Display Technology, VESA and EDID

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Abstract

EDID (Extended Display Identification Data) Standard defines data formats to carry configuration information about display devices.

It became E-EDID (Enhanced Extended Display Identification Data) in 1999 when extension blocks were added. For this presentation, we will refer to EDID to mean E-EDID or EDID.

This is an overview of display technologies and EDID with respect to display devices will be given. EDID is needed as the primary identification mechanism with regard to displays for computer systems and any device which sends information to displays since about 1996. Yet EDID is diverse, with multiple parts. It is changing rapidly and has many associated VESA standards. EDID 1.4 has just been introduced. A review of those standards will be presented.
Display Technologies

- Primary Display Technologies in Use today
  - CRT’s
  - LCD’s
  - Plasmas
  - Projectors
    - Front Projectors, which fill a screen from a distant point
    - Rear Projectors, which are in self-contained enclosures
      - DLP (Digital Light Projects), based on TI’s DMM technology
      - LCOS (Liquid-Crystal on Silicon)
      - AM-LCD (Amorphous Silicon LCD)
      - Poly-LCD (Polysilicon LCD)
  - All use EDID to communicate their resolution capability
Displays and Scalers

- Most fixed-pixel array displays have scalers
  - Convert incoming timings into the display’s native timing
  - May have all of the EDID recommended base timings

- Newer and higher resolution displays have no pure scalers
  - e.g. 30-in LCD monitors at 2560x1600
    - Accept single resolutions, or direct divisions, such as 1280x800
  - Scalers tend to top out at 1920x1200
    - approximately the highest level of HDTV, or 1920x1080
  - EDID becomes critical for a graphics card to know how to drive such displays
### Most Common Display Interfaces

<table>
<thead>
<tr>
<th>Interface</th>
<th>Analog/Digital</th>
<th>Connector</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGA (D-Sub, HD-15)</td>
<td>Analog</td>
<td></td>
<td>1987</td>
</tr>
<tr>
<td>DVI-D</td>
<td>Digital</td>
<td></td>
<td>1999</td>
</tr>
<tr>
<td>DVI-I</td>
<td>Analog &amp; Digital</td>
<td></td>
<td>1999</td>
</tr>
<tr>
<td>HDMI</td>
<td>Release A</td>
<td></td>
<td>2005</td>
</tr>
<tr>
<td>DisplayPort</td>
<td>Digital</td>
<td></td>
<td>2006</td>
</tr>
</tbody>
</table>
Timing and Resolution

- A display device might have many timings.
  - EDID will specify the primary and alternate timings of a display.
  - However, a display may have many timings, well beyond those which can be contained in the limited space of an EDID block.
    - Some displays, like CRT's have infinite timing variation capabilities.
    - Other displays, have PLL's to try to capture incoming signals which are not recognized to be known timings.
      - DVI-D is much better than analog, since it has a pixel clock

- Other displays have few timings, maybe only one
  - e.g. 30-in LCD with 2560x1600 resolution
    - No scaler to adapt alternate timings
      - Native resolution, or native resolution/2
    - All handled by EDID
Default Timing

- EDID has one dominant purpose:
  - To assure video is seen on a display either at turn-on or when hot-plugged (e.g. plug and play)
    - Blanked-out displays for a running system mean **Trouble**!

- The most common default timing is VGA
  - 640x480 typically, but can be a variant, like 720x400
  - Some systems have their own default timings
    - e.g. Sun Microsystems 1Megapixel default of 1152x900
      - With composite sync
Signals to a Display

• Components of a Video Signal

✦ Video content
  ➡ For digital video, has a clock which times it content as pixels
  ➡ True analog video has no clock (or even pixels), which makes problems for flat panels

✦ Blanking

✦ Synchronization (sync)

• I²C Digital Signals are used for communications via DDC between a host and display

• Other signals might be present in other interfaces

✦ e.g. audio or control signals
About Timings

- **What is timing (for displays)?** *[Assume sequential scan]*
  - Timing is the rate at which the video signal is sent from a host to a display.
  - It is the temporal definition of the display signal which defines all of its characteristics to assure

