Chapter 10 Monitors

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.

The DVI specification provided by the Digital Display Working Group is the industry standard that allows designers to implement the digital interface with confidence. The large legacy of analog VGA monitors can still be fully supported by systems that meet the requirements presented in this system design guide.

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

Basic Monitor Requirements

This section summarizes the basic design requirements common to all monitor types. As with any device, monitors must meet all PC 2001 general device and driver requirements.

Note: Dot-pitch requirements are not specified in these requirements 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 must provide a sharp and clear image across the full range of resolutions they are intended to support.

MON–0232. Color monitor is E-DDC–compliant with unique EDID identifier

A monitor designed for or included with a PC 2001 system must be compliant with *VESA Enhanced Extended Display Data Channel Standard (E-DDC), Version 1*, Level 2B protocols (DDC2B), which defines the communications channel between the display and host system. A monitor must assume multiple I2C-compliant devices exist on the communications bus, and as such, a monitor must not impede the use of the I2C bus in any way. A monitor designed for, or included with, a PC 2001 system must not issue DDC1 transactions.

The monitor also must transmit an EDID structure containing unique ID Manufacturer Name and ID Product Code identifiers, plus all required fields, as defined in Section 3 of *VESA Enhanced Extended Display Identification Data Standard (E-EDID), Release A*.

Mobile PC Note   Mobile and other all-in-one systems are not required to support DDC monitor detection. Displays that are attached and connected using an internal interface are not required to provide EDID data identification. This exception applies to all DDC- and EDID-related requirements in this chapter.

MON–0233. Monitor supports EDID 1.3 data structure

All monitors must support E-EDID by implementing an EDID data structure, which includes the following:

- Set preferred mode bit for all monitor types.
- Include timing data for the preferred display mode in Timing #1.

  For an LCD or other fixed-format display, this would be the native mode of the panel. For other display types, this is the optimal display mode, which is based on the size and capabilities of the device, and must meet the requirements for refresh rates defined in this chapter.

- Implement monitor descriptors:
  - Monitor range limits
  - Monitor name

MON–0234. If implemented, LCD monitor or built-in LCD display contains display characterization data

LCD monitors and built-in displays must be optimized for Microsoft ClearType™ and other advanced operating system graphics features being implemented through DirectDraw, Direct3D, DirectShow, and GDI+. This optimization will require additional data regarding the characteristics of the attached display. These characteristics include, but are not limited to:

- Digital interface (external or internal).
- Vertical pixel striping orientation in normal orientation (subpixels of the same color aligned in vertical columns).
- Subpixel format is RGB (ordered left to right). Other formats might be acceptable but must be characterized in EDID.
- High contrast ratio (minimum of 50:1).
- No scaling or image filtering applied when display is at native resolution.
- Detailed gamma data.
- Additional color information.

- Monitor rotation capability.

Not all of these characteristics are currently supported in industry standards. These items are noted here for informational purposes and will be documented in appropriate industry specifications and other technical documents as the technologies mature.

The Update on ClearType Font Technology and LCD Displays Web page has additional information about ClearType technologies and is listed in "Monitors References."

MON–0235. Monitors support sRGB output or an ICC profile is provided

The monitor must default either to creating sRGB output or using a vendor-supplied ICC profile.

Windows Me and Windows 2000 support using color profiles that comply with the *Specification ICC.1:1998-09 File Format for Color Profiles.* The ICM APIs and functionality for Windows 98, Windows Me, and Windows 2000 are defined in the Microsoft Platform SDK, the Windows 98 DDK, Windows Me DDK, and the Windows 2000 DDK. The Color Management and Windows Operating Systems Web page has information about implementing color-matching capabilities for Windows operating systems.

Mobile PC Note Color-capable devices such as desktop cathode ray tube (CRT) monitors, LCDs on mobile systems, color plasma, and other flat-panel devices that do not default to sRGB output must install and associate with one or more ICC profiles for ICC color management. A monitor color-calibration utility can generate, edit, and install ICC profiles. The sRGB profile is distributed in Windows Me and Windows 2000. Mobile PCs with Double Supertwisted Nematic (DSTN) panels do not require ICC profiles.

The requirements for sRGB are defined in *IEC 61966-2-1 Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB,* listed in "Monitors References."

MON–0236. USB functionality does not interfere with monitor INF

If a monitor includes USB functionality from either a HID or USB hub, this functionality must be installed separately from the monitor INF file.

A USB hub included on a monitor must be self-powered or externally powered. It cannot be a bus-powered hub. For more information on USB, see the *Universal Serial Bus Specification, Revision 1.1* or later.

Monitor support for Windows is installed using a monitor INF file, such as the INF file defined in the Windows 98 DDK and Windows 2000 DDK.

MON–0237. Monitor meets minimum graphics resolution, based on monitor size

These specific monitor sizes are not required; they show the required pixel format for a given size monitor:

- 14-inch to 15-inch external monitor or built-in mobile PC display = 800×600, noninterlaced
- 17-inch external monitor or 13-inch to 15-inch external LCD = 1024×768, noninterlaced
- 19-inch and 21-inch external monitor or external LCDs larger than 16 inches = 1280×1024, noninterlaced
- 25-inch large-format monitors = 800×600

Note: Sizes for LCDs are the actual viewable image size, rounded to nearest inch. Sizes for CRTs are based on actual CRT size (not visible area) rounded to nearest inch.

