA is required if the minimum resource requirements cannot be met.

32. Support multiple adapters*Required*

For network communications devices, the Plug and Play identifiers and resource support must be sufficient to automatically support the addition of multiple network communications devices to the system. This is true for the same and differing types of network communications devices.

33. All resource settings can be changed in the user interface*Required*

For Windows 95, for example, this means that all possible resource settings are available in Device Manager.

Power Management for Network Communications

This section summarizes the specific power management requirements for network communications devices.

34. Compliance with “Device Class Power Management Reference Specification”*Required*

The “Device Class Power Management Reference Specification” for the Network Device Class provides definitions of the OnNow device power states (D0–D3) for these devices. The specification also covers device functionality expected in each power state and the possible Wakeup event definitions for the class.

Version 1.1 Clarification:

As of **July 1, 1997**, the device must meet the requirements defined in the *Network Device Class Power Management Specification* and the *Default Device Class Power Management Specification*, as described in the clarifications to item 5 of the “Basic PC 97” chapter. Wake-up support is optional.

35. Support Wakeup Events defined in “Device Class Power Management Reference Specification”*Optional*

The “Device Class Power Management Reference Specification” for network devices includes a defined mechanism for programming the network adapter with one or more “wakeup packets” that, when received over the network, will generate a wakeup signal to the system using the wakeup signaling mechanism defined for the bus to which the adapter is connected. For PC 97, the ability to cause such a Wakeup event is an optional feature.

Device Drivers and Installation for Network Communications

This section summarizes requirements for device drivers for network communications devices, in addition to the requirements for using an NDIS 4.0 miniport driver, as defined in the “Network Adapter Basic Features” section earlier in this chapter.

36. Device driver and installation meet Windows and Windows NT standards

Required

The manufacturer does not need to supply a driver if a standard driver is provided with the operating system. If a manufacturer supplies drivers, requirements for device drivers and installation include the following:

- All devices and drivers must pass testing by Microsoft WHQL.
- All configuration settings are stored in the registry. The driver must not use INI files for configuration settings.
- The correct miniport driver or any other manufacturer-supplied files specified in the device’s INF must be installed in the correct locations. For manufacturer-provided files, the vendor must not be identified as Microsoft, and all other copyright and version information must be correct for the manufacturer.
- Driver installation and removal use Windows-based methods as defined in the Windows 95 and Windows NT DDKs.
- Driver files provided by the vendor must not use the same file names as used by files included in Microsoft operating systems, unless specifically agreed with Microsoft.
- Only 32-bit protected-mode components are installed. No real-mode or 16-bit protected-mode components are provided in order to operate under Windows.
- Driver supports Plug and Play IRPs (for WDM drivers) or messages (for VxDs).

For complete details about standard installation requirements for drivers, see “Basic PC 97” in Part 2 of this guide.

37. Windows NT-based detection DLL works correctly

Required

This ensures that the network communications devices is correctly identified during installation.

38. Driver supports promiscuous mode

Required

This ensures that the adapter can be used with Microsoft Network Monitor Agent. This requirement applies only to LAN media (non-switched).

39. Driver works correctly with Microsoft network clients and protocols*Required*

This includes the 32-bit Microsoft client and NetWare-compatible clients provided with Windows, whether connected to a Windows NT-based server, a Novell NetWare 3.x or 4.x server, or a Windows-based peer server. For all cases, this includes connections using Microsoft TCP/IP, the IPX/SPX-compatible protocol, and NetBEUI.

40. NDIS miniport driver does not make operating system-specific kernel calls*Required*

A miniport driver that follows the NDIS specification must not make operating system-specific calls. A correct driver makes calls only to the NDIS library. The NDIS library provides all the functions a driver needs or should use. This results in binary compatibility of the driver between Windows 95 and Windows NT.

NDIS conformance must be validated over a single network connection and multiple connections. For Windows NT, this must be validated on a multiprocessor system for any device that receives the “Designed for Microsoft Windows” logo.

41. Driver detects adapter availability for removable devices*Required*

The device driver must sense the presence of the network device to determine whether the commands sent to and received from the network device are appropriate. This can be implemented using a known register address that can be queried. The device driver must inform the user if the network is not available.

42. Help file provided if special driver parameters are used*Required*

This ensures that the user can change settings correctly. The user interface for displaying any driver-specific Help file must display the correct file. The Help file must contain relevant information.

References for Network Communications

This section lists some of the publications, services, and tools available to help build hardware that works with Windows operating systems.

Windows NT 4.0 DDK and Windows 95 DDK

Microsoft Developer Network (MSDN)

Includes NDIS specifications, driver requirements, and Plug and Play support.

High-Speed Cable Data Service (HSCDS) RFP

An RFP for equipment and system integration capabilities that enables cable TV operators to offer High-Speed Cable Data Service (HSCDS) over the evolving hybrid fiber-coax (HFC) cable television infrastructure. Available from Cable Television Laboratories, Inc., 400 Centennial Parkway, Louisville, CO 80027.