- **Components of timing**
  - Resolution (e.g. 640x480, 1280x1024, 1920x1200)
    - This is the dominant characteristic which also defines the display capability
  - Vertical or refresh rate (e.g. 60Hz, 75Hz, 85Hz)
  - Horizontal rate (or line rate)
  - Blanking
  - Sync
About Timings, continued

- Where do timings come from?
  ✦ Historically hand-calculated, such as follows (for progressive scan):
    ➡ **Horizontal time** = \((\text{HPix} + \text{HblankPix}) / \text{PixClk}\) = 1 line
      ○ e.g. \((1280 + 408) / 108.0\text{MHz} = 15.630\mu\text{s}\)
    ➡ **Vertical time** = \(\text{Htime} \times (\text{Vpix} + \text{VblankPix})\) = 1 frame
      ○ e.g. \(15.630\mu\text{s} \times (1024 + 42) = 16.667\text{ms} = 1/60\text{Hz}\)

- Where can you find out about timings?
  ✦ VESA standards
    ➡ DMT (Display Monitor Timing) - pages of detailed timings
    ➡ CVT (Coordinated Video Timings) Standard & Spreadsheet
    ➡ GTF (Generalized Timing Formula) now replaced by CVT

- How to generate new timings or timings “on the fly”
  ✦ CVT, now incorporated into EDID & Hosts
Synchronization

- Synchronization can often make problems if not understood
- Three main sync types
  1. Separate sync
     - Can have either positive or negative for either H or V
     - Requires two signal paths, one for H and one for V
  2. Composite sync
     - H and V are combined in a single phase-coherent signal
     - Not "officially supported" for digital (DVI) but works,
       - As long as the monitor can handle it
     - Must be phase-coherent - Do not confuse this with X-Or-ing! (or X.org)
  3. Sync on green (SOG)
     - H and V combined as like "Composite Sync" but are added with a DC shift as part of the Green signal
       - Analog only - Does not work for digital (DVI)
What is EDID & why is EDID important

• What is EDID?
  ✦ EDID is 128 bytes of encoded data stored in a display or other interface device
  ✦ It can contain extension blocks of 128 bytes or more

• Why is EDID important?
  ✦ EDID is the basis for “Plug & Play” for all Display/Graphics subsystems.
    ➔ Without this feature, a graphics system and a monitor cannot be assured of working together, and may not display video sent to it.
    ➔ Blanked-out displays for a running system mean Trouble!
## Base EDID History

<table>
<thead>
<tr>
<th>Standard</th>
<th>Version/Release</th>
<th>Revision</th>
<th>Base EDID Structure</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDID 1.1</td>
<td>V2</td>
<td>0</td>
<td>V1 R0</td>
<td>Apr 9, 1996</td>
</tr>
<tr>
<td>EDID 1.2</td>
<td>V3</td>
<td>---</td>
<td>V1 R1</td>
<td>Nov 13, 1997</td>
</tr>
<tr>
<td>E-EDID 1.3</td>
<td>Release A</td>
<td>1</td>
<td>V1 R3</td>
<td>Feb 9, 2000</td>
</tr>
<tr>
<td>E-EDID 1.4</td>
<td>Release A</td>
<td>2</td>
<td>V1 R4</td>
<td>Sep 25, 2006</td>
</tr>
</tbody>
</table>
## EDID History with Relevant Associated Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Version/Release</th>
<th>Revision</th>
<th>Base EDID Structure</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPMS</td>
<td>V1.0</td>
<td>1.0</td>
<td>---</td>
<td>Aug 20, 1993</td>
</tr>
<tr>
<td>DDC</td>
<td>V1.0</td>
<td>0</td>
<td>V1 R0</td>
<td>Aug 12, 1994</td>
</tr>
<tr>
<td>EDID 1.1</td>
<td>V2</td>
<td>0</td>
<td>V1 R0</td>
<td>Apr 9, 1996</td>
</tr>
<tr>
<td>EDID 1.2</td>
<td>V3</td>
<td>---</td>
<td>V1 R1</td>
<td>Nov 13, 1997</td>
</tr>
<tr>
<td>E-EDID 1.3</td>
<td>Release A</td>
<td>1</td>
<td>V1 R3</td>
<td>Feb 9, 2000</td>
</tr>
<tr>
<td>DPM</td>
<td>Release A</td>
<td>---</td>
<td>---</td>
<td>Mar 3, 2003</td>
</tr>
<tr>
<td>E-DDC</td>
<td></td>
<td>1.1</td>
<td></td>
<td>Mar 24, 2004</td>
</tr>
<tr>
<td>Plug &amp; Play</td>
<td>Release A</td>
<td>---</td>
<td>---</td>
<td>Jun 7, 2004</td>
</tr>
<tr>
<td>E-EDID 1.4</td>
<td>Release A</td>
<td>2</td>
<td>V1 R4</td>
<td>Sep 25, 2006</td>
</tr>
</tbody>
</table>
Highest-selling standard in VESA is the FPDM
- Flat Panel Display Measurement Standard

