Chapter 9 Video

IMPORTANT: The requirements in this guide provide instructions for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows Millennium Edition or Windows 2000 Professional or later operating systems. These design requirements are not the basic system requirements for running any version of Windows operating systems.

This chapter presents the video capability requirements for systems and video receiver and capture components, and related adapters. Systems must be video capable, independent of the inclusion of a video source. For example, systems without DVD drives must still be able to decode MPEG-2. Inclusion of video sources often adds requirements. The following requirements apply for systems that provide DVD-Video playback software and hardware, however shipping of a DVD drive with the system does not imply that a system must pass these requirements.

The emphasis is on interoperability and universal video capabilities. Current broadcast television quality levels guide the quality standard set in this chapter.

Unless this chapter defines a specific requirement or exception, all requirements apply for video as presented in Chapter 3, "PC System," and Chapter 6, "Buses and Interfaces."

Baseline Video Features

This section describes basic video features required for all desktop systems. Mobile PCs must meet these requirements, with the exceptions noted in the mobile section.

Baseline Video Driver Support

This section describes video driver support.

VID–0209. System supports basic video capabilities

For all PC 2001 systems, all graphics and video capabilities must be fully supported at 1024×768, 32 bpp mode or better.

VID–0210. Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class or AV Stream class

The driver for any video or tuner/decoder device must use the Microsoft DirectX foundation class to control all video data. In a PC 2001 system, video input devices must use WDM device drivers. For implementation requirements, see the Windows 2000 DDK, listed in "Video References."

If implemented, the MPEG-2 decoder must support the current DirectShow APIs (including DirectX VA) and must support the WDM Stream class driver architecture. The WDM Stream Class or AV Stream Class must be used to support any data streaming. For information, see the DirectX DDK, the Windows Driver Model (WDM) Technology Web page, and the Windows 2000 DDK, listed in "Video References."

VID–0211. All video implementations use DirectShow for video routing and processing

Use the DirectShow environment for all TV or DVD-Video implementations. Typical applications include Transport Stream demultiplexing as well as general MPEG stream routing. Implement drivers using WDM.

While it is not a requirement to use the DirectShow filters provided with the operating system, alternatives must be fully pin compatible (that is, media-type compatible) with the filter APIs provided with the operating system. This will help ensure third-party software application compatibility. For information, see Microsoft DirectShow, listed in "Video References."

VID–0212. Dependent video device is not independently enumerated

If a video device is implemented as a dependent device on a multifunction adapter, it must not be independently enumerated. Instead, its parent must be responsible for installing and loading its driver and for updating the registry on its behalf. See also SYS–0032, "Multifunction device meets PC 2001 device requirements for each device," in Chapter 3.

VID–0213. If non-Microsoft provided DirectShow filters replace any filters included with the operating system, replacements provide a functional and qualitative superset of the replaced modules

Any replacement DirectShow filter must be able to accept the exact same input and output formats provided by the operating system version of the DirectShow filter.

VID–0215. All video implementations meet basic video quality requirements

This requirement defines how to treat, as a whole or by components, all consumer electronics (CE) high quality TV-style video streams. Video implementation must

preserve source quality during playback, storage, or processing of the video streams and not adversely affect overall PC performance.

Note: The following solutions are exceptions to this requirement: solutions serviced by nonisochronous video sources (Internet) and solutions that have inherent quality tradeoffs (conferencing cameras, dongles that convert TV-style video into conferencing-style video or still video). Video functions for monitoring purposes only and not for recreational viewing, such as monitor video windows (outputs) of video editing solutions, are also exempt.

Examples of CE quality video sources are NTSC at $720 \times 480 \times 29.97$ frames per second (fps) and PAL at $720 \times 576 \times 25$ fps, both at MPEG 4:2:2. These resolution and frame rates are the standard definition. Other resolution and frame rate combinations may be subject to the same requirements, depending on the source, but only if the source resolution does not exceed the overall pixel rate of the above example (approximately 10.5 megapixels per second).

