Display Transfer Characteristics Data Block

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VESA Display Transfer Characteristics Data Block Standard

Version 1.0
August 31, 2006

Purpose

This standard defines the Display Transfer Characteristics Data Block (DTCDB), for use in a CEA-861 compatible EDID extension, as originally proposed in the VESA TV Compatibility White Paper (released July 9, 2005).

Summary

VESA, working in cooperation with the Consumer Electronics Association (CEA), has proposed a convergence of the EDID extension definition used in both the PC and consumer electronics (TV) industries to describe monitor, TV, or 'multifunction' display products beyond the information provided by the base EDID file.

To achieve this, two new data blocks, compatible with the data block structure first defined by CEA-861-B, have been defined to replace the PC-only VESA Display Information Extension (DI-EXT) previously defined by VESA. This permits an extended EDID structure to be defined in a manner suitable for both industries, and containing information appropriate to monitor, television, and combined-use applications.

Future use of the DI-EXT definition in PC displays is discouraged in favor of this compatible approach. This standard defines a block which describes the transfer characteristic, or gamma curve, of the display in question.

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Clarifications and application notes to support this standard may be written. To obtain the latest standard and any support documentation, contact VESA.

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Revision History

August 31, 2006—Initial Release of the Standard

Acknowledgements

This document would not have been possible without the efforts of the VESA Display Systems Standards Committee's Television Compatibility (TVC) Task Group. In particular, the following individuals and their companies contributed significant time and knowledge to this edition of the VESA Display Device Characteristics Data Block standard.

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Glenn Adler	Philips	
Jim Carrington	Portrait Displays	
George Wiley	Qualcomm	
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VESA also acknowledges the participation of the membership of the CEA R4.8 committee, and particularly the members of Working Group 7 of that committee, and thanks them for their assistance in reviewing and commenting on this document.

1. Overview

This standard provides a definition for a variable-length (8, 16 or 32 bytes) data block, for use within an EDID extension as described by the CEA standard entitled "A DTV Profile for Uncompressed High Speed Digital Interfaces," also known as CEA-861. This definition is to be used as desired within such extensions as defined by CEA-861-C or later revisions.

This data block is intended to provide additional information regarding the display device's transfer or response curve characteristics (also known as the "gamma curve"), beyond that which is provided by the base EDID definition established elsewhere by VESA, and which is also used under the CEA-861 standard. The information provided by this block is similar to that provided in the earlier DI-EXT standard, but is defined here in a format compatible with the CEA-861 structure. (An additional data block definition, the VESA Display Device Information Data Block, provides the additional display features and characteristics information that was also formerly provided by DI-EXT.) This permits the creation of EDID extensions that will meet the needs of both the consumer electronics/TV and personal computer industries, while remaining fully compatible with the CEA extension structure and readable by all host devices. (Use of the earlier DI-EXT definition for new designs is not recommended, in favor of this CE/PC compatible system.)

The specific information provided by this block is limited to the transfer or response curve characteristics only – that is, how the luminance of the display varies with variations in the input signal level. This definition provides a means of describing either the combined white response, separate RGB (or other primaries) responses, or a combination of these, to a degree of accuracy not possible in the simple "gamma" model assumed in the base EDID definition. Under this standard, up to 32 points may be described on the transfer characteristic curve, in terms of their relative value vs. the full-input luminance, to ten bits of accuracy. The only assumptions necessary under this definition are that the response curve is monotonically increasing (i.e., that no input value ever results in an output luminance *less* than that resulting from a lesser value), and that there is no case in which the luminance changes by more than one quarter of the maximum luminance value between any two successive input levels described in the data given.

These assumptions permit the storage of transfer characteristic data in the form of successive incremental luminance values, each of which is summed to the previous total to obtain the relative luminance at that input level. (The peak luminance level, or that which is produced for the maximum permissible input level, is assumed to have the normalized max. 10-bit value of 3FFh, and so need not be explicitly given in the table of values.)

1.1 Display Transfer Characteristic Data Block – Overall Description

The definition of the VESA Display Transfer Characteristic Data Block shall be as given in Table 1-1 below.

Note: This block may, under the EIA/CEA-861 system, be located anywhere within the 128-byte extension which contains it; therefore, the addresses given in this table must be understood to be relative from the start of this particular block. Note that multiple Display Transfer Characteristic Data Blocks may appear within the entire EDID structure (base EDID plus all extensions) provided by a given display, limited only by the constraints of available space and the manufacturer's desire to provide detailed information of this nature; however, it is important to note that there is no requirement for even a single block of this type to be provided by any display. Use of this data block may, however, be necessary to satisfy the requirements of other non-VESA standards or specifications.

Table 1-1: Display Transfer Characteristic Data Block Structure

Relative address (hex)	No. bytes	Description
00h	1	3-bit Tag (for this block, “101”) 5 bits of length; this is per CEA-861C, and will give the number of bytes following this first tag byte. As there can only be 6, 14, or 30 incremental values given (starting in byte 02h), valid length values here are limited to 7, 15, and 31.
01h	1	Bits 7-6: Usage of this block, per the following code: 00 – White transfer characteristic 01 – Red transfer characteristic 02 – Green transfer characteristic 03 – Blue transfer characteristic Bits 5-0: Initial luminance value (normalized, and limited to 6 bits); absolute luminance when input signal level is at minimum level. Note that, as the maximum normalized luminance value is 3FFh, a maximum permissible initial value of 3Fh (max. possible in six bits) means that this block cannot be used for displays which exhibit an initial or “black level” luminance value in excess of 6.1% of the maximum or “white” luminance (i.e., a minimum CR of approx. 16:1).
02h – (07/0F/1F)h	6, 14 or 30	Incremental luminance values, for 6, 14 or 30 input values spread evenly over the input signal range, excluding the maximum value (which is normalized such that the peak output has a value of 3FFh). 8 bits each, permitting increments of 000h to 0FFh.

