CHAPTER 16

Monitors

This chapter presents the requirements and recommendations for display monitors.

Requirements for graphics adapters and television output capabilities are defined in Chapter 14, “Graphics Adapters.”

Mobile PC Note For issues related to liquid crystal displays (LCDs) for mobile systems, see Chapter 6, “Mobile PC 99.”

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PC 99A Recommendations for Digital Visual Interface

As the industry begins to move from analog to digital technologies, PC displays are poised for some dramatic changes. New space-saving and ergonomic flat-panel technologies are emerging, based on thin-film transistor (TFT) LCDs and plasma technologies. At the same time, the display interface is beginning its transition from VGA to pure digital technology. Both of these trends promise to create significant new opportunities for developers. The implementation of new flat-panel digital display products has been slowed by industry fragmentation caused by the multiple technical specifications that now exist. A universal and industry-wide digital display interface specification is essential to enable the more rapid and widespread adoption of these new display technologies.

While several technologies now exist that try to address the digital display interface issue, these are based on proprietary technologies and take different approaches. As a result, display interface technologies have not been open to all developers, and the goal of platform-independence has remained out of reach.

To address the fragmentation of the industry, a working group of seven companies was formed to create a robust, comprehensive, and extensible industry specification. This specification, *Digital Visual Interface (DVI)*, defines the digital interface between digital displays and the PC. The DVI specification addresses protocol, electrical, and mechanical definitions, and is the first specification written expressly for the Transition Minimized Differential Signaling (TMDS) digital interface, which ensures a degree of backward-compatibility with earlier approaches. The DVI specification is available at http://www.ddwg.org.

Implementing DVI-compliant products enables developers to immediately save costs by eliminating digital-to-analog conversion functions, while laying the groundwork for the eventual elimination of analog technology altogether. For PC users, digital displays provide sharper, more realistic visual experiences and automatically adjust to optimal resolution levels.

Microsoft and Intel recommend that any digital display interface implemented after 1H99 be based on DVI-V or DVI-I, with the Analog VGA port being optional (for legacy monitor support) for systems and graphics cards.

When implementing DVI, a designer should keep in mind the following emerging standards and features.

Support for VESA EDID Structure 1.3. VESA is nearly done with the definition for the 1.3 Extended Display Identification Data (EDID) structure. This definition is important for flat panel and future digital monitors because the existing data structure does not provide complete or adequate support for various digital display parameters. When VESA completes this structure, it will be required for DVI displays. Therefore, it will require appropriate support from both graphics drivers and operating system registration facilities. This will become a hardware requirement one year after adoption by VESA.

No date has been announced for operating system support at the time of this publication.

Support for Hot Plug Monitor Detection. A monitor hot-plug detection mechanism notifies the graphics controller that a monitor has been either plugged in or disconnected. The display driver must notify the operating system when a new display has been plugged in or disconnected. This change is determined by checking the voltage level of the Hot Plug Detection pin. If that pin transitions from low to high, a new monitor has been plugged in. If this pin transitions from high to low, the display has been disconnected. This mechanism is a requirement for DVI displays.

It is recommended that graphics chips implement hardware support for this feature in chip sets being introduced after 1H99.

Color-coding Scheme for Connectors. The color coding scheme recommended in item 3.18.3 for a Digital monitor/flat panel is white. It is recommended that this

digital implementation follow this color scheme. Both DVI-V (Digital only) and DVI-I (Digital with Analog Micro-cross) should be white.

PC 99A Digital Interface Recommendation. Microsoft and Intel recommend that any digital display interface implemented after 1H99 be based on DVI-V or DVI-I, with the analog VGA port being optional (for legacy monitor support) for systems and graphics cards. Any external digital display interface will be required to be based on the DVI specification in future design guidelines.

Intel and Microsoft anticipate that the digital interface will also be implemented for devices that normally would use an analog interface (such as CRT-based monitors).

Monitor Basic Features

This section summarizes the basic design requirements for desktop, Mobile PC, and Entertainment PC monitors.

Note: Dot-pitch requirements are not specified in these guidelines because dot pitch depends on resolution and size. Also, design features other than dot pitch contribute to usability for PC applications, such as focus and phosphor. Monitors should be designed to provide a sharp and clear image across the full range of resolutions they are intended to support.

