CHAPTER 19

Modems

This chapter presents the requirements for modems, fax modems, voice modems, voice/data modems, wireless and cellular modems, and serial Integrated Service Digital Network (ISDN) adapters.

For an overview of the design issues related to the modem requirements, see "Modem Design Issues" in Chapter 2, "PC 99 Design Initiatives."

Note: Communications standards mentioned in this chapter are available through Bellcore, European Telecommunication Standards Institute (ETSI), International Telecommunication Union (ITU) Sales, Telecommunications Industry Association (TIA), or Global Engineering Documents, as described in "Modem References" later in this chapter.

Notice also that, as for all PC 99 requirements, it is specifically noted in the text whether it is planned that a specific recommended feature will become a requirement in future versions of these guidelines.

Contents

System Requirements for Modems

This section summarizes the PC 99 system requirements for modems.

19.1. Modem device is provided with PC system

Consumer	*Office*	*Mobile*	*Workstation*	*Entertainment*
Required	*Recommended*	*Required*	*Recommended*	*Required*

PC 99A clarification: A modem or other communications support is **not** required for Workstation systems.

Recommended: Internal modem, or use USB or PC Card as the external modem connection.

This requirement can also be met by including support for alternative digital or analog public network communications devices, including ISDN, Digital Subscriber Line (DSL) technology, or cable modem, as appropriate to customer demand and geographic locale. The recommended interface for these technologies is to use a Network Driver Interface Specification (NDIS) miniport, as described in Chapter 20, “Network Communications.”

Mobile PC Note

The presence of a CardBus slot on the mobile PC meets the requirements for providing a modem. The minimum capabilities for an integrated modem are defined in Chapter 6, “Mobile PC 99.”

Modem Basic Features

This section defines basic hardware feature requirements for modems.

19.2. Modem controller meets PC 99 requirements

Required

The modem controller must support the following:

- V.250 (formerly V.25 *ter)*
- AT command buffer of at least 60 characters
- Semicolon (;) character dial string modifier, except when the modem is configured for operation in those countries that prohibit this dial modifier
- Universal Modem Driver (Unimodem) Diagnostics command, AT#UD
- Capable of software-based feature upgrades; provide upgradable ROM or Windows driver-based modem

Recommended: For compatibility with legacy applications that are not based on the Windows Telephony API (TAPI), the ATW2 command should be supported. This command specifies that a string specifying the receiver line bit rate is appended to the CONNECT result code.

19.3. Modem supports V.250 AT command set

Required

International Telecommunications Union (ITU) Recommendation V.250 is a superset of the TIA-602 basic AT command set with significant and useful improvements. It includes these new components:

- A standard format for extending the AT command set, with standard means for the PC to test the range of supported values for each command. This enables adaptive modem installation.
- Standard extensions for modem ID, port control, modulation control and reporting, error control, and data compression control and reporting. This reduces or eliminates the need for data-modem INF files.

Related Recommendation V.251, formerly known as Annex A/V.25 *ter*, provides standard commands that enable the PC to use V.25, V.8, and V.8 *bis* call-control features for point-to-point data calls, voice/data/video calls, and voice-to-data transitions.

It is not required to implement every AT command, result code, and information text defined in V.250. If a particular function is not implemented in a modem or is not controllable by way of the AT command, then the corresponding V.250 AT command need not be implemented.

However, any modem function controllable by way of the AT command must be controllable by the appropriate V.250 command if one is defined in V.250 for that function. Optionally, the function can be controlled by a proprietary command. Similarly, any reportable modem event must use the report defined in V.250, if one exists.

The essential V.250 commands are the following:

- All basic mode commands from TIA-602 (no + prefix)
- Identification: +GMI, +GMM, +GMR
- Port control: +IPR, +ICF, +IFC, +ILRR
- Modulation: +MS, +MR, +MA
- Error control: +ES, +ER, +EB, +ESR, +ETBM
- Compression: +DS, +DR

The modem must also be able to generate appropriate V.250 responses enabled by the +ILRR, +MR, +ER, and +DR commands. The standard format allows a future modem installer to adaptively install and use a modem, with minimal need for INF-file minidrivers.

PC 99A clarification: Windows Unimodem does not use the following commands directly; therefore, these are not in the sample INF and are not required: +ICF, +MA, +EB, +ESR, +ETBM. These commands are only required

if the function is controllable in the modem by way of AT commands; in that case, the standard V.250 commands defined here must be included.

19.4. Data modem supports V.90 (1998) analog modem modulation

Required

ITU-T Recommendation V.90 modulation supports pulse-code modulation (PCM) connections to digitally-connected central sites, at data rates from 56 Kbps down to 28 Kbps.

V.90 support implies support for V.34, which is used for analog-to-analog connections and for connections to central sites from users whose telephone lines do not support V.90 operation, at speeds from 33.6 Kbps down to 2400 bps.

Mobile PC Note

For mobile PCs, if modem capabilities are integrated in the base platform, then V.34 or higher is required. All other requirements for modems must be met as defined in this chapter.

19.5. Data modem supports Annex A/V.34 (1998) SRC

Recommended

Seamless Rate Change (SRC) procedures defined in new Annex A/V.34 (1998) enhance performance during data mode, because data pump speed changes take place without blocking data flow. SRC is critical for IP-Telephony applications such as H.323/PPP or H.324 over a V.34 data modem; without SRC, rate changes interrupt voice channels for 10 or more seconds (for retrains) or approximately 1 second (for rate negotiations). SRC might also allow a faster startup procedure, because the data pump can then quickly converge on a sub-optimal slower initial speed, for example, to initiate ISP connection negotiations, and then change to higher speeds as the pump training is refined.

