EXHIBIT B

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Attorneys for Plaintiff and Counterclaim Defendant
DISPLAYLINK CORPORATION

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN JOSE DIVISION

DISPLAYLINK CORPORATION, a Washington corporation,

Plaintiff,

v.

MAGIC CONTROL TECHNOLOGY CORPORATION, a Taiwanese corporation;

Defendant.

AND RELATED COUNTERCLAIMS

CASE NO.: 5:07-CV-01998-RMW

DECLARATION OF ALAN H. JONES, PH.D., IN SUPPORT OF DISPLAYLINK CORPORATION'S RESPONSIVE CLAIM CONSTRUCTION BRIEF

Date: March 3, 2008
Time: 1:30 pm
Courtroom: Courtroom 6 – 4th Floor
Before: Judge Ronald M. Whyte

I, Alan H. Jones, Ph.D., declare:

1. In 1981, I received a Bachelor of Arts degree in Physics from Cambridge University. I received a Diploma in Computer Science from Cambridge University in 1982. In 1986 I received my Ph.D. in Computer Science from Cambridge University.

2. I am currently Director and co-owner of Cotares Limited, a Cambridge, England based consulting and research company. I have more than 25 years of experience in the computer, computer network and computer communication industries. I have 14 published patents relating to communications between computers and peripheral components, telematics, as well as other technologies. I am also a named inventor on numerous other pending applications for letters patent. Further, I have co-authored 13 published articles relating to networks, computing, and streaming video data in distributed environments among other technologies. My published patents and article are listed in my *curriculum vitae*, a true and correct copy of which is attached as Exhibit 1.

I. REVIEW OF BACKGROUND MATERIALS

3. I have reviewed the following materials to determine the proper and correct scope of claims 1, 2, and 19 of U.S. Patent No. 7,203,788 (the "'788 Patent"):

a. The '788 Patent;[1]

b. The prosecution history of the '788 Patent, a true and correct copy of which is attached as Exhibit 2;

c. The deposition transcript of Dr. Paul S. Min, a true and correct copy of which is attached as Exhibit 3;

[1] The '788 Patent is included as Exhibit A to Defendant and Counterclaim Plaintiff Magic Control Technology's Opening Claims Construction Brief Pursuant to Local Rule 4-5 (Docket Entry No. 33).

d. PS/2 Video Subsystem Technical Reference Manual, a true and correct copy of excerpts from which are attached as Exhibit 4;[2]

e. IBM Personal System/2 and Personal Computer BIOS Interface Technical Reference, a true and correct copy of excerpts from which are attached as Exhibit 5;

f. USB 2.0 Specification, a true and correct copy of excerpts from which are attached as Exhibit 6;

g. USB 1.1 Specification, a true and correct copy of excerpts from which are attached hereto as Exhibit 7;

h. USB 1.0 Specification, a true and correct copy of excerpts from which are attached hereto as Exhibit 8;

i. USB Monitor Control Class Specification, revision 1.0, January 5, 1998, a true and correct copy of which is attached hereto as Exhibit 9;

j. The parties' Joint Claim Construction and Prehearing Statement Pursuant to Patent Local Rule 4-3, a true and correct copy of which is attached as Exhibit 10;

k. U.S. Patent Application No. 2004/0021615, a true and correct copy of which is attached as Exhibit 11;

l. U.S. Patent Application No. 2004/0017333, a true and correct copy of which is attached as Exhibit 12;

m. U.S. Patent Application No. 2003/0120849, a true and correct copy of which is attached as Exhibit 13;

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[2] Due to the volume of exhibits 4-8, we are submitting certain excerpts mentioned herein. Should the Court believe the specification in their entirety would be helpful, we will gladly submit each specification in its entirety.

n. U.S. Patent Application No.2002/0135584, a true and correct copy of which is attached as Exhibit 14;

o. IBM Personal Computer marketing brochure, a true and correct copy of which is attached as Exhibit 15; and

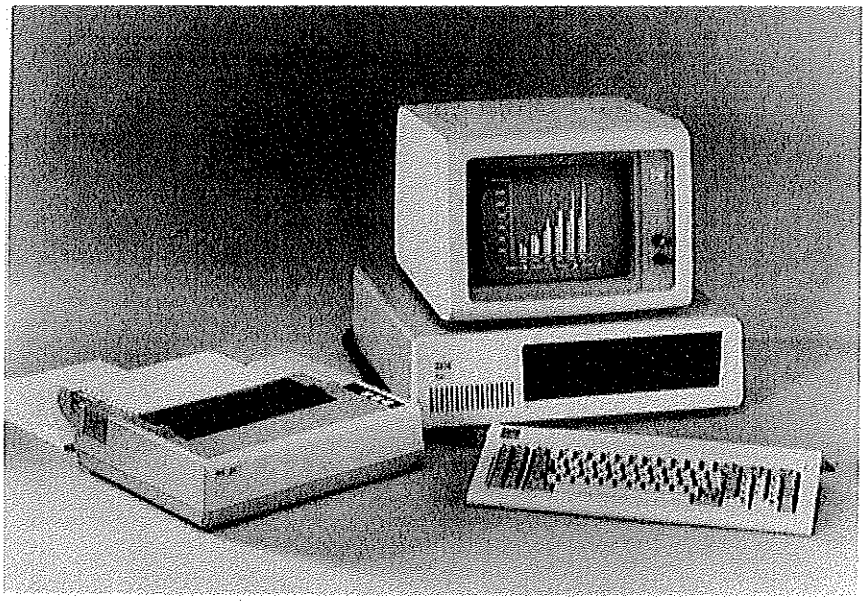
p. IBM (Information Systems Division, Entry Systems Business) Press Release, August 12, 1981, a true and correct copy of which is attached as Exhibit 16.

4. Based on my review of the above-referenced materials and my knowledge as a person of ordinary skill in the art, I offer my opinion as to the proper scope of claims 1, 2, and 19 of the '788 Patent, which are stated herein and reflected in the accompanying Markman Brief.