Video sources with higher pixel rates may cause system performance to degrade. Either dropped frames or reduced image quality, or a combination of both, become acceptable in that case. In the case of time-shifted playback, a slight relaxation is also acceptable. Combined reduction in image quality and frame rate should be commensurate with the excess in input data rate. For example, if the input data rate exceeds the standard definition pixel rate by a factor of four, acceptable performance could allow dropping half of all frames and image quality that is equivalent to having been high-quality scaled by a factor of two horizontally.

Notice that deinterlacing results in twice the display data rate when compared to the source data rate. However, de-interlacing by itself must never be the cause for frame rate or image quality reduction. Only increases in source resolution beyond this standard definition produce a relaxing of the video quality requirements. The requirements include the following.

- **VID–0215.1. TV-style video source frame and field rates must be preserved to memory and to the display.** While in steady-state mode, dropped frames may not exceed one per minute.

- **VID–0215.2. TV-style video source resolution must be preserved to memory and to the display.**

- **VID–0215.3. TV-style video source quality must be preserved to memory and display.** Image entropy consistent with approximately 400 TV lines of vertical resolution must be preserved.

- **VID–0215.4. TV-style video source color information must be preserved to memory and to the display.**

- **VID–0215.5. TV-style video source video aspect ratios are preserved and displayed correctly.**

- **VID–0215.6. TV-style MPEG-2 video stream playback consumes no more than an additional 45 percent of CPU measured during any given minute.**

Mobile PC Note
- **VID–0215.7. TV-style MPEG-2 video stream playback consumes no more than an additional 45 percent of memory, PCI, or AGP bandwidth during any given minute.** Mobile PCs are not required to meet this subrequirement.

- **VID–0215.8. TV-style video stream playback is audio-video synchronized to within 75 ms.** Audio-video synchronization drift is corrected without violating the specifics of the frame rate and field rate requirements.

- **VID–0215.9. Video is made available through input or transform filters in the YUY2 color format while maintaining all other baseline video requirements.**

- **VID–0215.10. Displayed video that enters the system interlaced but carrying a tag that identifies how the video fields were derived from a progressive source will be deinterlaced using the weave method.** Typically, deinterlacing is performed by the graphics subsystem.

  This requirement applies only to properly encoded content.

- **VID–0215.11. Displayed video that enters the system interlaced but carries a tag identifying the video source as 24 fps film will be (in combination with weave deinterlacing) played back using a suitable frame rate increasing process such as 3:2 pulldown or better.** Typically, deinterlacing is performed by the graphics subsystem.

- **VID–0215.12. Displayed video that enters the system interlaced and carries either no identifying tag or is tagged as interlaced material should be deinterlaced by the graphics subsystem using the bob method or a method superior to the bob method.** Deinterlacing also may take place outside of the graphics subsystem.

- **VID–0215.13. When video is displayed on a monitor that is refreshed at a different rate than the field rates and frame rates of the video stream, a consistent frame repeat pattern must be implemented that in itself causes no frames to be dropped.**

MPEG-2 Video Playback Requirements

This section presents MPEG-2 playback requirements.

VID–0216. If implemented, all MPEG-2 decoders can accept an MPEG-2 elementary stream

DirectShow provides the selection and demultiplexing of MPEG transport streams and program streams. Stream filtering in hardware can be used to aid this process. DirectShow feeds the appropriate video stream, such as Elementary Stream, to the MPEG decoder. The decoder must be able to take MPEG in that form. Packetized

Elementary Stream (PES) format support is also required without reliance on any packet sequence numbering. Decoders must not rely on packet sequence numbering to support applications where packet sequence numbers cannot be created. For example, audio and video might come from separate sources, such as video from disc being synchronized to audio from the Internet.

VID–0217. If implemented, all MPEG transport stream information is available to the central host processor

Video-quality standards must be maintained when streams are being routed via the host processor. MPEG streams can come from a number of sources. DirectShow provides support for selecting the required MPEG streams, demultiplexing them, and feeding them to the appropriate decoder or subsystem. Stream filtering in hardware can be used to aid this process.