19.6. Data modem supports V.42 LAPM, V.42 *bis,* and V.80 Synchronous Access data protocols

Required

The V.42 Link Access Procedure for Modems (LAPM), which provides error control, together with the V.42 *bis* data compression procedures, are particularly well-suited to traditional bulk data delivery modem applications.

The Synchronous Access modes defined in Chapter 8 of V.80 allow the data protocols in the modem to be bypassed and allow any arbitrary, non-traditional protocol to be implemented in the host. For example, it allows host-based V.70 Simultaneous Voice/Data or host-based H.324 video telephony systems to be implemented. Chapter 8 of V.80 requires implementation of both Framed sub-Mode and Transparent sub-Mode.

Because V.42 LAPM is the default mode of operation in most modems, it is commonly used when accessing Internet Service Providers (ISPs). The

asynchronous (character-oriented) form of the Point-to-Point Protocol (PPP) runs on top of LAPM.

For enhanced, lower-latency performance for such applications as Internet telephony, V.80 can be used together with the synchronous form of PPP. V.8 *bis* can be used to negotiate the use of V.80. In particular, the AT+ITF command defined in V.80 is useful in reducing the buffering delays in the modem transmitter.

19.7. Modem supports call control signaling, controlled using V.251 modem commands

Required

To comply with PC 99 requirements, V.90 and V.34 modems must support ITU Recommendations V.8, V.8 *bis*, and Recommendation V.251.

ITU Recommendation V.8 *bis* provides for the negotiation and selection of call functions between end points, and enables smooth voice-to-modem transitions during a call. V.8 *bis* is required for multimedia modes such as V.61 Analog Simultaneous Voice and Data (ASVD) and V.70 Digital Simultaneous Voice and Data (DSVD). V.8 *bis* is also used to negotiate the use of manufacturer-specific modulations and features. V.8 *bis* defines code points for V.42 and V.80 modes of operation. It enhances the basic call function selection embodied in the recommendations for V.25 and V.8.

ITU Recommendation V.251 enables the PC to participate in call control, allowing flexibility and a visual user interface as well as saving modem complexity. At a minimum, the V.251 implementation must:

- Support V.8 operation that is controlled by Data Circuit Terminating Equipment (DCE) with Data Terminal Equipment (DTE) notification
- Support DTE-controlled V.8 *bis* operation
- Support backward compatibility for media detection with terminals using V.25 signaling, for example, data calling tone and fax calling tone
- Support backward compatibility for media detection with older modems, for example, V.32 and V.32 *bis*
- Provide a means for turning on the V.8 Calling Indicator (CI) signal for originating calls

Video-Ready Modem Handbook specification from Intel Corporation describes an example using V.251 for call control and call function selection. The specification also gives implementation guidance for the use of V.80 in low-latency applications.

To support media detection in future Microsoft Back Office® family of products, it is recommended that the V.251 modem implement the <a8a> codepoints for DTE-controlled operations (2, 3, and 4).

19.8. Fax modem supports 14.4 Kbps (V.17) with Class 1 (TIA-578-A) command set

Required

Fax capabilities are required. The fax modem must support 14.4 Kbps (V.17) with the Class 1 (TIA-578-A) command set.

In addition to the required fax capabilities, the following enhanced capabilities are recommended for fax modems:

- Class 1.0 (ITU T.31) with +FAR support, which allows the hardware to perform adaptive carrier detection
- Class 2.0 (ITU T.32 or TIA-592) for rack-mounted server modems
- Adaptive DATA/FAX call classification based on the Class 2.0 +FAA command or equivalent (for example, +FAE), particularly for rack-mounted server modems
- V.34 half-duplex (33.6 Kbps) modulation, controlled by Annex B/T.31 procedures

Windows includes fax modem support. Windows 2000 Professional and future versions of Microsoft BackOffice family of products will support Class 1.0 and Class 2.0 fax modems and adaptive FAX/DATA call classification. To benefit from this support, modem vendors should extend their modem INF files to support the registry keys for these features, as defined in the Windows Modem Developers Kit (MDK).

19.9. Modem supports delayed and blacklisted number clearing

Recommended

This support is recommended for modems supporting delayed and blacklisted number tables. The modem should clear its delayed and blacklisted number tables if the associated handset goes off hook.

During certain international Post, Telephone, and Telegraph (PTT) certification processes, modems must support the delayed and blacklisted numbers feature. That means that when the modem fails to connect to a specific number for a certain number of times, the dialed number is stored in an internal list. Subsequent automated dialing operations to this number are then either delayed for a time or might be forbidden until some form of manual intervention occurs (blacklisted). The international certification processes specify that manual intervention using an external device is required in order to clear these numbers.

Windows provides error messages corresponding to delayed and blacklisted error reports in order to reduce customer confusion.

19.10. Modem supports TDD, meeting V.18-1996 with V.250 AT commands

Recommended

People who are deaf or hard of hearing can use Telephone Device for the Deaf (TDD), also known as Text Telephones, to communicate over phone lines. The U.S. Americans with Disabilities Act (ADA) requires all businesses of a certain size or larger to have Text Telephone services available and to be able to receive calls from people using Text Telephones.