II. BACKGROUND OF THE TECHNOLOGY

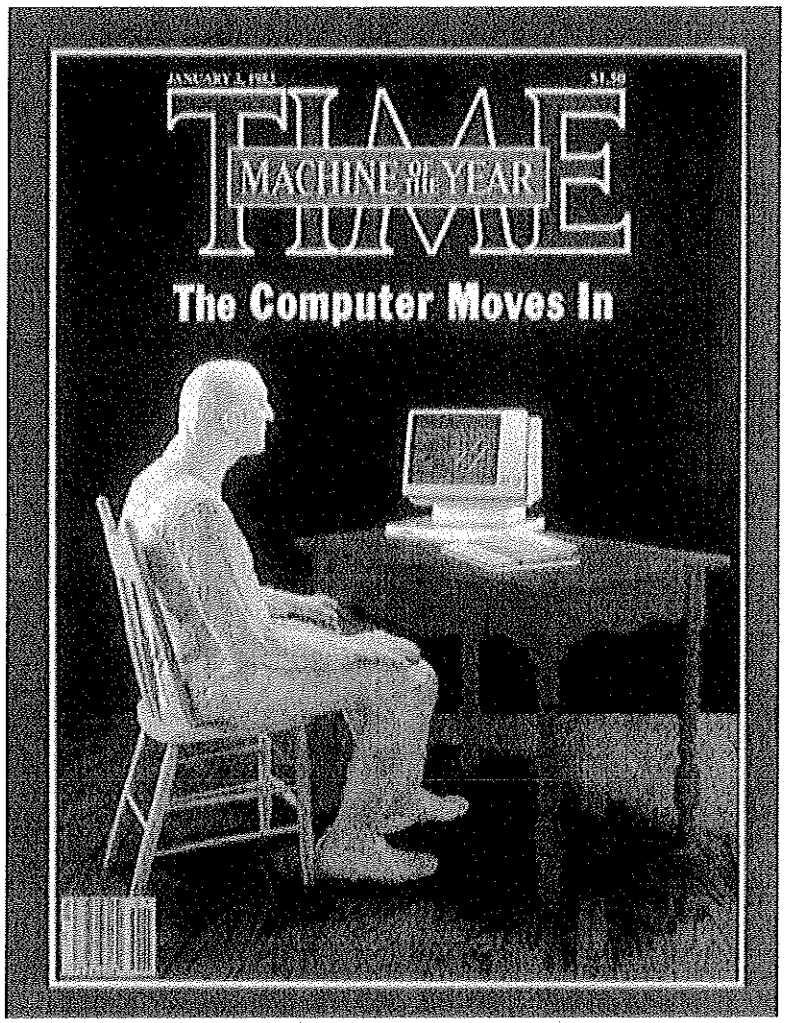
5. The Micro Instrumentation and Telemetry Systems Altair 8800 was introduced in 1975. Arrival of the Altair 8800 was announced in the January 1975 issue of Popular Electronics. Today, the Altair is widely touted as the first personal computer and recognized as the spark that led to the personal computer revolution of the next few years.

6. In August 1981, International Business Machines Corporation released the IBM Personal Computer. Exhibit 16 at 1. The model number used by IBM to identify this product was 5150. The IBM 5150 was based on an open architecture including five expansion slots for additional memory and display, printer, communications, and game adaptors. *Id.* at 2; Exhibit 15 at 2 and 6. The brain of the IBM 5150 was an Intel 8088 processor and expansion of the IBM 5150 was facilitated through an 8-bit bus that became known as the ISA (Industry Standard Architecture) bus. *See*, *id.* at 4; http://www-03.ibm.com/ibm/history/exhibits/pc25/pc25_birth.html.



The IBM 5150.

7. According to Time, the "Person of the Year is an annual issue of TIME magazine that features a profile on the man, woman, couple, group, idea, place, or machine that "for better or worse, has most influenced events in the preceding year." In its January 3, 1983 issue, however, Time renamed its annual "Person of the Year" issue to the "Machine of the Year" in acknowledgement of the affect of developments in the personal computer industry in the preceding year.



Time's "Machine of the Year" Issue January 3, 1983.

8. Since the advent of the IBM PC, the availability of PC peripherals has exploded. An owner of an IBM PC could connect to their system: one or more printers and/or monitors, laboratory equipment, gaming devices, external data storage, and information and voice communications equipment, to name a few. Before 1996, the selection of a peripheral often required the user to select from different – typically incompatible – interfaces with which to connect a desired peripheral to the PC.

9. Between 1981 and 1985, there were two primary video controllers or adapters available: MDA and CGA. An MDA, or Monochrome Display Adapter,

equipped personal computer supported only a single 80x25 monochromatic text mode (BIOS mode 07h) in a relatively high resolution of 720x350. This adapter was very limited in capability, but suitable, for non-graphical applications. A CGA, or Color Graphics Adapter, equipped personal computer, on the other hand, in addition to text modes, supported 320x200 4-color or 640x200 monochromatic graphics modes. In early 1985, the EGA, or Enhanced Graphics Adapter, a superset of MDA and CGA, was introduced. An EGA (Enhanced Graphics Adapter) equipped personal computer supported 80x25 (or up to 80x43 with custom programming) text modes and up to 640x350 16-color graphics modes (with basic 64K of memory expanded to 256K). EGA also supported programmable character fonts, providing very flexible text mode support.

10. Reflecting not only a change in name but a change in technology, Video Graphics Array or VGA equipped personal computers and VGA driven monitors appeared on the IBM PS/2 line of personal computers first launched in 1987. *See*, http://www-03.ibm.com/ibm/history/exhibits/pc25/pc25_PH06.html. The details of the VGA graphics architecture are described in a series of Technical Reference Manuals published by IBM.[3] Today, these Technical Reference Manuals are readily recognized as the origin of VGA. Dr. Paul S. Min, Magic Control Technology Corporation's claim construction expert, acknowledges that this is the case. *See, e.g.*, Exhibit 3 at 127:20-128:17; 135:9-136:15. Today, most Windows-based personal computers and many other personal computers generally include support for VGA as promulgated by IBM beginning in 1987.