When conditional access systems allow it, the transport stream demultiplexing must be performed by the central host processor. In situations where this is not possible, all streams from the original broadcast must be sent to the processor if the processor requests them.

It is not acceptable to implement an "around-the-side" hardware path from the receiver to the MPEG decoder. All digital compressed video streams must be routed using the central host software; this will also make it easier to migrate to video-capable home network environment, where the receiver functions and display functions will typically be in completely separate boxes. It is also necessary for features such as intelligent TV timeshifting.

VID–0340. If implemented, MPEG decoders with motion compensation or Inverse DCT hardware acceleration use the Microsoft-provided DirectX VA API

The required DirectX VA API is documented in the DirectX 8.0 DDK or SDK, listed in "Video References."

DVD-Video Playback Requirements

The following requirements apply for systems that provide DVD-Video playback software and hardware. However, shipping of a DVD drive with the system does not imply that a system needs to pass DVD Video Playback requirements, since a system with a DVD drive is not required to include an MPEG decoder. The goal for DVD and other audio/video (A/V) playback is to ensure that the end-user experience is the same as or better than with a stand-alone DVD player.

VID–0218. If DVD-Video playback is implemented, DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment

Vendor-supplied minidrivers for DVD, MPEG-2, and AC-3 decoders must:

- Use the correct media types, including validation of all format block fields on connection and on every IPin::QueryAccept message.
- Query for IMediaSample2 on every received media sample to test for a time discontinuity bit.

  It is also acceptable to query on every A/V frame to reduce CPU overhead.

- Adjust the decode rate in response to IPin::NewSegment () calls for video and subpicture.

For details about APIs, see the DirectShow documentation in the Microsoft Platform SDK, listed in "Video References."

VID–0219. If DVD-Video playback is implemented, DVD decoder supports subpicture compositing and closed captioning

The system must be capable of displaying subpicture data as well as providing closed-captioning support for all such data stored on the disc. This requires YUV offscreen overlay surface support.

Subpicture streams must be supported as defined in *DVD Specification, Version 1.0,* from Toshiba Corporation.

Note: Alpha blending, or a driver-implemented emulation, is required for static menus.

VID–0220. If DVD-Video playback is implemented, subpicture decoder correctly handles subpicture properties and other functions

The minidriver for the subpicture decoder must be able to:

- Set the subpicture properties.
- Turn the subpicture compositing on and off.
- Set the highlight rect parameters.

For more information, see the Microsoft DirectX SDK and the DirectX information in the Windows 2000 DDK, listed in "Video References."

VID–0221. If DVD-Video playback is implemented, system supports seamless DVD-Video 1.0 navigation

This requirement includes menu navigation, video selection, and language and subpicture track selection in support of the user's ability to navigate DVD-Video discs.

For any system capable of playing back a DVD-Video title, DVD playback must work with the latest released version of the Microsoft DirectShow Navigator/Splitter filter and other DirectShow test filters to ensure that it conforms to the input and output standards established by the Navigator/Splitter. In particular, it must work with the most recent versions of the following:

- IdvdGraphBuilder
- DirectShow DVD Navigator
- DirectShow Overlay Mixer

The requirement to work with the DirectShow Navigator/Splitter filter is not intended to preclude the use of differentiating product features and enhancements.

VID–0222. If DVD-Video playback is implemented, DVD-Video player provides seamless DVD navigation

All DVD-Video players must navigate chapter breaks seamlessly. This requirement applies even if the underlying elementary streams were created as separate program chain objects. If the navigation calls for a seamless transition, the player must deliver for any legal group of pictures structure, bit rate, or both.

For PC 2001, this player requirement allows independent placement of the layer break position, without regard to chapter navigation. Classically, the layer break is acceptable only during nonseamless transitions.

