C H A P T E R   1 7

Audio Components

This chapter presents the requirements and recommendations for audio devices under the Microsoft Windows family of operating systems.

Version 1.1
Includes changes to items 7, 8, 24, and References for Audio, 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: Audio FAQs for WHQL Testing on http://www.microsoft.com/hwtest/faqs/faq_audio.stm

Contents

Overview for Audio Components

For PC 97, the important design issues for basic audio under Microsoft Windows are to ensure a complete Plug and Play experience for end users and to ensure that audio capabilities meet minimum standards.

Microsoft DirectSound technology provides APIs for low-latency mixing, hardware acceleration, and direct access to the sound device, while maintaining compatibility with earlier Windows-based applications and device drivers. DirectSound provides a device-independent interface that application developers can use to take advantage of any hardware capabilities. The device driver reports the capabilities of the hardware to DirectSound and passes DirectSound requests to the hardware.

Note For additional Entertainment PC 97 and DVD-related audio requirements, see the section on DVD playback requirements in the "Video Components" chapter in Part 4 of this guide.

System Requirements for Audio Components

This section summarizes the hardware requirements for audio for PC 97 system designs.

1. Baseline audio meets PC 97 requirements

Basic PC 97	Workstation 97	Entertainment PC 97
Recommended	Recommended	Advanced audio required

If baseline audio capabilities are included in a PC system, audio must meet the minimum requirements defined in "Basic Requirements for Audio Components" in this chapter.

2. PC 97 Advanced audio capabilities included in the PC system

Basic PC 97	Workstation 97	Entertainment PC 97
Recommended	Recommended	Required

Each feature for Advanced audio that is implemented in a PC 97 system must meet the minimum requirements for that feature as defined in "PC 97 Advanced Audio" in this chapter.

Basic Requirements for Audio Components

This section defines requirements for basic hardware features for audio components and the specific features for PC 97. Device performance is measured by the WHQL Audio Compatibility Tests (ACT). ACT currently measures performance of the driver/hardware combination for opening, closing, and resetting the device.

Note WHQL compatibility tests are revised quarterly. To ensure that you have the most recent ACT, see http://www.microsoft.com/hwtest/outtest.htm.

Baseline Audio for PC 97

This section defines the requirements for baseline audio, which is typically implemented as a system board solution for business PCs. Although audio is not required on a PC 97 Basic or Workstation system, if baseline audio is implemented in the system it must meet the requirements defined in this section.

3. General device requirements for PC 97
Required

These include the standard PC 97 requirements for a Plug and Play device identifier, automated software-only settings for device configuration, standard device drivers and Windows-based installation, and icons for external connectors. For more information, see the "Basic PC 97" chapter in Part 2 of this guide.

4. Minimum standards for output
Required

- 16-bit digital-to-analog converter (DAC)
- Support for monaural output

  Recommended: Support for stereo (required for PC 97 Advanced audio)
- Support for 8-bit and 16-bit linear pulse-code modulation (PCM) digital audio
- Required sampling rates: 8 kHz, 11.025 kHz, 22.050 kHz, and 44.1 kHz

  Recommended sampling rates: 16 kHz, 32 kHz, and 48 kHz (required for PC 97 Advanced audio)
- Support for MIDI playback; if implemented as music synthesis, the minimum support must include 16 voices plus 6 timbres for basic audio

5. Minimum standards for input
Required

- 16-bit analog-to-digital (A/D) converter

- Support for monaural input

   Recommended: Support for stereo (required for PC 97 Advanced audio)

- Support for 8-bit and 16-bit input

- Required sampling rates: 8 kHz, 11.025 kHz, 22.050 kHz, and 44.1 kHz

   Recommended sampling rates: 16 kHz, 32 kHz, and 48 kHz (required for PC 97 Advanced audio)

6. One line out and one line in, minimum
Required

At a minimum, the system must include support for one line in and one line out. The minimum line-in support can include 3.5-mm microphone in or 3.5-mm line in. The minimum line-out support can include 3.5-mm headphone out, line out, or speaker out.

Typically, a baseline audio implementation will include additional line-in/line-out support, but this bare minimum is defined to allow alternate solutions for designs sensitive to form-factor issues.

7. Minimum audio performance characteristics

Basic PC 97	Workstation 97	Entertainment PC 97
Required	*Required*	*Required*

The following is required for input (record) and output (playback):

- 75 dB signal-to-noise ratio (SNR).