It is recommended to include Text Telephone capability for the type commonly used in the country of sale and use, for example, Baudot in the United States, Minitel in France, and so on. In North America and Europe, the following types of Text Telephones are used:

- Baudot: 45 or 50 bps Frequency-Shift-Keyed (FSK) and 5-bit Baudot coding
- ASCII: 300 bps Bell 103 and 7-bit ASCII coding
- European Deaf Telephone (EDT): 110 bps half-duplex V.21 and 7-bit coding
- Minitel: V.23 modems and 7-bit coding
- Modems and 7-bit coding
- Dual-tone multifrequency (DTMF): 2-digit or 3-digit character coding

ITU Recommendation V.18 codifies how all these devices work and how to adaptively connect to all of them. ITU Recommendation V.250 contains these AT commands for control of V.18 features in a modem: +MV18S, +MV18R, +MV18AM, +MV18P.

Voice Modem Requirements

Voice capabilities are not required for PC 99 modems, but if implemented, the requirements defined in this section must be met.

A separate category of voice-only device can be integrated with a telephone. These voice-only devices are not required to support modem data or fax, but must comply with the requirements defined in this section.

19.11. Voice modem supports ITU V.253 (AT+V)

Required in modems supporting voice

TIA IS-101-1994, the interim standard for Voice DCE, has been superseded by TIA-695. TIA-695 adds voice formats and speakerphone control commands. ITU-T V.253 (formerly V.voice) was completed in January 1998 and is a superset of the TIA-695 U.S. standard. V.253 includes small corrections to TIA-695 and adds provisions for bi-directional, digitized voice over the serial port.

The following voice modem features are required:

- Voice recording and playback (+VTX, +VRX)

- DTMF generation and detection during voice I/O
- Voice I/O support of 8-bit, 8-kHz PCM formats: unsigned linear, G.711
- Programmable gain control for all audio channels
- Support for speakerphone operation (+VTR)
- **PC 99A clarification:** Support for full-duplex voice (+VTR).

Voice-only devices—AT command set devices that do not implement data or fax functions—must also support voice I/O to the handset.

19.12. Voice modem support includes PC 99 recommendations

Recommended

The following voice modem features are recommended:

- Sense local telephone line state (on hook/off hook) without the modem going off hook
- Extension (parallel) telephone answer and hang-up detection and reporting
- Programmable gain control for all audio channels
- Remote (far end) telephone answer and hang-up detection and reporting
- Message waiting signal (stuttered dial tone) detection reporting
- Special Information Tone (SIT) detection and reporting
- Distinctive ring detection and reporting
- Powered interface to the local telephone to support voice I/O and DTMF I/O

It is not required for a voice modem that implements any recommended feature to implement every feature in this list.

19.13. Voice modem supports Caller ID Detection and Reporting

Recommended

Caller ID reporting is controlled with the AT+VCID and AT+VRID commands. As specified in V.253, Caller ID reporting is available in operating modes other than FCLASS 8 (Voice Mode). Therefore, it is recommended that the modem support the AT+VCID and AT+VRID commands even if Voice Mode is not supported.

19.14. Voice modem supports speakerphone

Required in modems supporting voice

Audio I/O for speakerphone can be implemented in any of the following ways. At least one of the following methods is required for voice modems:

- Simultaneous, bi-directional digitized audio to host, using the host modem asynchronous port. This method is defined in V.253, and allows speakerphone

operation with PC audio peripherals, as well as host-based acoustic echo cancellation.

This method is essential for speakerphone operation with PC Card modems, which lack the connectors for external audio I/O. Because this method requires the least amount of hardware components in the modem and is therefore the lowest-cost solution, it is the preferred speakerphone implementation.

- Internal analog connection to the PC audio system. Some OEM internal voice modems incorporate an audio codec, which connects using an internal cable to the host studio peripherals. This allows speakerphone operation with PC audio peripherals, but it requires additional hardware components in the modem and a cumbersome, proprietary analog cable connection inside the PC.
- Jacks to external audio I/O. I/O jacks such as microphone, speaker, or handset jacks are optional, but if they are included on the modem, speakerphone operation should be supported through them.
- Built-in audio I/O. Microphone and speaker support are appropriate for voice-only non-modem devices, such as PC-connected phones.

Wireless and Cellular Modem Requirements

This section provides requirements and recommendations for wireless and cellular modems.

19.15. Wireless support is implemented for modems

Recommended

There are a variety of wireless modems and look-alike modems. These include the common types: North American analog cellular, cellular digital packet data (CDPD), global system for mobile communications (GSM) and other digital cellular systems, and so on. However, there are several other types, such as the Ricochet modem from Metricom.

For all wireless and cellular modems, the commands in TIA-678 are recommended. The +WS-46 command, which selects the wide area network (WAN), is required.

Windows has registry keys that support analog cellular modems. Windows also supports data access in GSM and other wireless modem types. Participants in the Mobile Data Initiative are developing extensions for other services on digital cellular modems, as described in the following requirement.

19.16. Digital cellular phone support is implemented for modems

Recommended

Digital cellular support is not a requirement, but if implemented, the following appropriate digital cellular control standards must be supported:

TIA-678 +WS-46 selector command	Class 2.0 facsimile services, per appropriate

+CBC battery power monitoring command

+CPAS phone activity status

+CSQ signal quality monitoring command

standard

For GSM modems, +CBST protocol selection command

To allow software applications to specify settings and manipulate Short Messaging Service (SMS) through a GSM modem card, it is recommended that the card support the following GSM 07.05 commands.

+CMGF: Message Format

+CMGL: List Messages

+CMGR: Read Messages

+CMGS: Send Messages

+CMGW: Write Messages

+CNMI: New Message Indications to terminal equipment (TE)

+CPMS: Preferred Message Storage

+CRES: Restore Settings

+CSAS: Save Settings

+CSCA: Service Center Address

+CSCS: TE character set selection

+CSMS: Select Messaging Service

Unlike wireline data modems, these devices are not required to support V.34 signaling; it is not available. 9600 bps capability is required; higher speeds are recommended where available.