Highest-usage standard in VESA is EDID
- In use in nearly every monitor since 1996, with CRT’s, LCD’s, Plasmas, or any variant of projectors
EDID Diagram

- Header: 8 Bytes
- Vendor / Product Identification: 10 Bytes
- EDID Structure / Revision: 2 Bytes
- Basic Display Parameters/Features: 5 Bytes
- Color Characteristics: 10 Bytes
- Established Timings: 3 Bytes
- Standard Timing Identification (Preferred Timing Mode): 16 Bytes
- Detailed Timing Identification (Alternately display descriptors): 18 Bytes
- Detailed Timing Identification (Alternately display descriptors): 18 Bytes
- Detailed Timing Identification (Alternately display descriptors): 18 Bytes
- Detailed Timing Identification (Alternately display descriptors): 18 Bytes
- Extension Flag: 1 Byte
- Checksum: 1 Byte
## EDID Timing Priority Order

<table>
<thead>
<tr>
<th>Priority</th>
<th>Timing Modes Listing in Base EDID and Extensions Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>“Preferred Timing Mode” as defined in Base EDID</td>
</tr>
<tr>
<td>2</td>
<td>Other ‘Detailed Timing Modes’ in the order listed in BASE EDID</td>
</tr>
<tr>
<td>3</td>
<td>Any additional ‘Detailed Timing Modes’ (priority is in the order listed) in optional EXTENSION Blocks to the BASE EDID</td>
</tr>
<tr>
<td>4</td>
<td>Any optional 3-Byte CVT Codes (defined in optional Display Descriptors) listed in BASE EDID or an optional Extension Block.</td>
</tr>
<tr>
<td>5</td>
<td>‘Standard Timings’ listed in BASE EDID and in optional EXTENSION Blocks.</td>
</tr>
<tr>
<td>6</td>
<td>Additional Timing Mode Information: Established Timings I, II &amp; III, Default GTF, GTF Secondary Curve &amp; CVT</td>
</tr>
<tr>
<td>7</td>
<td>BASE VIDEO MODE (Default is often VGA)</td>
</tr>
</tbody>
</table>
VESA Standards Relevant to EDID

- DDC (E-DDC) - Interface
- CVT & DMT - Timing
- DPM - Display Power Management
- Extension Blocks - Extra EDID information
- DDC/CI - Display Data Channel Command Interface
- DPVL - Digital Packet Video Link
- MCCS - Monitor Control Command Set
  ✦ Set of commands used to control display settings for any communication protocol between host and display
- MDDI - Mobile Display Interface Standard
DDC / E-DDC (Enhanced Display Data Channel)

- Defines a communication channel between a display and a host system
  - Bi-directional communications using an I²C bus
- Used to carry configuration information to plug and play by communicating to the EDID memory block
- Exists on all display interface types today
- DDC went to E-DDC to support E-EDID
- Carried on three pins – data, clock and ground
CVT / DMT

- CVT - Coordinated Video Timings
- DMT - Detailed Monitor Timings
- CVT is a standard for generating timings for displays
  - Has both reduced-blanking timings (efficient for flat panels) and longer-blanking timings for CRT’s.
  - Has a spreadsheet tool for entering timing details
  - Replaces GTF (General Timing Formula)
- DMT is a standard which lists detailed monitor timings
  - Established monitor timings
  - Some are according to CVT and some predate it.
DPM (Display Power Management)