11. VGA replaced the digital interfaces of MDA and CGA with an analog interface. In addition, VGA offered a resolution of up to 640x480, an increased color

[3] IBM Corporation, Personal System/2 Hardware Interface Technical Reference (1988 and as updated in 1991) and IBM Personal System/2 and Personal Computer BIOS Interface Technical Reference (1991).

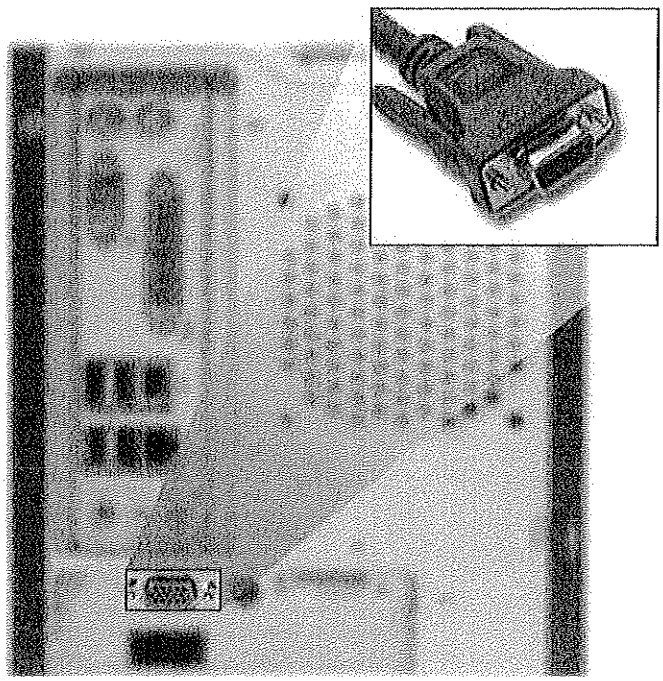
palette of 262,144 colors, and the ability to simultaneously display up to 256 colors. By comparison, MDA was monochrome and CGA could simultaneously show no more than 16 colors. EGA was capable of showing 16 colors which were software selectable from a palette of 64 colors.

12. At the time the application for the '788 Patent was filed, there were other well-known video graphic standards such as SVGA or Super Video Graphics Array.

13. The later published standards to VGA, such as SVGA, are defined by their own distinct specifications. *See, e.g.*, Exhibit 3 at 135:9-136:5. SVGA and other later developed graphics standards were designed, generally, to provide higher levels of video and graphics performance. The SVGA specification, as well as other later published graphics standards specifications, provides "backward" compatibility to the VGA standard. It is important to note that the VGA standard is not capable of supporting SVGA specific commands and/or instructions. Stated another way, while an SVGA enabled controller or display device can render and present VGA signals, a VGA enabled PC or display device can not render and present the full range of SVGA signals. Furthermore, I have read page 19 of MCT's opening brief where they attempt to equate VGA with such later developed graphics standards as SVGA, XGA or Extended Graphics Array, SXGA or Super Extended Graphics Array, UXGA or Ultra Extended Graphics Array, and QXGA or Quad Extended Graphics Array. Without question, a person of ordinary skill in the art of the '788 Patent would not confuse Video Graphics Array with such later developed graphics standards as Super Video Graphics Array, Extended Graphics Array, Super Extended Graphics Array, Ultra Extended Graphics Array, Quad Extended Graphics Array or any other later developed graphics standard.

14. A person of ordinary skill would understand that VGA refers to more than a 15-pin-D-subminiature connector. VGA also includes the type and nature of the

display signals that can be sent to a display device. An SVGA standard monitor uses the same physical connector but would not be considered a VGA monitor because a VGA monitor could not use or process the full range of SVGA signals. Similarly, an SVGA signal that is sent to a display device would not be considered to be a VGA signal to such a device.



15-pin D-subminiature connectors.

15. Before the introduction of USB, a keyboard was connected to the PC through any of a variety of means. Indeed, until recently, the keyboard and the mouse have been connected to the PC using a PS/2 port. Predecessors to the PS/2 port, at least for the keyboard, include the XT and AT ports, named after the line of IBM PCs on which they appeared – similar to the circumstances that lead to the naming of the PS/2 port. In addition to these interfaces, many pre-USB PCs came with serial or COM ports (using the RS-232 standard) and a parallel port (often referred to as an LPT or printer port).

16. As it existed before the development and deployment of USB, the PC was fraught with expandability problems. The PC possessed a very limited number of slots that could be used to connect the computer to a peripheral. This limited number of slots sometimes restricted users to a mere two additional peripherals. More significantly, in order for a user to add a peripheral, the user was often required to acquire an expansion card that had to be installed into an available slot. With a little luck, the expansion card would properly seat in the expansion slot such that the operating system running on the PC would detect the presence of the card on the system's motherboard. Once detected, the user would then be required to install driver software specific to the expansion card to register the card with the operating system and enable the card and the operating system to communicate. If everything went according to plan – which it often did not – users were required to delve into the low level operation and configuration of the PC in an effort to manage the system's limited IRQs (*i.e.*, interrupts) and other resources in an effort to convince the expansion card and the operating system to communicate. Once the expansion card and driver software were installed and properly recognized by the PC, only then could the user connect the actual peripheral device to the required expansion card. As was often the case, if a PC was loaded to capacity with expansion cards and peripherals, the rear of the PC and the path between the PC and the peripherals was a mess of wires.

17. One of the primary motivations behind USB or Universal Serial Bus was to eliminate the trend of adding a new interface to the PC for every new function, peripheral or capability introduced. Exhibit 8 at 11. With this motivation in mind, USB revision 1.0 was released in 1996. USB 1.1, which was released to fix problems noted in Revision 1.0, was released in 1998. Exhibit 7 at ii. USB 2.0, the last USB specification released, was released in 2000. *See*, Exhibit 6 at i-ii. USB 2.0 was released to make

available a bus data rate of 480 Mbits/s, far exceeding the 12 Mbits/s data rate available in USB 1.0 and 1.1. *Id.* at ii. As of today, USB 1.0, 1.1, and 2.0 are the only USB specifications. These are the only USB specifications prepared, approved and adopted by USB Implementers Forum, Inc., ("USB IF") the corporation founded by the developers of USB to provide a support organization and forum for the advancement and adoption of USB technology. *See*, http://www.usb.org/developers/docs/. Such approval and adoption processes are common in the PC industry. By nature of USB's widespread acceptance, it is well understood in the personal computer industry that USB refers to the technology defined in and by the specifications promulgated and adopted by the USB IF. Indeed, while many other serial bus topologies exist – some of which may have one or more characteristics similar to that of USB – but which are not implemented in accordance with one of the USB specifications, such interfaces are interfaces by another name.