- Frequency response: 20 Hz to 20 kHz, A-weighted.

   For mobile PCs, the signal-to-noise requirement is 75 dB from 20 Hz to 15 kHz, A-weighted.

- 0.02 per cent total harmonic distortion.

Signal-to-noise (S/N) ratio is defined as the ratio of the RMS output level with 1 kHz full scale input to the RMS output level with all zeros into the digital input (AES17-1991).

Version 1.1 Correction:
Logo testing for audio performance is occurring in two steps:

   1. As of **July 1, 1997,** audio systems must provide a signal-to-noise ratio (SNR) of 72 dB, 0.3 percent total harmonic distortion plus noise (THD+N), and a frequency response of 20 Hz to 16 kHz or better.
   2. After **January 1, 1998,** audio systems must provide an SNR of 75 dB, 0.2

percent THD+N, and a frequency response of 20 Hz to 17.6 kHz or better using source data 44.1 kHz. (Change date: October 10, 1997)

The following is required for output (playback) on both desktop and portable machines:

- 72 dBr SNR, A weighted, using line-level back termination (> 100 ohms) on output.
- Frequency response: 20 Hz to 16 kHz, using F3 endpoints of -3 dBr relative to 1 kHz.
- 0.30 percent THD+N.

SNR is defined as the ratio of the RMS output level with 1 kHz full scale input to the RMS output level with all zeros into the digital input (AES17-1991). (Change dates: June 6, 1997; June 17, 1997)

PC 97 Advanced Audio

This section defines the guidelines for PC 97 Advanced audio, including guidelines for hardware acceleration features.

Note The requirements in this section do not apply if baseline audio is implemented on the system board. Notice also that if any component of PC 97 Advanced audio is implemented in a system, it must meet the standards defined in this section for that component.

8. Advanced audio meets additional standards for input and output

Basic PC 97	Workstation 97	Entertainment PC 97
Required	*Required*	*Required*

The requirements for minimum input and output standards are defined in the "Baseline Audio for PC 97" section in this chapter. The following lists the additional related requirements for PC 97 Advanced audio:

- Line in and line out capabilities and DAC support must be stereo.
- Additional required sampling rates for both input and output: 16 kHz, 32 kHz, and 48 kHz.
- Minimum input capabilities must include 3.5-mm microphone.
- Minimum audio performance characteristics:
  - 75 dB SNR for input; 85 dB SNR for output.
  - 90 dB analog signal path SNR through mixer.
  - Frequency response: 20 Hz to 20 kHz, A-weighted.
  - 0.02 per cent total harmonic distortion.

Version 1.1 Correction:
 Minimum audio performance characteristics:

- 75 dBr SNR for input; 85 dBr SNR for output; A weighted, using line-level back termination (> 100 ohms).
- 90 dBr analog signal path SNR through mixer, A weighted, using line-level back termination (> 100 ohms).
- Frequency response: 20 Hz to 20 kHz, using F3 endpoints of -3 dBr relative to 1 kHz.
- 0.02 percent THD+N.

(Change date: June 6, 1997; June 17, 1997)

9. Full duplex operation

Basic PC 97	Workstation 97	Entertainment PC 97
Required	Required	Required

The PC 97 Advanced audio subsystem must support full duplex operation for simultaneous encoding and decoding of audio data, enabling audio playback while simultaneously supporting audio input.

10. Input and output support independent sampling rates

Basic PC 97	Workstation 97	Entertainment PC 97
Recommended	Recommended	Required

The input (A/D) and output (D/A) portions of the audio subsystem should support independent sampling rates. For example, the audio playback could be set at 44.1 kHz for high-quality audio while the microphone input is sampled at 8 kHz to support a conferencing application.

11. Support sample position for stream synchronization

Basic PC 97	Workstation 97	Entertainment PC 97
Required	Required	Required

This means that the driver must be capable of returning an accurate indication of the current position in the buffer being rendered. Sample accuracy is in relation to the samples given to the codec. Accurate reporting of the current position in the buffer being rendered means reporting position within 1 ms. This will apply for compressed or uncompressed data.

12. Support for music synthesis

Basic PC 97	Workstation 97	Entertainment PC 97
Recommended	Recommended	Required

Recommended: Hardware support for downloadable samples.

A software or hardware solution can be implemented. This includes supporting, at a minimum, standard MIDI 24-voice polyphony plus 16 timbres for PC 97 Advanced audio.