Although not explicitly allowed in the formal DVD-Video specification, seamless chapter-break transitions span the layer break on some popular DVD features. Therefore, the DVD PC must be able to flawlessly reproducing seamless chapter breaks that are collocated with layer transitions, just as if the layer break weren't there.

VID–0223. If DVD-Video playback is implemented, All DVD-Video decoders must support Line21 closed-caption data

All DVD-Video decoders must support Line21 closed-captioned data output compatible for use with the DirectShow Line21 decoder filter. In addition to ensuring closed-captioned output for the hearing impaired, it enables applications that use the Line21 channel on DVD as a data channel for non-Line21 data.

VBI Data Delivery Requirements

VID–0224. If implemented, video input or capture device provides raw sampled VBI data to the host

The VBI data must be made available to the host processor to provide enhancement data, Web pages, and information about elements such as video formats and timecode. VBI data must not be affected by any type of video

operation, such as cropping, scaling, or frame dropping, that the hardware or the driver is performing on the related video frames.

VID–0225. If implemented, VBI capture oversamples VBI data exactly 4.7 or 5 times

To ensure accurate data reception, data transmitted on all lines of the VBI must be oversampled exactly 4.7 or 5 times the North American Basic Teletext (NABTS) data bit rate (or locale-specific data bit rate). For example, if there are 288 bits of NABTS data on a scan line, approximately 1,354 one-byte samples, plus the necessary margin, must be captured per scan line if 4.7x oversampling is used. This represents the number required for timing tolerances in the NABTS specification and also for timing uncertainties within the capture hardware.

If the hardware cannot provide 4.7 or 5 times oversampled VBI data, the device-specific driver must compensate by resampling, so that 4.7 or 5 times oversampled data are presented to the operating system.

Digital TV Receiver Module Requirements

The requirements in this section apply for any system that implements a digital broadcast subsystem, whether receiving satellite, cable, or terrestrial broadcasts.

Implement receiver modules in the following form factors: Device Bay modules, PCI modules, external modules, or set-top boxes using IEEE 1394. For a receiver module limited to low bit-rate transmissions (less than 5 Mbps), using standard USB is acceptable. Device Bay is a good solution for receivers requiring conditional access systems, but conditional access systems are acceptable with any of the other receiver types.

Digital broadcast and satellite support as defined under these requirements includes all the requirements for hardware decoder capabilities and driver support as defined in this chapter, plus support for the DirectX foundation class, as defined in the Windows 2000 DDK.

VID–0226. If implemented, digital broadcast module can receive all streams contained in the particular transport stream

This receiver module can be a receiver for cable, satellite, or terrestrial, and other digital TV broadcasts. The receiver module must provide data tuning, demodulation, conditional access, and other network-specific functions.

The receiver module must be able to receive both normal broadcast network-related information, such as MPEG video, audio, and program guide information, as well as data-stream information.

The receiver card must provide a way to allow the host to obtain peak cell rate (PCR) and other transport stream fields, such as the discontinuity indicator bit,

when the card is performing PES packet building. In this mode, the driver must make the relevant information available to the host. In addition, the receiver card must provide a mode in which the host can obtain full MPEG-2 transport or program stream headers, and data for selected elementary streams.

VID–0227. If implemented, digital broadcast module can receive full bandwidth from each frequency

The receiver module must be able to receive all information transmitted on any tuner or transponder frequency. If demultiplexing is performed on the receiver module, the stream selection and routing must be controlled by software running on the host processor.

VID–0228. If implemented, digital broadcast module can receive a minimum of 32 simultaneous elementary streams

The receiver module must be able to simultaneously receive on the same carrier frequency and send to the host either a transport stream or the complete set of elementary streams and accompanying data. Any receiver doing transport stream splitting, for example, a receiver that provides a proprietary conditional access scheme, must support a minimum of 32 elementary streams being sent to the host. The streams can be of any type, such as 32 simultaneous data streams. These streams, identified by unique service channel IDs or program IDs, are subdivisions of bandwidth on a single tuner frequency.