18. The Universal Serial Bus Specification Revision 2.0, as did its predecessors, defines industry-standard USB. *See, e.g.*, Exhibit 6 at 1; Exhibit 7 at 1; Exhibit 8 at 11. "The specification describes the bus attributes, the protocol definition, types of transactions, bus management, and the programming interface required to design and build systems and peripherals that are compliant with this standard." *Id.* "The goal is to enable such devices from vendors to interoperate in an open architecture. The specification is intended as an enhancement to the PC architecture, spanning portable, business desktop, and home environments. It is intended that the specification allow system OEMs and peripheral developers adequate room or product versatility and market differentiation without the burden of carrying obsolete interfaces or losing compatibility." *Id.*

19. The USB Specifications define, among other things, the requirements for developing USB-compatible and USB-compliant peripherals. Specifically, the USB

Specifications define (1) the USB interconnect including, bus topology, inter-layer relationships, data flow models and USB schedule, (2) the USB host architecture and (3) the USB device architecture. Exhibit 6 at 15; Exhibit 7 at 15; Exhibit 8 at 27. The USB Specification also details the parameters of the cables, connectors and cable assemblies to interconnect USB devices. *See, e.g., id.* at Chapter 6.

20. A big advantage of USB from the user perspective was that the new USB hardware came integrated with a new PC. This meant that if a user wanted to expand their system by adding peripherals, all they had to do was acquire and connect a USB-enabled peripheral into the existing USB port – no more separate expansion cards or drivers to buy, install and configure. This advantage alone ended the need for the wiring mess resulting from using the numerous and disparate interfaces that had historically been included on the PC.

21. Nearly simultaneously with the release of USB 1.0 (and continuing today), peripheral component manufacturers were designing converters that permitted users to transition their legacy devices – which would not have been otherwise usable with the USB port due to connector incompatibility – to new PCs that replaced legacy ports with USB ports. Examples of these devices are many. For example, there are USB-to-PS/2 converters extending the lives of PS/2 interface based mice and keyboards. Likewise, there are USB-to-parallel converters extending the life of parallel port-based printing equipment. There also exist USB-to-RS-232 converters. Of course, that this is the case comes as no surprise since the same events followed prior interface transitions, *e.g.*, converters were developed to ease the keyboard interface transition from AT to PS/2 as well as for the transition of the mouse from a serial port to a PS/2 connection.

22. At a maximum data rate of 12 Mbits/s, USB 1.0 and USB 1.1 provided insufficient bandwidth for the transmission of the data actually displayed on the monitor,

although that goal was contemplated. Exhibit 9 at 2. However, with a data rate of 480 Mbits/s, USB 2.0 opened the door to the possibility of sending display data over a USB connection. Early efforts at sending video over a USB, particularly USB-to-VGA conversion, may be found in, for example, Exhibits 11 to 14.

III. ORDINARY SKILL IN THE ART

23. Based on many years of experience as an engineer, consultant and research scientist, it is my opinion that the individual of ordinary skill in the art of the '788 Patent would have at least (1) a degree in electrical engineering or computer science and (2) experience in hardware design, including (a) work on the concepts of timing, data throughput, and how the device will need to interact with the intended system and (b) implementing devices that comply with well-known industry standards such as the USB and VGA standards.

IV. CONSTRUCTION OF THE DISPUTED TERMS

A. USB

24. An individual of ordinary skill in the art of the '788 Patent would understand that the term USB refers to Universal Serial Bus, the technology described in the Universal Serial Bus Specification Revision 2.0 and its predecessor revisions.

25. My review of the '788 Patent and its prosecution reveal no evidence to suggest the term USB was defined to mean anything other than Universal Serial Bus as would be understood by a person of ordinary skill in the relevant art. That a person of ordinary skill in the art would understand USB to refer to the technology described in the Universal Serial Bus Specification Revision 2.0 and its predecessor revisions is plain from the '788 Patent specification. '788 Patent at 1:6-7. Furthermore, that USB in the '788 Patent was meant to refer to the technology described in the Universal Serial Bus Specification Revision 2.0 and its predecessor revisions is acknowledged by other

persons of ordinary skill in the art throughout the prosecution history. *See, e.g.*, Exhibit 11 at ¶0017; Exhibit 14 at ¶¶0027 & 0029.

26. Dr. Min confirmed that the most current USB Specification in existence at the time of the filing of the application for the '788 Patent was Universal Serial Bus Specification Revision 2.0. *See*, Exhibit 3 at 106:21-107:9. This is the very specification Dr. Min stated "would be what at [the time of filing of the application for the '788 Patent] a person of ordinary skill would look at." *Id.*

27. I find nothing to suggest that any of the references in the '788 Patent specification, claims or prosecution history to USB and Universal Serial Bus generically refer to any serial bus specifications that are compatible with any USB port/plug. It is also noteworthy that an individual of ordinary skill in the art of the '788 Patent would turn to the technology described in the Universal Serial Bus Specification Revision 2.0 or one of its predecessor revisions to implement the USB port/plug in MCT's faulty construction.

B. VGA

28. An individual of ordinary skill in the art of the '788 Patent would understand that the term VGA refers to Video Graphics Array, the technology described in the IBM Corporation's Personal System/2 Hardware Interface Technical Reference and in the IBM Personal System/2 and Personal Computer BIOS Interface Technical Reference.