- Display Power Management Standard
  ✦ To define a common method for producing and recognizing low power states for displays
  ✦ Uses video signal components to trigger power management states
  ✦ Replaces DPMS
  ✦ Usually decoded to DE (Display Enable) for DVI digital channels

### Display Power Management Table

<table>
<thead>
<tr>
<th>State</th>
<th>Horizontal</th>
<th>Vertical</th>
<th>Video</th>
<th>DPM Compliance</th>
<th>Power Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>Pulses</td>
<td>Pulses</td>
<td>Active</td>
<td>Mandatory</td>
<td>Normal</td>
</tr>
<tr>
<td>Off</td>
<td>No Pulses</td>
<td>No Pulses</td>
<td>None</td>
<td>Mandatory</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Pulses</td>
<td>No Pulses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Pulses</td>
<td>Pulses</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DPM, continued

- Display Power Management Standard
  - DPM Replaces DPMS

**DPMS and DPM Definition Table**

<table>
<thead>
<tr>
<th>DPMS State</th>
<th>DPM State</th>
<th>Industry Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>On</td>
<td>On</td>
<td>On</td>
</tr>
<tr>
<td>Standby*</td>
<td>Off</td>
<td>Sleep</td>
</tr>
<tr>
<td>Suspend*</td>
<td>Off</td>
<td>Sleep</td>
</tr>
<tr>
<td>Off</td>
<td>Off</td>
<td>Off/Deep Sleep/Standby Power</td>
</tr>
</tbody>
</table>

* Not Commonly Used
### EDID Structure Extension Tag Numbers

<table>
<thead>
<tr>
<th>Tag Numbers</th>
<th>Extension Block Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>02h</td>
<td>CEA-EXT: CEA 861 Series Extension</td>
</tr>
<tr>
<td>10h</td>
<td>VTB-EXT: Video Timing Block Extension</td>
</tr>
<tr>
<td>40h</td>
<td>DI-EXT: Display Information Extension</td>
</tr>
<tr>
<td>50h</td>
<td>LS-EXT: Localized String Extension</td>
</tr>
<tr>
<td>60h</td>
<td>DPVL-EXT: Digital Packet Video Link Extension</td>
</tr>
<tr>
<td>F0h</td>
<td>Extension Block Map</td>
</tr>
<tr>
<td>FFh</td>
<td>Extensions defined by the display manufacturer</td>
</tr>
</tbody>
</table>
EDID Extensions

- CEA-861C
  - DTV profile for uncompressed high speed digital video
  - From CEA, not VESA

- VTB-EXT - Video Timing Block Extension
  - Expansion EDID block for additional detailed timings

- DI-EXT - Display Information Extension Block
  - Useful display information like pixel layout, links, color depth, audio support, orientation, dithering, gamma details

- LS-EXT - Localized String Extensions
  - For user-friendly information (string tables) for any languages
DDC/CI

- **DDC/CI - Display Data Channel Command Interface**
  - An I^2^C - based protocol which operates over the DDC channel
    - Provides interactive bi-directional communications between a host and display
    - For control of any display technology or associated devices
    - Interfaces: VGA, DVI, HDMI, etc.
  - Dan have control over a network
  - Display technology independent
  - MCCS codes are recommended for standards communications protocols

- **Applications**
  - Remote adjustments of displays
    - Examples: Image, color, geometry, audio, windows, DPVL
  - Power control
DPVL – Digital Packet Video Link

- DPVL allows for packetized video
  - e.g. Only pixels which are update on a display have information transmitted on the video link
    - Graphics card transmits only a part of the image
  - Make for low bandwidth video interfaces for higher bandwidth displays
  - Overcomes bandwidth limits of interfaces
  - Allows for graphics cards normally incapable of transmitting high resolutions in real time to otherwise drive the displays.
MCCS

- MCCS - Monitor Control Command Set
  - Set of commands used to control display settings for any communication protocol between a host and display
  - Not only computers, but also DTV
  - Implemented via a bi-directional serial links
    - Examples: I²C - DDC based (like DVI or HDMI) or USB

- Types of Control Functions
  - Remote adjustments of displays
    - Examples: Image, color, geometry, audio, windows, DPVL
  - Manufacturer-specific controls
Brand New EDID – EDID 1.4

Why was EDID 1.4 developed?