MON–0238. CRT-based monitor synchronizes to a new format in less than three seconds

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

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

MON–0239. External monitor meets E-DDC and E-EDID standards

E-DDC defines the communications channel between the display and host system, and *VESA Enhanced Extended Display Identification Data Standard (E-EDID), Release A* 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 supports. Using either the established or the standard timings results in greater flexibility than using detailed timing descriptor blocks.

The following items are particularly critical:

- EDID content must indicate as much information on the range of the monitor's capabilities as possible. The VESA E-EDID standard clarifies the use of the established and standard timing sections of the EDID to indicate the factory preset modes. If an established or standard timing mode is

implemented as a factory preset, then it must be indicated in the appropriate EDID section.

Note: Not all factory preset modes will have a corresponding established or standard timing in the EDID.

- At least one piece of information must indicate the maximum resolution plus maximum timing at that resolution supported by the monitor. If this indication is not implemented using the established or standards timings, a detailed timing can be used.

To enhance the Plug and Play functionality of monitors, the following monitor descriptor definitions are required, as defined in the E-EDID Release A 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 must be concatenated into 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 is placed in the registry for easy access by asset-management software.

MON–0240. CRT-based monitor supports ergonomic timing standards

The monitor must, at a minimum, support the timings documented in either the *VESA Generalized Timing Formula (GTF), Version 1.1* or the *Computer Display Monitor Timing Specifications, Version 1, Rev. 0.8*. This timing support is required for the resolution specified for each monitor size in MON–0237, "Monitor meets minimum graphics resolution, based on monitor size." Other resolutions and refresh rates may be supported, but for any resolution less than the required resolution, there must be a timing for 75 Hz or better. The standards help ensure a clear, flicker-free display for traditional PC computing.

To support optimal playback of video content, monitors must be able to operate with the 59.94 variant of the 60 Hz VESA timing. All references to 60 Hz timing in this chapter also include the 59.94 variant.

Digital Monitor Requirements

This section describes the specific requirements for digital monitors. For DVI graphics adapter requirements, see GRPH–0169, "Adapter meets industry specifications for external display interface," in Chapter 8.

MON–0241. Digital display interface is DVI compliant

Digital Visual Interface (DVI), Revision 1.0 is the industry standard interface for digital display device interconnect interface. Any system implementing digital

monitor output capabilities must implement a DVI-compliant port. Any monitor or display device accepting digital input for display data must implement a DVI-compliant port.

MON–0242. Digital monitor supports hot plug detection

A digital monitor must provide a +5 volt (V) signal to the system within 250 milliseconds (ms) of the system's assertion of the +5V DDC signal to indicate that the monitor is present and capable of transmitting EDID data. A digital monitor must provide the +5V hot plug detection signal to the system as long as the system is providing the +5V DDC signal to the monitor.

MON–0243. Digital monitor supports VESA VGA Text Mode 3 timings, 640 × 480 and 640 × 400

Digital monitors must support lower resolution scanning formats as defined in the VESA VGA Text Mode 3 standard. Support for both 640 × 480 and 640 × 400 at 60 Hz is required. During system boot and in the event an error displays, Windows uses formats such as 640 × 480, 640 × 400, and "text mode 3."

Analog Monitor Requirements

This section describes the specific requirements for analog monitors.

MON–0244. Analog monitor complies with device-class power management reference specification

Display Device Class Power Management Reference Specification, Version 1.0b 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 wakeup event definitions for the class, if any.

Monitors 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.

Color Management and Windows Operating Systems Web page
    http://www.microsoft.com/hwdev/color/

Computer Display Monitor Timing Specifications, Version 1, Rev. 0.8
    http://www.vesa.org/standards.html

Digital Visual Interface (DVI), Revision 1.0
    http://www.ddwg.org

Display Device Class Power Management Reference Specification, Version 1.0b

> http://www.microsoft.com/hwdev/specs/PMref/

IEC 61966-2-1 Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB

> http://www.iec.ch

Specification ICC.1:1998-09 File Format for Color Profiles

> http://www.color.org/ICC-1_1998-09.PDF

Universal Serial Bus Specification, Revision 1.1

> http://www.usb.org/developers/docs.html

Update on ClearType Font Technology and LCD Displays Web page

> http://www.microsoft.com/hwdev/video/clrtype.htm

VESA Enhanced Extended Display Data Channel Standard (E-DDC), Version 1
VESA Enhanced Extended Display Identification Data Standard (E-EDID), Release A
VESA Extended Display Identification Data (EDID) Standard, Version 3
VESA Generalized Timing Formula (GTF), Version 1.1

> Video Electronics Standards Association (VESA)
> http://www.vesa.org/standards.html

Checklist for Monitors

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MON–0235. Monitors support sRGB output or an ICC profile is provided

MON–0236. USB functionality does not interfere with monitor INF

MON–0237. Monitor meets minimum graphics resolution, based on monitor size

MON–0238. CRT-based monitor synchronizes to a new format in less than three seconds

MON–0239. External monitor meets E-DDC and E-EDID standards

MON–0240. CRT-based monitor supports ergonomic timing standards

MON–0241. Digital display interface is DVI compliant

MON–0242. Digital monitor supports hot plug detection

MON–0243. Digital monitor supports VESA VGA Text Mode 3 timings, 640×480 and 640×400

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