Class 1.0 fax support is available on some of these devices, but it is not required; the error rates with transparent modem faxes are often very high.

Cellular telephone systems are widely deployed in the industrialized world and are now being deployed internationally. In North America, analog cellular systems (TIA-553) are currently predominant, although two types of digital cellular systems can also be deployed: code division multiplexed access (CDMA; TIA IS-95) and time division multiplexed access (TDMA; IS-136).

In Europe and the rest of the world, the GSM digital cellular system is widely deployed. In Europe, the infrastructure for data, fax, and short messaging is now in place.

For all three digital cellular systems, the system design has been extended to offer data, fax, voice, and SMS to mobile users. In all cases, a modem pool is added to the ground stations, where connection is made to the Public Switched Telephone Network (PSTN). Access to the logical serial ports of these modems is made using the digital error-controlled radio link to the equipped mobile phone and is exposed on a serial port or associated PC Card device.

Digital cellular communications equipment should default to using error correction on the radio link. For example, for GSM 7.07, the modem should initialize to +CBST=,,1 (which selects a “nontransparent” air interface).

To allow data cards to use GSM/ISDN V.110 “fast access” where available in the network, +CBST=71,, (9600 bps V.110) should be a valid setting.

The AT command sets for these digital cellular phone systems are contained in the following standards.

Standard	Command set
GSM 7.07	GSM system: data, fax, voice
GSM 7.05	GSM SMS
TIA IS-707	North American CDMA: data and fax
TIA IS-135	North American TDMA: data and fax

The TIA-678 +WS46 command has codes to indicate which system the modem is capable of. For example, the following values, quoted from Table 4 of the standard, are useful.

Value	System
1	Public telephone network (that is, a normal wireline modem)
4	CDPD
7	TIA-553 analog cellular system
10	Metricom Ricochet network
12	GSM digital cellular system
13	TIA IS-95 CDMA digital cellular
14	TIA IS-136 TDMA digital cellular (Personal Communications System [PCS])

ISDN Modem Requirements

There are two classes of ISDN adapters: parallel bus devices, supported by NDIS WAN drivers, and serial port devices, supported by Unimodem with INFs. This section addresses serial ISDN adapters, colloquially referred to as ISDN modems.

For a general discussion of ISDN and a list of requirements related to parallel bus devices based on NDIS under Windows 98 and Windows 2000, see Chapter 20, “Network Communications.”

ISDN modems share the following features:

- ISDN Basic Rate interface (2B+D)
- Serial AT command language, with proprietary ISDN extensions

ISDN modems also share the following differences from wireline PSTN modems:

- User (or device) must configure for switch type and service profile ID (SPID)
- Data only, in increments of one or two 64,000 bps B channels
- Fax not available
- V.42 and V.42 *bis* usually not available

This section defines the requirements for ISDN modems.

19.17. ISDN driver supports unattended installation, with limitations

Required

In general, the driver must meet the PC 99 requirements for drivers and installation, as defined in requirement 3.16, “Device driver and installation meet PC 99 requirements.” However, configuration of the dependent parameters, such as SPIDs and switch-type IDs, must be done using the ISDN Configuration Wizard included in the operating system.

19.18. ISDN modem supports required command set

Required

An ISDN modem must support the following:

- Basic AT commands, such as TIA-602, which is a subset of ITU V.250
- Commands to select the end-to-end protocol used over the ISDN, for example, synchronous PPP, V.110, V.120, and so on
- Commands to set the switch type, subscriber numbers, or directory numbers
- SPID or EAZ (where applicable) for user selection or if auto-detection fails, must be included, implemented in the device or in the communications driver

19.19. ISDN modem exposes both B channels

Recommended

ISDN modems should expose both B channels so that they can leverage the multilink PPP support included in the operating system. Multilink PPP, as defined in RFC 1717, combines several ISDN B channels to increase the bandwidth of PPP links.

When using ISDN modems connected to the PC by way of a single serial port, these capabilities included in the operating system cannot be leveraged and the users might not be able to fully benefit from the features in the ISDN device, such as supporting two B-channels and combining them into one fast link. This is because Windows cannot see both B channels of the ISDN connection unless each B channel is exposed to the operating system either as a COM port or by way of NDIS.

External ISDN modems should be connected on a port such as USB that is fast enough to expose the full bandwidth of both B channels. Providing two separate COM-port cables is not an acceptable solution.

19.20. ISDN modem supports asynchronous-to-synchronous conversion

Required

These types of ISDN devices are treated as modems, not as internal ISDN devices supported using NDIS WAN miniports. In the external case, the primary

implication is that the operating system will send byte-level PPP (also known as asynchronous PPP). In the NDIS WAN case, the implication is that the operating system will send bit-level PPP (also known as synchronous PPP).

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

19.21. ISDN modem defaults to HDLC PPP after INF installation

Recommended

High-level data link control (HDLC) framing is a standard for sending synchronous data. An ISDN modem can support multiple end-to-end protocols, but it should default to synchronous PPP (RFC 1662), which is used by the Microsoft Remote Access Services (RAS) and Dial Up Networking (DUN) protocol stacks.

19.22. ISDN modem uses high-speed port

Recommended

Because of speed limitations inherent in a PC's COM ports, the connection for ISDN modems should be by way of a high-speed bus such as USB or IEEE 1394. A specification for controlling an ISDN TA over USB is in development by the USB Communications Device Class working group.