- EDID 1.3 (first published on 9/02/99) is 7 years old.
- EDID 1.3 does not support some newer VESA Standards.
- EDID 1.3 is PC (IT) Centric --- no support for DTV products.
- E-EDID Standard Rel. A, Rev. 1 (2/09/00) contains errors.
- Examples in E-EDID Std. Rel. A, Rev.1 are obsolete.
- EDID 1.4 addresses some of these issues.
What’s new in EDID 1.4?

• Week & Year of Manufacturer or Model year
  ✦ For EDID 1.3:
    ➡ Week of Manufacture was optional
    ➡ Year of Manufacture was required, but not stated in standard
  ✦ For EDID 1.4:
    ➡ Week of Manufacture remains optional
    ➡ Year of Manufacture is required
      ☺ May be defined as Year of Manufacture or Model Year
    ➡ Stored Value = (Year of Manufacture {or Model year} - 1990)

<table>
<thead>
<tr>
<th>Address</th>
<th>2 Bytes</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10h</td>
<td>1</td>
<td>00h</td>
<td>Week of Manufacture is not specified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>01h - 36h</td>
<td>Week of Manufacture is specified (range is 1 - 54 weeks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FFh</td>
<td>Model Year Flag ---Model Year is specified at address 11h</td>
</tr>
<tr>
<td>11h</td>
<td>1</td>
<td>10h - FFh</td>
<td>If Byte 10h = FFh then Byte 11h contains Model Year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10h -&gt; FFh</td>
<td>If Byte 10h ≠ FFh then Byte 11h contains Year of Manufacture</td>
</tr>
</tbody>
</table>
What’s new in EDID 1.4? (continued)

✧ Video Input Definition
  ➡ Video Input Definition expanded to include
    ✢ Color Bit Depth Definition (Optional)
    ✢ Digital Video Interface Standard Supported (optional)
      • e.g. DVI, HDMI, MDDI, DisplayPort

✧ H & V Screen Size and Aspect Ratio
  ➡ H & V Screen Size can be defined as Aspect Ratio (add 15h, 16h)
    ✢ Landscape vs. Portrait Orientation

✧ Feature Support Byte
  ➡ Feature Support Byte (18h, Bits 4,3) may define
    ✢ Display Color Type (analog inputs)
      • e.g. Monochrome, Grayscale, Undefined
    ✢ Supported Color Encoding (digital inputs)
      • e.g. RGB 4:4:4, YCrCb 4:2:2, etc.
What’s new in EDID 1.4? (continued)

✦ Feature Support Byte (continued)
  ➡ Preferred Timing Mode (PTM) Bit 1 changed
    ◦ Can include Native Pixel Format & Preferred Refresh Rates
  ➡ Generalized Timing Formula (GTF) Bit 0 changed
    ◦ For continuous frequency vs. multi-mode

✦ Detailed Timing Descriptor (18 Bytes)
  ➡ Now supports Image Size or Aspect Ratio
    ◦ Preferred Timing Mode is the native pixel format with optimal timing.
  ➡ Display Product Name Descriptor is not optional but recommended
  ➡ Display Range Limits Descriptor (formally Monitor Range Limits) is now optional.
  ➡ Display Color Management (DCM) is now used
  ➡ Included CVT (Coordinated Video Timing)
  ➡ Increased Range Limits
    ◦ Max vertical rate goes from 255Hz to 510Hz
    ◦ Max horizontal rate goes from 255kHz to 510kHz
  ➡ Updated EDID Extension Block Tags
EDID 1.4 Summary

- EDID 1.4 (E-EDID Release A, Revision 2) is the result of a 2-year effort to revise the E-EDID 1.3 Standard
- Was designed to support both monitors, DTV, and combined products
- Proper use of EDID 1.4 will support Plug & Play
- VESA Recommendations:
  ⊳ Source professionals: Begin developing graphics drivers and/or programs capable of decoding both EDID 1.4 and EDID 1.3 data structures
  ⊳ Display professionals: Begin adding EDID 1.4 data tables to the displays
Next Generation – Display ID

- .....and then there’s Display ID

- .....but that’s another story.
End of Presentation

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