1.2 Other Documents Referenced

Note: Versions identified here are current, but users of this standard are advised to ensure they have the latest versions of referenced standards and documents.

Table 1-2: Reference Documents

Source	Name	Version / Date
VESA	White Paper – “Compatibility of PC and CE Displays”	1.0, July 9, 2005
VESA	Enhanced Extended Display Identification Data (E-EDID)	A.1 / Feb. 2000
VESA	Enhanced Display Data Channel (E-DDC)	1 / Sep. 1999
CEA	“A DTV Profile for Uncompressed High Speed Digital Interfaces” CEA-861	D/ May 2006

2. Example of Usage

To better understand how this block is to be used to convey transfer characteristic information, the following examples may be helpful.

Note: The values given here are only examples; the actual contents of the data block for any given display will vary depending on the size and type of transfer characteristic structure(s) chosen for use by the manufacturer, and the specific characteristics of the display in question.

For the purpose of this example, we will first assume that a white display transfer characteristic is to be stored in the form of sixteen white luminance points, taken for input video signal values spread evenly between the minimum allowable (i.e., the defined 'black level' for the video interface in question) and maximum allowable ('white level') values. The luminance data which has been (hypothetically) measured for this display is as follows; either a standard VGA analog interface or an 8-bit/primary digital interface may be assumed.

Table 2-1: Example Luminance Measurements

Sample No.	Analog input level (all inputs)	Digital input value (all inputs)	White Luminance (cd./m^2)
0 (black)	0.000V	00000000	0.56
1	0.047	00010001	3.21
2	0.093	00100010	7.45
3	0.140	00110011	12.62
4	0.187	01000100	18.79
5	0.233	01010101	24.63
6	0.280	01100110	33.98
7	0.327	01110111	40.55
8	0.373	10001000	47.92
9	0.420	10011001	58.41
10	0.467	10101010	65.10
11	0.513	10111011	77.84
12	0.560	11001100	85.33
13	0.607	11011101	91.06
14	0.653	11101110	97.51
15 (peak white)	0.700V	11111111	100.00

To convert these values for storage, the peak white value must first be normalized to 3FFh:

100.00 cd/m^2 ≡ 3FFh, therefore 1 lsb (least significant bit) ≡ 100.00/1023 = 0.098 cd/m^2

This fixes both the maximum and minimum values; the peak white level value is by definition 3FFh, and therefore does not need to be conveyed by this data block.

The black level luminance (which would be considered the offset in the typical gamma + offset response model) is therefore, for this display, 0.560/0.098 = 5.714 (normalized), which will be rounded to 6 and stored in the lower six bits of byte 1 of the data block as 000110. The top two bits of this byte are set to "00," indicating that this block provides a white transfer characteristic.

The remaining values, for samples 2 through 14, are given by storing eight-bit values which correspond to the incremental increase in luminance between samples N and N-1; in other words, the absolute luminance value at any sample point may be determined by summing up all of the eight-bit incremental values up to and including the increment for that sample, and multiplying the resulting value by the lsb luminance.

Note that in storing these increments, it shall be the norm to convert the absolute luminance value for any given sample to its ten-bit normalized equivalent first, rounding as necessary, and then determining the incremental value between it and the normalized absolute luminance of the sample immediately preceding. This is shown in the following table, again based on the previous table of luminance samples:

Table 2-2: – Example Values for DTCDB, Resulting from

Luminance Measurements as Given in Table 2-1.

Sample #	Luminance	Normalized Lum.	Value to be stored
0	0.56	0000000110 (006h)	00000110 (06h)
1	3.21	0000100001 (021h)	00011011 (1Bh)
2	7.45	0001001100 (04Dh)	00101100 (2Ch)
3	12.62	0010000001 (081h)	00110100 (34h)
4	18.79	0011000000 (0C0h)	00111111 (3Fh)
5	24.63	0011111100 (0FCh)	00111100 (3Ch)
6	33.98	0101011100 (15Ch)	01100000 (60h)
7	40.55	0110011111 (19Fh)	01000011 (43h)
8	47.92	0111101010 (1EAh)	01001011 (4Bh)
9	58.41	1001010110 (256h)	01101100 (6Ch)
10	65.10	1010011010 (29Ah)	01000100 (44h)
11	77.84	1100011100 (31Ch)	10000010 (82h)
12	85.33	1101101001 (369h)	01001101 (4Dh)
13	91.06	1110100100 (3A4h)	00101011 (3Bh)
14	97.51	1111100110 (3E6h)	01000010 (42h)
15	100.00	1111111111 (3FFh)	Not stored

Therefore, for this example, the complete Display Transfer Characteristic Data Block would be as follows in Table 2-3.

Table 2-3: – Complete DTCDB Contents Using Example Values Given in Section 2.

Byte	Value	Meaning
0	AFh	Data block tag (101); Length: 15 (01111)
1	06h	Normalized luminance for the black level (zero input) of 6 (000110); most significant two bits (00) indicate a white transfer characteristic.
2	1Bh	Increments for samples 2-14. The increment for sample 15 is not needed, as sample 15 is assumed to have a normalized luminance value of 3FFh (the "white" level).
3	2Ch	
4	34h	
5	3Fh	
6	3Ch	
7	60h	
8	43h	
9	4Bh	
10	6Ch	
11	44h	
12	82h	
13	4Dh	
14	3Bh	
15	42h	