Basic Modem Performance

This section presents performance-related recommendations and requirements. In the case of the first two tests, "modem pair" refers to the fact that the identical make or model of the modem under test is present on both ends of the connection.

19.23. Modem pair passes basic V.34 file transfer test

Required

TIA standard TSB-38 specifies test procedures for evaluating modems. Test file **4.TST** contains random data and does not benefit from data compression.

This requirement is a basic test of modem functionality and verifies that the modem is able to connect at 31.2 Kbps, stay connected, and transfer data on a clean line for at least a half hour, which is a typical time period for a modem session.

While operating in V.34 modulation on TIA TSB-37A line 18C2, the modems must be able to transfer 256 repetitions of the TSB-38 test file **4.TST** in 40 minutes or less, simultaneously in both directions, without hanging up or otherwise aborting the transfer. V.42 LAPM is enabled during this test. Data transmission runs directly on the modems without the use of an additional protocol such as Zmodem.

Impairment combination 18C2 in the TIA TSB-37A PSTN consists of very mild impairments. No V.34 modem should have difficulty operating on this line at least 31.2 Kbps.

Note: For modems certified for operation only in those countries outside of North America, impairment combination 2C4 as specified in ITU-T Recommendation V.56 *bis*, can be substituted for TSB-37A line 18C2. Recommendation V.56 *bis* is an international equivalent of TIA TSB-37A.

19.24. Modem pair passes basic call connect reliability test

Required

This requirement is a basic test of modem functionality and verifies that the modem can reliably connect a large number of times on good telephone channels.

While operating in V.34 modulation, the modems must be able to perform four repetitions of the Call Connect vs. Test Loop Combination test defined in TIA TSB-38 (476 total connection attempts), with an overall call completion success ratio of 97 percent, and with neither modem stalling in an unresponsive, inoperable state.

As specified in TSB-38, the test channels 17C1 though 17C7 are used in this test because impairment combination 17C represents more than 55 percent of the combinations in the PSTN model defined in TSB-37A.

At the conclusion of each connection or connection attempt during the test, the modem port will be closed and then reopened for the next attempt.

Note: For modems certified for operation only in those countries outside of North America, the Call Connect Reliability Test specified in ITU-T Recommendation V.56 *ter*, can be substituted for that in TSB-38. Recommendation V.56 *ter*, an international equivalent of TIA TSB-38, specifies use of the PSTN model defined in Recommendation V.56 *bis*.

19.25. Modem pair passes concurrency test

Required

In this series of concurrency tests, the modem runs while a series of representative communications applications are running on the PC, for example, e-mail, web browsing, and H.263+ video teleconferencing.

PC 99A clarification: A standard concurrency test procedure will be published as part of the Modem Compatibility Test suite, which defines hardware compatibility with Windows operating systems. This will become part of compliance testing when a comprehensive and reproducible concurrency test is available.

Driver-based Modem Guidelines

The following requirements and recommendations apply to Windows driver-based modems.

Note: These recommendations are intended to guide designers in the development of WDM-based software modem implementations. Instrumentation techniques suggested here might only be realizable by designers with access to driver source code. They might not be applicable to external “black box” testing of modem performance.

19.26. Driver-based modem uses a WDM-based driver solution

Required

Windows 98 and Windows 2000 share WDM kernel calls. Driver-based modems must use the WDM kernel so that both operating systems can use a common driver binary. For Windows 2000, these drivers must also support symmetric multiprocessors.

19.27. Driver-based modem processor usage is not excessive

Recommended

Processor usage guidelines refer to performance on the minimum processor required by this guide for Consumer PC systems, as defined in requirement 3.1, “System performance meets PC 99 minimum requirements.” Performance guidelines are the following:

- **19.27.1 Driver minimum-maximum cycle times are appropriate.** The driver interrupt period or cycle time for computational processing needs to be short enough so that the signal processor can be responsive to line events, yet long enough so that system context switching overhead is not excessive.

  Cycle times in the range of 3 to 16 milliseconds are recommended. The 3-millisecond minimum ensures a reasonable bound on interrupts and task switching overheads. The 16-millisecond maximum establishes an upper bound for continuous execution at real-time thread priority, which can impact the minimum-sized audio buffer that can be used for low-latency audio during software modem sessions. Some manufacturers have cycle times as long as 20 milliseconds; this will impair low latency multimedia audio, such as G.729 audio on H.324 or H.323.

  In subsequent guidelines, the examples are based on the 16-millisecond maximum.

- **19.27.2 Average processor usage during data transmission does not exceed 25 percent.** In data transmission mode, the average processor usage by a driver-based V.34 or V.90 modem should not exceed 25 percent. For example, processor usage should not exceed 4 milliseconds during each 16-millisecond interval.

- **19.27.3 Total processor usage during data transmission does not exceed 50 percent.** In data transmission mode, the total processor usage by a driver-based modem should not exceed 50 percent of any period equal to the cycle time—for example, 8 milliseconds out of a 16-millisecond period. This accommodates back-to-back service of double-buffered tasks, while leaving adequate processing time available for low latency audio.
- **19.27.4 Average processor usage in retrain mode does not exceed 50 percent.** In (re)train mode, the average processor usage by a driver-based modem should not exceed 50 percent. For example, processor usage should not exceed 8 milliseconds in each 16-millisecond interval.
- **19.27.5 Total processor usage in retrain mode does not exceed 75 percent.** In retrain mode, the total processor usage by a driver-based modem should not exceed 75 percent of any period equal to twice the cycle time, for example, 24 milliseconds out of a 32-millisecond period. This percentage accommodates atypical usage peaks of very short duration, such as back-to-back service of double-buffered retrain mode tasks, while leaving adequate processing time available for low latency audio.