16.1. Color monitor is DDC2B-compliant with unique EDID identifier

Required

A monitor designed for or included with a PC 99 system must be compliant with *Display Data Channel Standard, Version 3.0*, Level 2B protocols (DDC2B), which defines the communications channel between the display and host system.

PC 99A clarification: The required support defined in Version 3.0 of these standards is also defined in the earlier version and revisions of these standards. As such, the Version 3.0 standards provide the correct references for both Windows 2000 and Windows 98.

The monitor also must transmit an Extended Display Identification Data (EDID) structure containing unique ID Manufacturer Name and ID Product Code identifiers, plus all required fields, as defined in Section 3 of *Extended Display Identification Data Standard, Version 3.0* or later.

PC 99A clarification: The Image Color Management (ICM) APIs and functionality for Windows and Windows 2000 are described in the Microsoft Platform SDK and “Color Management for Displays” in Part 2 of “Graphics Drivers Design Guide” in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/dpyddi_8hev.htm).

Mobile PC Note Mobile computers do not need to support DDC between the graphics adapter and

the display if both are in the same enclosure.

16.2. Monitor supports Integrated Color Management

Required

Windows 98, and Windows2000 Professional operating systems support using color profiles that comply with the International Color Consortium (ICC) Profile Format specification. The Integrated Color Management (ICM) APIs and functionality for Windows 98and Windows 2000 are described in the Microsoft Platform SDK and the Windows 2000 DDK.

PC 99A clarification: The default profile should be for the "optimal" display mode supported by the display. Typically, this mode is defined by the display manufacturer. Specifically, there is no need to have a separate default ICM profile for each color depth or resolution.

Mobile PC Note

Color-capable devices such as desktop CRT monitors, LCDs on mobile systems, color plasma and other flat-panel devices, printers, scanners, or still-image cameras are required to install one or more ICC profiles for ICC color management. A monitor color-calibration utility is recommended for generating, editing, and installing ICC profiles. The standard RGB (sRGB) profile will be distributed in Windows 98 and Windows 2000.

PC 99A Mobile PC note: Because most Mobile PCs do not support Plug and Play for their installed LCD panel, the ICC profile must be installed manually using an appropriate monitor INF. OEMs should install the correct configuration as part of the operating system pre-install process. If necessary, the INF will be available to the user for manual re-installation.

16.3. Monitor meets all PC 99 general device and driver requirements

Required

This includes the basic requirements for Plug and Play device IDs, automated software-only settings for device configuration, device drivers and Windows-based installation, and icons for external connectors. For more information, see "PC 99 General Device Requirements" in Chapter 3, "PC 99 Basic Requirements."

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, it must comply with requirement 3.16, "Device driver and installation meet PC 99 requirements." The requirements include driver support for unattended installation and Help file support if special driver parameters are used.

Note: Monitor support for Windows is installed using a monitor INF file, as defined in the Windows 95 DDK and Windows 2000 DDK.

PC 99A clarification: Monitor support for Windows is installed using a monitor INF file, as defined in "INF and Installation Requirements" in Part 2 of "Graphics

Drivers Design Guide" in the Windows 2000 DDK and in "Sample Display INF File" of "Windows 95 Documentation Programmers Guide" in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/vidintro_9von.htm and http://www.microsoft.com/ddk/ddkdocs/win98ddk/devinst_167q.htm, respectively).

16.4. CRT-based monitor supports a mechanism for control from host software

Recommended

The control of brightness, contrast, screen offset, and so on, should be controllable from host software. This can be accomplished using USB or, when implemented, the proposed VESA DDC/CI standard.

Other controls, such as picture offset, are important since the system will need to switch between desktop refresh rates, such as 75 Hz, and video refresh rates, such as 60 Hz, to optimize video playback. Software control is also important in remote control applications such as IR/RF remote.

Desktop Monitor Requirements

This section lists the hardware requirements and features for desktop monitors.

16.5. Monitor meets minimum graphics resolution, based on monitor size

Required

With the following higher resolutions, a larger desktop area can be displayed, more applications can be shown on the display at once, individual windows can be larger, applications can be fully displayed side by side, and so on.