29. In context, indeed from plain language, the term VGA is used in the '788 Patent to refer to Video Graphics Array. *See*, '788 Patent at 1:7. I find no suggestion of an alternative use of the term VGA in the specification or prosecution history of the '788

Patent.[4] I find no suggestion in the intrinsic record that indicates the term VGA has meaning contrary to its well-understood and ordinary meaning. Further, I find nothing in the specification to suggest that the term VGA in the '788 Patent refers to a video standard that is backward compatible with VGA. I find nothing in the intrinsic or in extrinsic evidence to suggest that the term VGA in the context of the '788 Patent refers to all video display standards compatible with any 15-pin VGA port/plug. Indeed, VGA must refer to more that just the plug/port as VGA is used to modify at least the terms signal, controller, and port/plug.

30. Furthermore, I have read page 19 of MCT's opening brief where they attempt to equate VGA with such later developed graphics standards as SVGA, XGA or Extended Graphics Array, SXGA or Super Extended Graphics Array, UXGA or Ultra Extended Graphics Array, and QXGA or Quad Extended Graphics Array. Notably, there is no reference in the '788 Patent specification or claims to any of these later developed graphics standards. Further, there is nothing in the '788 Patent specification or claims to suggest that the term VGA encompasses these distinct video standards. Without question, a person of ordinary skill in the art of the '788 Patent would not confuse Video Graphics Array with such later developed graphics standards as Super Video Graphics Array, Extended Graphics Array, Super Extended Graphics Array, Ultra Extended Graphics Array, Quad Extended Graphics Array or any other later developed graphics standard.

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[4] Even the references to VGA in Exhibit 14, which defines a video graphics adaptor, suggests the VGA standard developed by IBM in the late 1980s and early 1990s. In particular, Exhibit 14 describes a video graphics adaptor which converts digital display data into analog display data for transmission to a sub-monitor – precisely the implementation defined in the VGA system defined in the IBM specification's identified by DisplayLink.

31. Here again it is worthy of note that an individual of ordinary skill in the art of the '788 Patent would turn to the IBM Corporation's Personal System/2 Hardware Interface Technical Reference and in the IBM Personal System/2 and Personal Computer BIOS Interface Technical Reference to implement the 15-pin VGA port/plug in MCT's proposed construction. *See, e.g.*, Exhibit 4 at 1-2; Exhibit 3 at 143:20-144:16.

C. Display Device

32. An individual of ordinary skill in the art of the '788 Patent would understand that the term display device refers to an electronic device for visually representing VGA signals.

33. The display device of the '788 Patent is a VGA-enabled display device meaning that in order for it to properly visually represent display signals it must receive VGA signals. There are numerous bases for this conclusion. The plain language of the claims indicates that the VGA controller conveys and applies "VGA signals to the display device." '788 Patent at 4:65-67; 5:10-11; 6:42-44; 6:55-56. An express object of the purported invention of the '788 Patent is "to provide a USB-to-VGA converter which converts USB based display signals issued from a host computer into VGA signals that can be received and recognized by a display device." '788 Patent 1:31-36; 1:45-60. These examples state clearly that the display device of the '788 Patent is an electronic device for visually representing VGA signals.

34. At no point do the claims or the specification describe anything other than VGA signals being applied to the display device. At no point do the claims or specification describe converting VGA signals into an alternate form before the signals are applied to the display device. Indeed, Dr. Min confirms that the '788 Patent discloses only the application of VGA signals to the display device. Exhibit 3 at 46:18-47:20.

D. USB Controller

35. An individual of ordinary skill in the art of the '788 Patent would understand that the term USB controller refers to a component or components that control the receipt, storage, and routing of USB encoded data.

36. The '788 Patent teaches that the claimed USB controller must be something more than a passive device. The '788 Patent specification expressly states that the "USB controller 10 is connectable to a USB port 210 of a host computer 200 ***for receiving*** USB based display signals from the host computer 200." '788 Patent at 2:26-29 (emphasis added). Claims 1 and 19, on their face, require "a USB controller disposed external to the computer and adapted to detachably connect to a USB port of the computer for ***receiving*** exclusively therethrough USB based display signals from the computer." '788 Patent at 4:60-64; 6:37-41 (emphasis added).

37. The USB controller is further required to be able to control this receipt and, further, to store data. Specifically, it is not until the bridge issues a first-in-first-out ("FIFO")[5] control command that data is to be read from the USB controller. '788 Patent at 5:1-7; 6:45-51. If the USB controller was unable to control the receipt of USB encoded data – that is data that is transmitted in a format specified in the USB Specifications – and provide for its storage, there would be no apparent reason for the bridge to issue a FIFO read command. Indeed, without the ability to control the receipt and storage of USB encoded display signals, there would likely be little to no usable display data for the bridge to request in a FIFO manner.

38. The USB controller must also be able to control the routing of USB based display signals. Specifically, the USB controller of the claims is required to pass USB

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[5] First-in-first-out, in the computer arts, is an ages old data storage technique. In this context and in the context of the '788 Patent, as the name suggests, the first data that is received (in) is the first data that is read (out) when the time is right (*e.g.*, upon receipt of a FIFO read request).

based display signals ***to the bridge***, not of its own accord, but ***in response to*** the bridge's issuance of a FIFO control signal. '788 Patent at 5:1-7; 6:45-51. That the USB controller is required to be able to control the routing of data is further evidenced in the requirement that the USB controller ***issue a bus control command***. '788 Patent at 4:60-64; 6:36-40.

39. The issuance of a bus control command plainly evidences routing control. Such commands are typically issued to let other components know that data is present and/or that device issuing the command wishes, or is ready, to transmit data to one or more other devices on the bus. Furthermore, according to the '788 Patent claims, issuance of this bus control command to the bridge also defines a measure of control of the receipt of data by the bridge – "the bridge receiving the bus control command and issuing a first-in-first-out control signal to the USB controller to receive the USB based display signals from the USB controller in a first-in-first-out manner." '788 Patent at 5:1-7; 6:45-51.