The receiver module must provide a means for the host processor to control the demultiplexing of the transport stream (containing the multiple data streams) or pass the complete transport stream to the host processor for software demultiplexing. The fundamental requirement is that the resulting MPEG elementary streams are routed by the software running on the host processor.

VID–0229. If implemented, ATSC DTV tuner/demodulator complies with A/53

If an Advanced Television Systems Committee (ATSC) DTV tuner/demodulator is implemented, it must meet the requirements for packetized data transport structure, and modulation and transmission systems as specified in *ATSC Digital Television Standard and Amendment No.1* (A/53).

Mobile PC Video Design

This section defines the specific video capabilities for mobile PC 2001 systems. These requirements apply only when the mobile system is running on alternating current (AC) power and is not thermally throttled in any way. No video playback performance requirements apply when the system is running on battery power or in a CPU or bus throttled mode. It is expected that performance—but not

functionality—will be compromised when the mobile unit is operating under battery power or in a throttled mode.

MOBL–0231. Mobile system meets mobile PC 2001 basic video requirements

A mobile system is not required to support any motion video capabilities, such as playback. The basic video requirements for such mobile PC systems are defined in the following list:

- Comply with GRPH–0205, "Driver does not bypass any Microsoft-provided system components," in Chapter 8.
- Support all related desktop video requirements if the mobile system implements support for optional video capabilities, with the following basic mobile video requirements:

  There are no CPU utilization limitations or bus bandwidth restrictions for MPEG-2 playback.

  Systems must preserve source frame rates and video quality during video playback to at least 50 percent of desktop requirements.

Mobile PCs are required to support these capabilities only up to their native resolution.

Video References

Following are the references, services, and tools cited in this chapter that are available to help build hardware that works optimally with Windows operating systems.

ATSC Digital Television Standard and Amendment No.1 (A/53)
> National Association of Broadcasters, (800) 368-5644
> Society of Motion Picture and Television Engineers, (914) 761-1100
> E-mail: mktg@smpte.org
> http://www.atsc.org/Standards/stan_rps.html

DVD Specification, Version 1.0
> Toshiba Corporation
> http://www.toshiba.com

Microsoft DirectShow
> http://msdn.microsoft.com/directx/

Windows Driver Model (WDM) Technology Web page
> http://www.microsoft.com/hwdev/wdm/

Windows 98 DDK, Windows 2000 DDK, and DirectX DDK and SDK
> http://msdn.microsoft.com/library/default.asp

Checklist for Video

VID–0209. System supports basic video capabilities

VID–0210. Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class or AV Stream class

VID–0211. All video implementations use DirectShow for video routing and processing

VID–0212. Dependent video device is not independently enumerated

VID–0213. If non-Microsoft provided DirectShow filters replace any filters included with the operating system, replacements provide a functional and qualitative superset of the replaced modules

VID–0215. All video implementations meet basic video quality requirements

VID–0216. If implemented, all MPEG-2 decoders can accept an MPEG-2 elementary stream

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VID–0340. If implemented, MPEG decoders with motion compensation or Inverse DCT hardware acceleration use the Microsoft-provided DirectVA API

VID–0218. If DVD-Video playback is implemented, DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment

VID–0219. If DVD-Video playback is implemented, DVD decoder supports subpicture compositing and closed captioning

VID–0220. If DVD-Video playback is implemented, subpicture decoder correctly handles subpicture properties and other functions

VID–0221. If DVD-Video playback is implemented, system supports seamless DVD-Video 1.0 navigation

VID–0222. If DVD-Video playback is implemented, DVD-Video player provides seamless DVD navigation

VID–0223. If DVD-Video playback is implemented, All DVD-Video decoders must support Line21 closed-caption data

VID–0224. If implemented, video input or capture device provides raw sampled VBI data to the host

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VID–0228. If implemented, digital broadcast module can receive a minimum of 32 simultaneous elementary streams

VID–0229. If implemented, ATSC DTV tuner/demodulator complies with A/53

MOBL–0231. Mobile system meets mobile PC 2001 basic video requirements