  Implementers can verify that their driver meets these guidelines by using a profiling tool such as VTune or by instrumenting their code to use the processor time-stamp counter model-specific register or an equivalent. Because usage includes system calls made by the driver, as well as operating system overhead incurred to schedule deferred procedure calls (DPCs) and threads, profiling measurements should be made using differencing techniques that compare driver plus operating system usage in active and inactive states.

19.28. Driver does not disable interrupts for excessive periods of time

Recommended

The maximum time during which a driver-based modem disables interrupts should not exceed 100 microseconds. The total time during which a driver-based modem has disabled interrupts should not exceed 200 microseconds during any 1-millisecond interval. This percentage accommodates back-to-back interrupt servicing.

Implementers can verify that their driver meets this guideline by designing their code to use a processor performance monitoring counter with a “cycles interrupts masked” or equivalent event selected.

19.29. Driver handles thread priorities appropriately

Recommended

Under WDM, driver writers can take advantage of kernel-mode threads with real-time priorities to minimize any need to perform extended processing with thread scheduling disabled. Computation in WDM DPCs takes place with thread scheduling disabled and can not be preempted by other DPCs. Such computation should be limited, maintaining system responsiveness and minimizing the DPC and thread latency experienced by the operating system and all drivers, including

modem drivers. Furthermore, because a range of DPC priorities (High, Medium, and LowImportance) are available, it is desirable that the maximum execution time of a DPC be tightly bounded to ensure that high priority DPCs do not suffer unduly from priority inversion.

- **19.29.1 Driver uses thread priorities 28 and above.** Only kernel-mode threads have access to the priority range 27 through 30. This guide recommends that driver-based modems perform the bulk of their computation in kernel mode threads, using thread priorities in the range 28 through 30. Thread priority 31 should be reserved for short-duration time-critical processing by the operating system. Non-modem thread-based drivers should use thread priorities 27 and lower.
- **19.29.2 Driver limits execution of simultaneously queued DPCs.** At any instant in time, the total execution time required for all DPCs that have been queued by a WDM driver-based modem, but have not been executed, should not exceed 500 microseconds.

  PC 99A clarification: Revised sentence: "At any instant in time, the total execution time required for all delayed procedure calls (DPCs) that have been queued by a WDM driver-based modem, but have not dequeued and started executing, should not exceed 500 milliseconds."

  Furthermore, DPCs requiring over 250 microseconds to execute should be initialized to low DPC priority (LowImportance) so as to bound the length of the priority inversion during which a driver-based modem prevents a higher-priority DPC from executing.
- **19.29.3 Driver does not disable thread preemption for excessive periods of time.** A WDM driver-based modem should not continuously disable thread preemption for more than 3.3 milliseconds. This guideline accommodates 300 microseconds of interrupts being disabled together with two back-to-back episodes of 1.5 milliseconds of extended processing at DISPATCH_LEVEL, as up to three 500-microsecond DPCs execute sequentially.

  PC 99A clarification: Revised sentence: "A WDM driver-based modem should not continuously disable thread preemption for more than 4.4 milliseconds. This guideline accommodates 400 microseconds of interrupts being disabled together with two back-to-back episodes of 2.0 milliseconds of extended processing at DISPATCH_LEVEL, as up to four 500-microsecond DPCs execute sequentially."

Implementers can verify that their driver meets these guidelines by designing code that uses the processor time-stamp counter model-specific register or an equivalent.

19.30. Driver tolerates reasonable operating system and bus latencies

Recommended

The following guidelines concern modem driver tolerance for hold-off from processing caused by the operating system, other drivers, or both. The recommended tolerances are designed to ensure minimum degradation in modem Quality of Service (QoS)—meaning effective throughput, connection rate, and line drop. It is strongly suggested that driver-based modems be designed to degrade gracefully in the event of a longer hold-off than recommended here, for example, by recovering from bit errors without either retraining or stepping down to a lower speed. The recommendations are:

- **19.30.1 Driver tolerates interrupt latency.** A driver-based modem should be able to tolerate a period of 2 milliseconds with interrupts disabled.

  PC 99A clarification: Revised sentence: "A driver-based modem should be able to tolerate a period of 4 milliseconds with interrupts disabled."

- **19.30.2 Driver tolerates DPC latency.** A driver-based modem should be able to tolerate a continuous period of 5 milliseconds during which a queued DPC is held-off from execution, possibly by other DPCs.

  PC 99A clarification: Revised sentence: "A driver-based modem should be able to tolerate a continuous period of 8 milliseconds during which a queued DPC is held off from execution, possibly by other DPCs."

- **19.30.3 Driver tolerates thread latency.** A WDM driver-based modem should be able to tolerate a 12-millisecond period when thread scheduling is continuously disabled.

  PC 99A clarification: Revised sentence: "A WDM driver-based modem should be able to tolerate a 16-millisecond period when thread scheduling is continuously disabled."

- **19.30.4 Driver tolerates PCI bus latency.** A WDM driver-based modem should be able to tolerate a 100-microsecond hold-off from access to the PCI bus caused by other bus masters.

19.31. Driver does not make excessive use of locked memory

Recommended

Use of page-locked memory by a V.34 or V.90 WDM driver-based modem should not exceed 5 percent of the minimum physical memory configuration required by this guide for a Consumer PC system: 1.6 MB out of 32 MB.

PC 99 Design for Modems

This section summarizes PC 99 requirements related to the design initiatives in Part 1 of this guide.

Plug and Play and Bus Design for Modems

This section defines requirements for Plug and Play capabilities.