40. Each of the USB Specifications states that USB devices consist of three layers. Exhibits 6-8 at Chapter 9. "The bottom layer is a bus interface that transmits and ***receives*** packets. The middle layer handles routing data between the bus interface and various endpoints on the device. . . . The top layer is the functionality provided by the serial bus device." *Id.* In order to control the routing of incoming USB packets as required, storage capabilities are needed. For example, in order to determine the USB endpoint to which data is directed, the USB controller must be able to store the data long enough for the controller to determine the intended endpoint and to route the data accordingly. Any USB device implements at least endpoint 0 and one or more additional endpoints. As such, even the most rudimentary USB device will necessarily perform the routing of incoming USB data between at least endpoint 0 and another endpoint.

E. VGA Controller

41. An individual of ordinary skill in the art of the '788 Patent would understand that the term VGA controller refers to a component or components that control the routing of VGA signals pursuant to the VGA standard.

42. Throughout the '788 Patent specification, it is the VGA controller that conveys, forwards, supplies or applies the VGA signals to the display device. *See, e.g.*, '788 Patent at 1:50-51; 1:58-59; 2:38-40; 4:33-35. The specification states that VGA controller, after it receives VGA signals from the bridge, "forwards the VGA signals to the display device 300 for display by the display device 300." '788 Patent at 2:33-40. To an individual of ordinary skill, the '788 Patent makes it clear that the VGA controller exerts control over the passage of VGA signals to the display device. An individual of ordinary skill would not characterize a passive device, *i.e.*, a device that does not exert control over data, as one that conveys, forward, supplies, or applies data. Indeed, if the VGA controller did not exert control over the VGA signals, the VGA controller would be nothing more than a VGA port or plug. This cannot be the case as Dr. Min stated that the VGA controller was something different than the VGA port/plug. Exhibit 3 at 136:19-137:4. Specifically, Dr. Min stated that the VGA controller was functional while the VGA port/plug was merely mechanical. *Id.*

43. The claims of the '788 Patent include similar language. Specifically, claims 1 and 19 both state that the VGA controller conveys and applies VGA signals to the display device. '788 Patent at 4:65-67; 5:10-11; 6:42-44; 6:55-56. Thus, the claim language dictates the same conclusion as the specification – a conclusion affirmed by Dr. Min.

44. Furthermore, the VGA standard, the technology described in the IBM Corporation's Personal System/2 Hardware Interface Technical Reference and in the IBM Personal System/2 and Personal Computer BIOS Interface Technical Reference,

requires the VGA controller to perform routing of VGA signals. Specifically, the VGA video subsystem provides for the routing of VGA signals as it formats information in video memory and directs the output to the video digital-to-analog converter. *See, e.g.*, Exhibit 4 at 2-5.

F. USB Based Display Signals

45. An individual of ordinary skill in the art of the '788 Patent would understand that the term USB based display signals refers to USB encoded display signals.

46. The plain language of the claims indicates that USB based display signals are USB encoded display signals. Specifically, the claims require a USB controller connected "to a USB port of the computer for receiving . . . USB based display signals." '788 Patent at 4:60-63; 6:36-39. In order for the display signals of the '788 Patent to pass through the USB port of the computer and be received by the USB controller, the display signals must be encoded according to one of the USB specifications. Any signal passed through a USB port of the computer that is not USB encoded would be more than likely be unusable by receiving processes. The claims expressly require "USB based display signals" be display signals received from a computer be in a USB format and these received signals be converted into a different format – *i.e.*, the VGA format – for transmission to a display device. '788 Patent at 5:1-11; 6:45-55. Because the USB based display signals are converted into VGA signals that are applied to the display device, the USB based display signals must be display signals, not mere display information.

47. For these same reasons, the myriad references in the specification to USB based display signals passed from the host to the USB controller also require that the display signals be USB encoded. For example, the Summary of the Invention states that an object of the purported invention "is to provide a USB-to-VGA converter which

converts USB based display signals issued from a host computer into VGA signals that can be received and recognized by a display device whereby [the] image to be displayed can be transmitted from the host computer ***in USB form***." '788 Patent at 1:31-34 (emphasis added). This passage makes it clear that display signals, *i.e.*, image signals, are to be transmitted to the USB controller through the USB port on the computer be ***in USB form*** or USB encoded.

48. I find no suggestion in the claims or the specification that anything other than display signals are to be USB encoded and transmitted across the USB link to the USB controller and eventual conversion to VGA signals that are applied to a display device.

49. Although the USB Specifications define the encoding required of data transmitted on a USB compliant bus, the concept of encoding data for transmission across a given bus according to the requirements of that particular bus is fundamental. For example, data sent across a PCI (Peripheral Component Interconnect) or AGP (Advanced Graphics Port) bus must be appropriately encoded for that data to reach its intended destination and for it arrive in a form usable by the destination process or device.

G. USB Based Display Signals from the Computer

50. An individual of ordinary skill in the art of the '788 Patent would understand that the term USB based display signals from the computer refers to USB encoded display signals representing the image rendered by the computer.

51. According to the language of the claims, the display signals that are to be converted into VGA signals by the bridge represent the image rendered by the computer. The claims require that the bridge convert the USB based display signals from the computer into VGA signals that are applied to the display device. '788 Patent at 4:57-5:11; 6:32-55. If the VGA signals resulting from the conversion of the USB based

display signals from the computer into VGA signals are to be displayed by the display device, the USB based display signals from the computer must represent the image rendered by the computer. Anything short of rendered data would not result in an image being displayed at the display device, regardless of the conversion from USB based display signals into VGA signals.

52. This is the sole teaching of the specification. The '788 Patent states that an object of the purported invention "is to provide a USB-to-VGA converter which converts USB based display signals issued from a host computer into ***VGA signals that can be received and recognized by a display device***." '788 Patent at 1:31-34 (emphasis added). To an individual of ordinary skill in the art of the '788 Patent, for a given set of USB based display signals from the computer to be converted into "VGA signals that can be received and recognized by a display device," the USB based display signals from the computer must represent the image rendered by the computer. Rendering, the process of computing the data that defines the visual image, is a prerequisite to the display of any image.