ATM User-Network Interface Specification v. 3.1

Prentice Hall, 1995

ISBN 0-13-393828-X

Device Class Power Management Reference Specification

<http://www.microsoft.com/hwdev/onnow.htm>

Version 1.1 References Update:

1997 Version of National ISDN Basic Rate Interface Terminal Equipment Generic Guidelines, Document Number SR-3888

Phone: (800) 521-2673 (North America)

(908) 699-5800 (Outside North America)

<http://www.bellcore.com>

ATM User-Network Interface Specification, Version 3.1

Prentice Hall, 1995

ISBN 0-13-393828-X

Device Bay Interface Specification, Version 1.0

<http://www.device-bay.org>

Network Device Class Power Management Reference Specification, Version 1.0

<http://www.microsoft.com/hwdev/onnow.htm>

High-Speed Cable Data Service (HSCDS) Request for Proposals (RFP)

Cable Television Laboratories, Inc.

400 Centennial Parkway

Louisville, CO 80027

<http://www.cablelabs.com>

An Interoperable End-to-End Broadband Service Architecture over ADSL System

<http://www.microsoft.com/isp/supercomm/> (click the “High Speed Access” link in the frame on the left, then scroll down to the bottom of the frame on the right)

NDIS and Windows networking white papers

<http://www.microsoft.com/communications/>

USB specifications

Phone: (503) 264-0590

Fax: (503) 693-7975

<http://www.usb.org>

Windows 95 and Windows NT DDKs

MSDN Professional membership

Includes NDIS specifications, driver requirements, and Plug and Play support.

Checklist for Network Communications

<i>Basic PC 97</i>	<i>Workstation PC 97</i>	<i>Entertainment PC 97</i>
System Requirements for Network Communications		
1. Network adapter included in PC system <i>Recommended</i>	<i>Required if no modem</i>	<i>Recommended</i>
2. Internal or external ISDN devices <i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
3. Cable modem built into PC <i>Optional</i>	<i>Optional</i>	<i>Optional</i>
4. ATM adapter built into PC <i>Optional</i>	<i>Optional</i>	<i>Optional</i>
Network Device Requirements		
Network Adapter Basic Features		
5. Support NDIS 4.0 using a miniport driver <i>Required</i>		
6. Automatically sense presence of link or carrier to the network <i>Required</i>		
7. Automatically sense transceiver type (TP, AUI, BNC) <i>Required</i>		
8. Support quad-word buffer alignment or better for receive and support byte buffer alignment for send <i>Required</i>		
9. Adapter communicates with driver across any bridge <i>Required</i>		
ISDN Basic Features		
10. Support PC 97 requirements for network adapters <i>Required</i>		
11. Synchronous HDLC framing for internal ISDN device <i>Required</i>		
12. AT command set for external ISDN device: TIA-602 <i>Required</i>		
13. Async-to-sync conversion for external ISDN device <i>Required</i>		
14. Built-in NT-1 <i>Recommended</i>		
15. Multilink PPP (RFC 1717) for external ISDN device <i>Recommended</i>		
16. External ISDN device uses high-speed port <i>Recommended</i>		
17. NDIS WAN miniport for internal ISDN device <i>Required</i>		
18. Binary compatibility between Windows 95 and Windows NT for ISDN drivers <i>Recommended</i>		

Cable Modem Basic Features

- 19. *Support PC 97 requirements for network adapters*
Required
- 20. *Provide platform support for external cable modems*
Recommended
- 21. *Provide Ethernet card solution*
Recommended
- 22. *Participate in developing standards*
Recommended

ATM Adapter Basic Features

- 23. *Support PC 97 requirements for network adapters*
Required
- 24. *Minimum VPI and VCI range*
Required
- 25. *Traffic shaping*
Required
- 26. *Operation and maintenance (OAM) support*
Recommended for Client system
Required for Server system (layers F1-F5)
- 27. *Buffer chaining (Tx + Rx)*
Recommended for Client system
Required for Server system
- 28. *External clocking*
Required

PC 97 Design for Network Communications**Plug and Play and Bus Design for Network Communications**

- 29. *Plug and Play device identifier*
Required
- 30. *Automatic resource assignment and dynamic disable capabilities*
Required
- 31. *Minimum resource requirements for non-PCI devices*
Required
- 32. *Support multiple adapters*
Required
- 33. *All resource settings can be changed in the user interface*
Required

Power Management for Network Communications

- 34. *Compliance with "Device Class Power Management Reference Specification"*
Required
- 35. *Support Wakeup Events defined in "Device Class Power Management Reference Specification"*
Optional

Device Drivers and Installation for Network Communications

36. Device driver and installation meet Windows and Windows NT standards

Required

37. Windows NT-based detection DLL works correctly

Required

38. Driver supports promiscuous mode

Required

39. Driver works correctly with Microsoft network clients and protocols

Required

40. NDIS miniport driver does not make operating system-specific kernel calls

Required

41. Driver detects adapter availability for removable devices

Required

42. Help file provided if special driver parameters are used

Required