19.32. Each hardware device has a unique Plug and Play device ID

Required

For a system-board device, there must be a device-specific ID.

Each bus-specific device must provide device IDs in the manner required for the bus it uses as defined in Part 3 of this guide. For example, PCI devices must comply with PCI 2.1 and must also provide a Subsystem ID and Subsystem Vendor ID as defined in Chapter 9, “PCI.”

Note: The device must implement either a bus Plug and Play ID or a COM-port Plug and Play ID, but not both.

19.33. Each device has a Plug and Play compatible ID

Required

The various bus-specific Plug and Play specifications provide the means for reporting a Compatible ID as well as a device unique ID.

At least one Compatible ID is required for PC 99. Its primary use is for back up in case the driver or INF file associated with the unique ID is not available, for example, if the customer lost the disk. The goal is for the modem to retain essential data functionality.

The most useful Compatible IDs would point either to an earlier version of the same product, whose INF file is included in shipping versions of Windows, or point to a reference INF file, provided by the modem chip-set manufacturer.

19.34. Dynamic resource configuration is supported for all devices

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. When the end user changes this device or adds it to the system, setting resource assignments 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.

19.35. PCI modem meets PC 99 requirements

Required

This device must comply with PCI 2.1 or later if PCI is used as the bus connection for the modem. The device must also meet all requirements defined in Chapter 9, “PCI,” including compliance with the Maximum Completion Time ECN for devices based on PCI 2.1. Additional power management capabilities are defined

for PCI devices in requirement 19.38, “Device complies with device class power management reference specification.”

19.36. USB modem meets PC 99 specifications

Required

A modem that uses USB must comply with all related USB specifications, including:

- *USB Specification, Version 1.0* or later
- *Universal Serial Bus Device Class Definition for Communication Devices, Version 1.0* or later

For compatibility with Unimodem and Windows USB serial drivers, a USB modem that incorporates the modem controller function must support the mandatory and optional requests and notifications for Abstract Control Model Serial Emulation defined in section 3.5.1.2.1 of the *USB Class Definitions for Communication Devices Specification.*

19.37. Device Bay modem meets PC 99 requirements

Required

A modem designed as a Device Bay peripheral must interface with either USB, IEEE 1394, or both buses. If implemented to use the USB bus, the device must support relevant USB device class specifications. All Device Bay peripherals must meet the requirements defined in *Device Bay Interface Specification, Version 1.0* or later.

Power Management for Modems

This section summarizes the modem power management requirements. See also the specific power management requirements for each bus defined in Part 3 of this guide.

19.38. Device complies with device class power management reference specification

Required

The *Communications Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions for the OnNow device power states (D0–D3) for modems. The specification also covers the device functionality expected in each power state and the possible wake-up event definitions for the class.

Power states D0 and D3 are required for modems on power-managed buses, including PCI, CardBus, and USB.

Modem adapters that use the PCI bus must be capable of generating a power management event (PME# assertion) from the D3 cold device state. It is recommended that modem adapters also support capture of Caller ID with hardware support for the AT+VRID “resend caller ID” voice modem command.

PC 99A clarification: Support for power states D0 and D3 cold are required for PCI modems, including wake on ring.

19.39. Device supports wake-up events

Required

A modem must be able to cause a wake-up event on an incoming ring as defined in *Communications Device Class Power Management Reference Specification.* This applies for modems on all power-managed buses, including PCI, CardBus, and USB.

The D2 power state is defined specifically for this purpose in the power management reference specification. The ability for a modem to cause a wake-up event from the D3 power state is also possible, and using the D3 state is recommend because it realizes better system power savings. To comply with this requirement, a modem must be able to cause a wake-up event from either the D2 state, the D3 state, or both states.

PC 99A clarification: PCI devices are required to support D3 cold on a PCI 2.2-based system with auxiliary power. On all other power-managed buses (such as USB), support for either D2 or D3 is acceptable.

Because caller-ID reporting would be missed by PCs while in a sleep state, the ability for a modem to retain and repeat the last caller-ID reporting on demand is recommended. The mechanism for doing this is described in *Communications Device Class Power Management Reference Specification* and in the V.253 voice modem specifications.

Device Drivers and Installation for Modems

This section summarizes device driver requirements for modems. The items in this section are requirements for all PC 99 systems.

19.40. Device drivers and installation meet PC 99 requirements

Required

The manufacturer does not need to supply a driver if a PC 99-compliant driver provided with the operating system can be used. If the manufacturer supplies a driver, the requirements for the device drivers and installation are defined in Chapter 3, “PC 99 Basic Requirements.” The basic requirements include driver support for unattended installation and Help file support if special driver parameters are used.

For information about WDM-based support for controllerless and software modems, see the Windows 2000 DDK. See also the related articles at http://www.microsoft.com/hwdev/modem/. For guidelines about implementing driver and installation support for modems under the Windows operating system, see the Windows MDK.

PC 99A clarification: For information about WDM-based support for controllerless and software modems, and for guidelines about implementing driver and installation support for modems under the Windows operating system, see the Windows Modem Development Kit (MDK) in the "Supplemental Documentation" section of the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/mdk_6y3j.htm).

19.41. Driver supports Unimodem

Required

The device driver must include Unimodem support. Typically, this requires a modem INF file, developed and verified using the MDK and pretested by the modem manufacturer.

19.42. Applications provided with device meet Win32 requirements

Required

Any Windows-based applications provided with the device, such as fax utilities, must meet requirements for software compatibility as defined in the Microsoft Platform SDK.