- 14-inch to 15-inch external monitor or built-in mobile PC display = 800 × 600, non-interlaced
- 17-inch external monitor or 13-inch to 15-inch LCD = 1024 × 768, non-interlaced
- 19-inch and larger monitors or LCDs larger than 15 inches = 1280 × 1024, non-interlaced

Note: These specific monitor sizes are not listed as recommended or required; they merely show the required resolution for a given size. Wide-format monitors and flat panel displays intended for entertainment applications must met the requirements contained in "Entertainment Monitor Requirements" later in this chapter.

16.6. CRT-based monitor supports ergonomic timing standards

Required

Recommended: 85 Hz

The monitor must, at a minimum, support the timings documented in *VESA and Industry Standards and Guidelines for Computer Display Monitor Timing Version 1.0, Revision 0.7* or later, for all resolutions supported by the monitor, as based on monitor size, as cited earlier in this section. The standards ensure a clear, flicker-free display for traditional PC computing.

It is also a requirement that monitors are able to operate with the 59.94 variant of the 60-Hz VESA timing. All references to 60-Hz timing in this chapter should be taken to also indicate the 59.94 variant.

16.7. CRT-based monitor synchronizes to a new format in a timely fashion

Recommended

When the scanning rate into the monitor is changed from one of its valid rates to another valid rate, it should resynchronize to the new format and produce a stable picture within three seconds from the graphics adapter becoming stable.

This capability is important because it will sometimes be necessary to change from a high refresh-rate graphics mode to a 60-Hz (or 59.94 variant) mode in order to optimize video playback.

It is preferred that the monitor be designed to minimize the noise emitted as it transitions between rates as this can be alarming to some users.

Entertainment Monitor Requirements

The Entertainment PC system requires a picture tube ideal for both PC graphics and television/movie video. This section defines the requirements for large-screen entertainment monitors.

Although an entertainment monitor is only a recommendation for Entertainment PC systems, a large-screen monitor that is sold with an Entertainment PC system must meet the requirements defined in this section.

16.8. Large-screen monitor is 20 inches (viewable diagonal) or larger if included with an Entertainment PC system

Required

Recommended: Monitor size of about 32 inches, measured on the diagonal.

16.9. Entertainment CRT-based monitor supports 800 × 600 at 60 Hz refresh rate

Required

Recommended refresh rate: 60 Hz (and 59.94 variant) for North America. Various rates are appropriate for Europe, such as 50, 60, or 75 Hz, depending on the video processing capabilities of the host PC.

It is acceptable to use 60 Hz (or the 59.94 variant) in North America because these types of monitor are intended to be viewed from at least a 6-foot distance, thus avoiding excessive flicker. Keeping the rate the same as the native video source will result in the best video quality because of the judder problems associated with using linear video processing to change refresh rates.

A display format of 800 × 600 at 60 Hz progressive (or the wide-screen equivalent) requires a refresh rate of about 38 kHz. This rate is commonly available in CRT-based large-screen TV-style monitors. A display format of 1024 × 768 at 60 Hz progressive (or the wide-screen equivalent) is preferable, but requires a scan rate of around 47 kHz. With the advent of good scaling on graphics adapters and program-enhancing additional data services, good use can be made of the higher resolution if it is available.

This requirement does not mean to imply the entertainment monitor needs to use CRT technology. The use of flat-panel alternatives is encouraged as soon as technology allows. The resolution and size, but not timing, requirements are the same as for CRT devices.

16.10. Entertainment monitor operates at the lower scan rates used by the operating system

Required

During system boot and in the event of an error, Windows 98 and Windows 2000 use lower resolution scanning formats such as 640 × 480, 640 × 400, and "text mode 3." The monitor must be able to display these important screens. It can be confirmed that a monitor compiles with this requirement by booting a PC and ensuring that the monitor is able to sync to all the screens displayed during the boot sequence.

This requirement applies to all monitor types, not just entertainment monitors, but is stated here because there is a potential problem on some large entertainment monitors.

16.11. Entertainment monitor's host control has digitally controlled geometry

Recommended

The host control of the monitor should be implemented using the same methods described in requirement 16.4, "CRT-based monitor supports a mechanism for control from host software."