53. Figure 4 of the '788 Patent and its associated written description describe that the USB based display signals from the computer represent the image rendered by the computer. The '788 Patent states that in response to an application's request for a display of messages, the display messages are forwarded to a graphics engine for processing the messages to be displayed. '788 Patent at 3:52-65. Then a graphics driver is actuated "to process and drive ***the displayed screen information***" before this information is transmitted via the USB interface. *Id.* (emphasis added). Consequently, the '788 Patent specification teaches that the USB based display signals from the computer represent the image rendered by the computer.

54. The '788 Patent specification's teaching that the VGA controller merely "forwards" the VGA signals resulting from the USB display signal conversion performed by the bridge further supports this conclusion. '788 Patent at 2:33-40. Here again, the '788 Patent specification suggests that the USB based display signals from the computer represent the image rendered by the computer as the USB based display from the computer are simply unwrapped from its USB encoding, converted into VGA signals and simply "forwarded" to the display device for display. There is no teaching of further processing the data to put the data is a displayable format. The teaching that the "USB signal [from the computer in 'USB form'] is then converted into a VGA signal for proper display by the display device" provides further confirmation that the USB based display signals from the computer represent the image rendered by the computer. '788 Patent at 4:36-48.

H. For Receiving Exclusively Therethrough USB Based Display Signals

55. An individual of ordinary skill in the art of the '788 Patent would understand that the limitation for receiving exclusively therethrough USB based display signals refers to receiving only USB based display signals into the USB controller.

56. The plain language of the claims indicates that the USB controller is connected to the USB port of the computer for the sole purpose of "receiving exclusively therethrough USB based display signals." '788 Patent at 4:60-64; 6:36-40. I note nothing in the claimed phrase suggesting that the USB controller controls forwarding operations. That the USB controller would control forwarding conflicts with the operation of the bridge which directs data flow by issuing a FIFO signal to the USB controller to receive USB based display signals from the USB controller in a FIFO manner. '788 Patent at 5:1-7; 6:45-51. Thus, the claims plainly show that the phrase for

receiving exclusively therethrough USB based display signals refers to receiving only USB based display signals into the USB controller.

57. As described in the claims, the display device receives the USB based display signals taken in by the USB controller from the USB port of the computer. '788 Patent at 4:57-5:11; 6:32-55. The claims further require that the USB based display signals be converted into corresponding VGA signals before being conveyed or applied to the display device. *Id.* Consequently, because the claims require that the USB based display signals be applied to the display device – albeit in VGA signal form – the plain meaning of the claims requires that the phrase for receiving exclusively therethrough USB based display signals refers to receiving only USB based display signals into the USB controller.

58. The patent specification describes "a USB-to-VGA converter which converts USB based display signals from a host computer into VGA signals that can be received and recognized by a display device whereby image to be displayed can be transmitted from the host computer in USB form." '788 Patent at 1:31-36. Without argument, VGA signals that can be received and recognized by a display device are analog signals according to the VGA standard which are converted into a visual image by a display device. The patent further describes "a USB-to-VGA converter that allows for direct transmission of USB signals from a host computer to a display device without adding any display interface card inside the host computer." '788 Patent at 1:41-45. In addition, the patent requires a "USB controller 10 [that] is connectable to a USB port 210 of a host computer 200 for receiving USB based display signals from host computer 200." '788 Patent at 2:26-29. In view of these teachings, the specification makes clear that the claimed USB-to-VGA converter connects the computer to an external monitor

and further that the USB controller receives only USB based display signals from the computer.

59. During prosecution of the '788 Patent MCT amended claim 1 to change the language of the claim from "for receiving USB Based Display Signals" to "for receiving exclusively therethrough USB Based Display Signals." Exhibit 2 at DL000106-107. MCT stated the change was made to clarify the scope of claims 1 and 19 so that the 'converter includes among its combination of features that of a USB controller 'external to the computer' which 'detachably' connects to the computer's USB port for 'receiving exclusively therethrough' the 'USB based display signals form the computer." Exhibit 2 at DL000113. To a person of ordinary skill, this amendment requires that the phrase "for receiving exclusively therethrough USB based display signals" refer to receiving only USB based display signals from the computer.

I. Bridge

60. An individual of ordinary skill in the art of the '788 Patent would understand that the term bridge refers to a component or components for communicating between two or more buses each using different interface standards.

61. The meaning of the term bridge is plain for the claims and specification. The specification makes it clear that a FIFO controller is positioned between the USB controller and the bridge, the FIFO controller connecting each of the bridge and the USB controller via a "data bus." '788 Patent at 2:54-67. The USB controller also issues a ***bus*** control command in the sequence that facilitates the data to be moved from the USB controller to the bridge. '788 Patent at 4:60-64, 6:36-40 (emphasis added). There would be no apparent need for a bus control command if there were no bus present.

62. That there is a bus between the bridge and the VGA controller is also evidenced in the '788 Patent specification. The '788 Patent specification describes a

bridge converting USB based display signals received from a USB controller into VGA signals which can be of PCI type or AGP type. '788 Patent at 2:46-53. AGP and PCI are two very well know bus protocols. Notably, PCI and AGP (as well as PCIe – PCI Express) are bus protocols commonly used to interface video controllers with their host computing system's main processor. For the interpretation of the disputed bridge term, USB encoded signals cannot be transmitted across a PCI or AGP bus without significant data loss. Likewise, PCI or AGP encoded signals cannot be passed across a USB bus without significant data loss. Furthermore, USB is a serial bus whereas the bus in AGP and PCI are parallel – yet another incompatibility between USB and the PCI and AGP busses. Thus, the bridge must be able to not only change the packaging of the data from USB encoding into PCI or AGP encoding, it must also serialize or de-serialize the data exchanged between the busses.

63. The claims and the specification are clear that the bridge of the '788 Patent interconnects at least two busses – one between the USB controller and the bridge and one between the bridge and the VGA controller.

J. Connecting the USB Controller and the VGA Controller One to the Other for the Passage of Data Therebetween

64. An individual of ordinary skill in the art of the '788 Patent would understand that the limitation connecting the USB controller and the VGA controller one to the other for the passage of data therebetween means connecting the USB controller to the VGA controller such that the VGA controller can receive video data only from the USB controller via the bridge.