13. Support for echo cancellation

Basic PC 97	Workstation 97	Entertainment PC 97
Recommended	Recommended	Required

Recommended: Hardware provides reference signals on two channels (mono in, mono out).

This feature allows the user to remove speaker content from the incoming microphone input stream. For example, if the user has other audio output mixed with the incoming voice in an audio-conferencing or multiplayer application, all speaker content is removed from the input microphone stream.

PC 97 Design for Audio

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

Plug and Play for Audio

The items in this section are requirements for all PC 97 systems that implement audio in any form.

14. Plug and Play device identifier
Required

- For a non-bus-specific system board device, there must be a device-specific identifier.

- Each bus-specific device must have a Plug and Play device identifier as 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.

Note Each separate device or function that is enumerated by the BIOS on an audio adapter must have a separate Plug and Play device ID and separate resource configuration. If a game port or CD-ROM interface is supplied, resources must be allocated in addition to those required for the audio device. Such devices must also have independent dynamic disable capabilities. For complete information about requirements and exceptions for multifunction cards under PC 97, see the "Basic PC 97" chapter in Part 2 of this guide.

15. 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. All configuration settings must be capable of being made through software, with no system reboot required. Changing or adding this device to the system must not require changing jumpers or switches on either the adapter or the system board to set resource assignments. 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. The device must not claim any resources while disabled.

Requirements for ISA Devices

This section defines requirements if the audio device uses ISA. However, ISA is not a recommended solution for supporting audio in a PC 97 system.

16. Unique 16-bit address for I/O decode
Required

As for all PC 97 devices, this is required for both onboard and add-on devices. For information, see the "Basic PC 97" chapter in Part 1 of this guide.

17. Minimum resource requirements
Required

These are the required resource settings for ISA devices:

- 4 unique I/O locations

  Recommended: 7 I/O locations

- 4 unique IRQ signals

  Recommended: 7 IRQ signals

- 3 DMA channel selections, if DMA is used

  Recommend: 16-bit F-mode DMA

Note Type F DMA is strongly recommended for system-board audio implementations or for add-on devices that use ISA.

18. Unique IDs include Serial Number field for each ISA card
Recommended

Unique IDs with Serial Number fields ensure correct support for multiple instances of the same device type. If unique serial numbers are not supported, the Serial Number field must contain 0xFFFFFFFF, as required in the ISA Plug and Play specification. For more information, see the "ISA" chapter in Part 3 of this guide.

Requirements for PCI Devices

This section defines the hardware requirements if the audio device uses PCI.

19. PCI v. 2.1 (or higher) and additional PC 97 requirements
Required

If the device uses PCI, it must meet the requirements defined in the "PCI" chapter in Part 3 of this guide, including requirements for providing a Subsystem ID and Subsystem Vendor ID.

20. Initiator, target, and block transfer support
Required

For complete implementation details, see the PCI v. 2.1 specification.

21. PCI audio components comply with ISA Plug and Play requirements if using ISA resources
Required

Any PCI audio components that use any ISA resources such as DMA, IRQ, or I/O addresses must meet all Plug and Play requirements for ISA, including dynamic disable capabilities, as defined in the "ISA" chapter in Part 3 of this guide. PCI devices on the system board do not have to provide relocatable I/O addresses for the following legacy I/O registers:

Sound Blaster register (220h–22Fh)   MPU-401 register (330h–331h)
FM synthesis register (388h–38Bh)   WSS-compatible register (534h–537h)

Requirements for USB Devices

This section defines requirements if the audio device uses USB.

22. USB Specification and USB audio device class specifications
Required

This device must comply with the Universal Serial Bus Specification (v. 1.0 or higher) and the related USB device class specification. This ensures that all Plug and Play requirements are met and that Microsoft drivers support this device.

Requirements for IEEE 1394 Devices

This section defines requirements if the audio device uses IEEE 1394.

23. Advanced audio meets PC 97 requirements for IEEE 1394
Required

For requirements related to IEEE 1394 peripherals, see the "IEEE 1394" chapter in Part 3 of this guide.

Power Management for Audio Components

This section summarizes the specific power management requirements for audio components.

24. Compliance with "Device Class Power Management Reference Specification" for audio devices
Required

The "Device Class Power Management Reference Specification" for audio 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. Power states D0 and D3 are required. Other power states are recommended.

Version 1.1 Clarification:

As of **July 1, 1997,** the device must meet the requirements defined in the *Audio 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.