Telephony applications and service providers provided with PC 99 systems must be implemented using TAPI 2.0. Among other enhancements, applications can request, negotiate, and renegotiate QoS parameters with the network and receive indication of QoS on inbound calls and when QoS is changed by the network. For a summary of the TAPI 2.0 architecture and a description of how to write a TAPI service provider, see http://www.microsoft.com/win32dev/netwrk/tapiwp.htm. For implementation information, see the Microsoft Platform SDK.

Modem References

The following represents some of the references, services, and tools available to help build hardware that is optimized to work with Windows operating systems.

ANSI, TIA, and other standards
Global Engineering Documents
Phone: (800) 854-7179 (US)
(613) 237-4250 (Canada)
(303) 792-2181 (Outside North America)
Fax: 1 (303) 397-2740
ftp://ftp.symbios.com/pub/standards/io/

Bellcore Technical References
Bellcore (Bell Communications Research)
Phone: (800) 521-2673 (North America)
(908) 699-5800 (Outside North America)
http://www.bellcore.com

Communications Device Class Power Management Reference Specification, Version 1.0
http://www.microsoft.com/hwdev/specs/PMref/PMcom.htm

Device Bay Interface Specification, Version 1.0
http://www.device-bay.org

European Telecommunications Standards Institute (ETSI) or Global System for Mobile (GSM) standards
Phone: +33-92 94 42 00
FAX: +33-93 65 47 16
E-mail: secretariat@etsi.fr

ITU communications standards
ITU Sales
Phone: +41 (22) 730-6141
Fax: +41 (22) 730-5194
E-mail: sales@itu.ch
http://www.itu.int/publications/index.html

Microsoft Platform SDK, Windows 98 DDK, and Windows 2000 DDK, including information about WDM and NDIS
MSDN Professional subscription

Microsoft Windows Modem Developer Kit (MDK) and related white papers
Unimodem Diagnostics Command Reference Specification
http://www.microsoft.com/hwdev/modem/

PCI Local Bus Specification, Revision 2.1 (PCI 2.1)
http://www.pcisig.com/specs.html

Plug and Play specifications
http://www.microsoft.com/hwdev/respec/pnpspecs.htm

Telephony API (TAPI) overview and white papers
http://www.microsoft.com/communications/telephony.htm

USB specifications
http://www.usb.org/developers/index.html

WDM device driver support white papers
http://www.microsoft.com/hwdev/wdm/

Video-Ready Modem Handbook Specification, Version 1.0
http://developer.intel.com/IAL/vidred.htm

Checklist for Modems

If a recommended feature is implemented, it must meet the PC 99 requirements for that feature as defined in this document.

Consumer	Office	Mobile	Workstation	Entertainment
19.1. Modem device is provided with PC system				
Required	*Recommended*	*Required*	*Recommended*	*Required*
19.2. Modem controller meets PC 99 requirements				
Required				
19.3. Modem supports V.250 AT command set				
Required				
19.4. Data modem supports V.90 (1998) analog modem modulation				
Required				
19.5. Data modem supports Annex A/V.34 (1998) SRC				
Recommended				
19.6. Data modem supports V.42 LAPM, V.42 bis, and V.80 Synchronous Access data protocols				
Required				
19.7. Modem supports call control signaling, controlled using V.251 modem commands				
Required				
19.8. Fax modem supports 14.4 Kbps (V.17) with Class 1 (TIA-578-A) command set				
Required				
19.9. Modem supports delayed and blacklisted number clearing				
Recommended				
19.10. Modem supports TDD, meeting V.18-1996 with V.250 AT commands				
Recommended				
19.11. Voice modem supports ITU V.253 (AT+V)				
Required in modems supporting voice				
19.12. Voice modem support includes PC 99 recommendations				
Recommended				
19.13. Voice modem supports Caller ID Detection and Reporting				
Recommended				
19.14. Voice modem supports speakerphone				
Required in modems supporting voice				
19.15. Wireless support is implemented for modems				
Recommended				
19.16. Digital cellular phone support is implemented for modems				
Recommended				
19.17. ISDN driver supports unattended installation, with limitations				
Required				
19.18. ISDN modem supports required command set				
Required				
19.19. ISDN modem exposes both B channels				
Recommended				
19.20. ISDN modem supports asynchronous-to-synchronous conversion				
Required				
19.21. ISDN modem defaults to HDLC PPP after INF installation				
Recommended				
19.22. ISDN modem uses high-speed port				
Recommended				

19.23. Modem pair passes basic V.34 file transfer test
Required

19.24. Modem pair passes basic call connect reliability test
Required

19.25. Modem pair passes concurrency test
Required

19.26. Driver-based modem uses a WDM-based driver solution
Required

19.27. Driver-based modem processor usage is not excessive
Recommended

19.28. Driver does not disable interrupts for excessive periods of time
Recommended

19.29. Driver handles thread priorities appropriately
Recommended

19.30. Driver tolerates reasonable operating system and bus latencies.
Recommended

19.31. Driver does not make excessive use of locked memory
Recommended

19.32. Each hardware device has a unique Plug and Play device ID
Required

19.33. Each device has a Plug and Play compatible ID
Required

19.34. Dynamic resource configuration is supported for all devices
Required

19.35. PCI modem meets PC 99 requirements
Required

19.36. USB modem meets PC 99 specifications
Required

19.37. Device Bay modem meets PC 99 requirements
Required

19.38. Device complies with device class power management reference specification
Required

19.39. Device supports wake-up events
Required

19.40. Device drivers and installation meet PC 99 requirements
Required

19.41. Driver supports Unimodem
Required

19.42. Applications provided with device meet Win32 requirements
Required