Geometry control is necessary for adjustment of PC television images and includes the following controls: skew, pin cushion, size, brightness, contrast, and position. If implemented, geometry control must be provided through a software application rather than through dials on the monitor case. Controls must be revealed through a driver with a remote-controllable user interface.

Plug and Play Design for Monitors

The items in this section summarize requirements for Plug and Play.

16.12. External monitor meets DDC2B and EDID standards

Required

This requirement is based on DDC2B, which defines the communications channel between the display and host system, and on EDID Version 3.0, which defines data formats for configuration information. This requirement includes the identification string and other EDID data that the monitor sends to the system.

Use the established standard or (if necessary) detailed timings to indicate the maximum resolution that the monitor will support. Using either the established or the standard timings will result in greater flexibility when using detailed timing descriptor blocks.

The following items are particularly critical:

- EDID content must indicate the complete range of the monitor's capabilities.

  Do not use the EDID to indicate only the preset modes that the monitor supports. Take advantage of the established and standard timings to include as much information about the monitor's capabilities as possible.
- At least one piece of information must indicate the maximum resolution plus maximum timing at that resolution supported by the monitor. If this is not implemented using the established or standards timings, then a detailed timing can be used.

PC 99A correction: For analog CRTs, Extended Display Identification Data (EDID) content must indicate at least one VESA mode at 75 Hz, or better, for each resolution supported.

To enhance the Plug and Play functionality of monitors, the following monitor descriptor definitions are strongly recommended, as defined in the VESA EDID standard:

- **FD (monitor range).** This information is essential for enabling the operating system to calculate the optimal refresh rate for any selected resolution.
- **FC (monitor name).** Up to three detailed timing blocks can be used to incorporate the company and model name. These descriptors will be concatenated for a single string, and the blocks must be used in the order in which they are to be concatenated.
- **FF (monitor serial number).** If provided, this information will be placed into the registry for easy access by asset-management software.

Power Management for Monitors

This section summarizes the specific power management requirements for monitors.

16.13. Monitor complies with device class power management reference specification

Required

The *Display Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions of the OnNow device power states (D0–D3) for graphics adapters and monitors. The specification also covers device functionality expected in each power state and the possible wake-up event definitions for the class, if any. CRT monitors must support the D0, D2, and D3 power states. The D1 power state is optional for monitors.

Mobile PC Note Flat panel displays for mobile and desktop applications can implement just two states: on or off.

Monitors 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.

Display Data Channel Standard, Version 3.0, Level 2B protocols
Extended Display Identification Data (EDID) Standard, Version 3.0
VESA and Industry Standards and Guidelines for Computer Display Monitor Timing, Version 1.0, Revision 0.6
Video Electronics Standards Association (VESA)
Phone: (408) 435-0333
Fax: (408) 435-8225
http://www.vesa.org/standards.html

Display Device Class Power Management Specification, Version 1.0
http://www.microsoft.com/hwdev/specs/PMref/PMdisplay.htm

International Color Consortium ICC Profile Format specification
http://www.color.org

Microsoft Windows 95 DDK, Windows 2000 DDK, DirectX DDK, and Microsoft Platform SDK
MSDN Professional subscription

Universal Serial Bus Monitor Control Class Specification, Revision 1.0
http://www.usb.org/developers/index.html

Checklist for Monitors

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

16.1. Color monitor is DDC2B-compliant with unique EDID identifier
Required

16.2. Monitor supports Integrated Color Management
Required

16.3. Monitor meets all PC 99 general device and driver requirements
Required

16.4. CRT-based monitor supports a mechanism for control from host software
Recommended

16.5. Monitor meets minimum graphics resolution, based on monitor size
Required

16.6. CRT-based monitor supports ergonomic timing standards
Required

16.7. CRT-based monitor synchronizes to a new format in a timely fashion
Recommended

16.8. Large-screen monitor is 20 inches (viewable diagonal) or larger if included with an Entertainment PC system
Required

16.9. Entertainment CRT-based monitor supports 800 × 600 at 60 Hz refresh rate
Required

16.10. Entertainment monitor operates at the lower scan rates used by the operating system
Required

16.11. Entertainment monitor's host control has digitally controlled geometry
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16.12. External monitor meets DDC2B and EDID standards
Required

16.13. Monitor complies with device class power management reference specification
Required