25. Support Wakeup Events defined in "Device Class Power Management Reference Specification"
Optional

For PC 97, the ability to cause a Wakeup event as defined in the "Device Class Power Management Reference Specification" for audio devices is an optional feature.

Device Drivers and Installation for Audio Components

This section summarizes requirements for device drivers for audio. The items in this section are required for all PC 97 systems.

26. Device driver and installation meet Windows and Windows NT standards
Required

The manufacturer does not need to supply a driver if a standard driver provided with the operating system can be used. If the manufacturer supplies drivers, the requirements include the following:

- All devices and drivers must pass testing by Microsoft WHQL.

- All configuration settings are stored in the registry.

- The correct minidriver, VxD, and any other manufacturer-supplied files specified in the device's INF must be installed in the correct locations.

- 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).

- If support using WDM drivers is provided in the operating system, the driver supplied by the manufacturer must be a WDM driver.

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

27. Applications provided with device meet Windows standards
Required

Any Windows-based applications provided with the device must meet Microsoft requirements for software compatibility as indicated by the "Designed for Microsoft Windows" logo.

References for Audio

The following presents some of the references, services, and tools available to help build hardware that works with Windows operating systems.

WHQL Audio Compatibility Tests
   http://www.microsoft.com/hwtest/outtest.htm

Current information on audio design and Windows support
   http://www.microsoft.com/hwdev/devdes/

Device Class Power Management Reference Specification
   http://www.microsoft.com/hwdev/onnow.htm

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

Windows 95 DDK, Windows NT DDK, and DirectX DDK
   MSDN Professional membership

Version 1.1 References Update:
Advanced Configuration and Power Interface Specification, Revision 1.0
   http://www.teleport.com/~acpi/

Audio '98 Roadmap, Audio Codec '97 Component Specification, and
Audio Codec '97 Design Guide papers
   Intel Corporation
   http://developer.intel.com/pc-supp/platform/aud98/

Audio design for Windows operating systems white papers
  http://www.microsoft.com/hwdev/devdes/

Audio Device Class Power Management Reference Specification, Version 1.0
  http://www.microsoft.com/hwdev/onnow.htm

Downloadable Samples (DLS) specification
  MIDI Manufacturers Association
  Fax: (714) 736-9775
  E-mail: mma@midi.org
  http://www.midi.org

Personal Computer Audio Quality Measurement Definitions
by Dr. Steven Harris and Cliff Sanchez, Crystal Semiconductor
  http://www.crystal.com/new/papers/meas.htm

PCI Local Bus Specification, Revision 2.1 (PCI 2.1)
PCI Bus Power Management Specification, Revision 1.0 (PCI PM)
  http://www.pcisig.com

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

Universal Bus Specification, Version 1.0
USB device class specifications
  http://www.usb.org

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

Windows DDK, Windows NT DDK, DirectX DDK, and Win32 SDK
  MSDN Professional membership

Checklist for Audio

Basic PC 97	Workstation PC 97	Entertainment PC 97
System Requirements for Audio Components		
1. Baseline audio meets PC 97 requirements		
Recommended	*Recommended*	*Advanced audio required*
2. PC 97 Advanced audio capabilities included in the PC system		
Recommended	*Recommended*	*Required*
Basic Requirements for Audio Components		
Baseline Audio for PC 97		
3. General device requirements for PC 97		
Required		
4. Minimum standards for output		
Required		
5. Minimum standards for input		
Required		
6. One line out and one line in, minimum		
Required		
7. Minimum audio performance characteristics		
Required	*Required*	*Required*
PC 97 Advanced Audio		
8. Advanced audio meets additional standards for input and output		
Required	*Required*	*Required*
9. Full duplex operation		
Required	*Required*	*Required*
10. Input and output support independent sampling rates		
Recommended	*Recommended*	*Required*
11. Support sample position for stream synchronization		
Required	*Required*	*Required*
12. Support for music synthesis		
Recommended	*Recommended*	*Required*
13. Support for echo cancellation		
Recommended	*Recommended*	*Required*
PC 97 Design for Audio		
Plug and Play for Audio		
14. Plug and Play device identifier		
Required		
15. Automatic resource assignment and dynamic disable capabilities		
Required		
Requirements for ISA Devices		
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Required		
17. Minimum resource requirements		
Required		

18. Unique IDs include Serial Number field for each ISA card
Recommended

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Required

Power Management for Audio Components

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Required

25. Support Wakeup Events defined in "Device Class Power Management Reference Specification"
Optional

Device Drivers and Installation for Audio Components

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