65. The'788 Patent claims a USB-to-VGA converter external to the computer which provides for the "image to be displayed [to] be transmitted from the host computer in USB form." '788 Patent at 1:31-36. The claims further require that the USB controller and the VGA controller be able to communicate data. '788 Patent at 5:1-3;

6:45-47. In this vein, the claims require that the USB controller – which receives exclusively USB based display signals – communicate video or display data to the VGA controller. Specifically, the USB controller receives exclusively USB based display signals which are converted by the bridge into corresponding VGA signals. '788 Patent at 5:1-11; 6:45-55. Following conversion of the USB based display signals, the VGA controller applies these VGA signals to the display device. *Id.* The only data usable by a display device receiving analog VGA signals is video or display data.

66. This is further evidenced throughout the specification. The patent describes "a USB-to-VGA converter which converts USB based display signals from a host computer into VGA signals that can be received and recognized by a display device whereby image to be displayed can be transmitted from the host computer in USB form." '788 Patent at 1:31-36. The patent further describes "a USB-to-VGA converter that allows for direct transmission of USB signals from a host computer to a display device without adding any display interface card inside the host computer." '788 Patent at 1:41-45. The patent fails to describe the VGA controller receiving data from any source other than the USB controller.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed this 11th day of February, 2008, in Cambridge, England.

Alan H. Jones, Ph.D.

EXHIBIT 9

USB Monitor Control Class Specification

Revision 1.0

January 5, 1998

Scope of this Revision

This revision is intended for implementation.

Revision History

Rev	Date	Filename	Comments
1.0	January 5, 1998	USBMON10.DOC	Initial release for implementation

USB Monitor Control Class Specification
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Table of Contents

1. Introduction 1
1.1 Purpose 1
1.2 Scope 1
1.3 Related Documents 1
1.4 Terms and Abbreviations 1
2. Management Overview 2
3. Background 3
4. Monitor Class Overview 4
5. Monitor Class Reference 6
5.1 Monitor Descriptors 6
5.2 Monitor Requests 6
5.3 Monitor Reports 6
5.3.1 Individual Monitor Reports 7
5.4 Power Management 7
5.5 Top-Level Collection 7
6. Appendices - Usage Pages 8
6.1.1 USB Monitor Usage Page 8
6.2 Monitor Enumerated Values [Usage Page] 8
6.3 VESA Virtual Control Usage Page 9
6.5 Example Monitor Report Descriptions 15

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1. Introduction

1.1 Purpose

This document defines how a monitor with a USB Monitor Control interface interacts with a USB-enabled host system.

1.2 Scope

This document is intended to provide enough information to allow developers of monitors with USB Monitor Control interfaces to build compliant devices. This document will allow developers of USB-enabled operating environments to provide standard support for monitor control through a single Monitor Class device driver.

1.3 Related Documents

ACCESS.bus Industry Group, *ACCESS.bus™ Specifications*, Section 7, Monitor Device Protocol Specifications, Version 3.0 March 1995. ACCESS.bus Industry Group

Compaq, Digital Equipment Corporation, IBM PC Company, Intel, Microsoft, NEC, and Northern Telecom, *Universal Serial Bus Specification*, Version 1.0 - January 19, 1996. USB Implementers Forum (www.usb.org)

Universal Serial Bus Implementers Forum, *Device Class Definition for Human Interface Devices (HID)*, Firmware Specification, 1.0 - Final, June 21, 1997. (www.usb.org)

Video Electronics Standards Association, *VESA Display Information Format VDIF Standard*, Version Number 1.0, August 23, 1993, VESA (www.vesa.org)

Video Electronics Standards Association, *Extended Display Identification Data (EDID™) Standard*, Version 2, Revision O, April 9, 1996, VESA (www.vesa.org)

Video Electronics Standards Association, *VESA Monitor Control Command Set*, (Proposal), VESA (www.vesa.org)

1.4 Terms and Abbreviations

ACCESS.bus	Serial interface bus that runs at a slower speed than USB.
DPMS	Acronym for Display Power Management Services.
EDID	Acronym for Extended Display Information Data. Describes monitor characteristics to host system.
HID	Acronym for Human Interface Device.
VCP	Acronym for Virtual Control Panel.
VDIF	Acronym for VESA Display Information Format. Describes monitor characteristics to host system.
VESA	Acronym for Video Electronics Standards Association.

2. Management Overview

The Universal Serial Bus Monitor Control Class focuses on the management and control of monitors. USB is not used to transfer the information actually displayed on the monitor. USB's available bandwidth is not sufficient for this task.

This specification defines a protocol for communications between monitor devices and host systems using USB. This protocol manages typical user controls such as brightness, contrast, size and position, as well as internal settings used to adjust the performance of the monitor for different video adapter modes. In addition, this specification describes how monitor power management is performed through USB.

There are a number of parameters that describe a monitor's characteristics to a host system. This information may be used to constrain the supported modes of a video adapter to those that are compatible with the monitor. When the host system inquires about these characteristics, the monitor returns the information requested. This allows the host environment to determine the monitor type and characteristics without end-user intervention.

The protocol of the USB Monitor Control Class has been designed within the constraints imposed by the *USB Device Class Definition for Human Interface Devices (HID) Specification*. A monitor is a HID device.

This allows host support for Monitor Class devices to be simpler as they may rely on a HID Class driver for direct access to their device; the devices need not be concerned with the interaction between the HID Class driver and lower-system software layers.

This specification builds on previous industry efforts by using reporting formats standardized by the Video Electronics Standard Association (VESA) and virtual control panel op-codes standardized by the ACCESS.bus Industry Group.

3. Background

Monitors typically provide a number of controls to allow end-users to adjust monitor performance to an individual's preference. When a video adapter changes modes, a monitor may also require adjustment of those controls to compensate for changes in the characteristics of the video signal.

The Video Electronics Standard Association (VESA) describes a method of reporting a monitor's timing information to allow video adapters to be optimally programmed. Two standards relating to monitor timing have been released. The VESA Display Information Format (VDIF) includes descriptive information about the monitor, operational limits, pre-adjusted timings and, optionally, gamma information from a calibration device.

VDIF permits one or more pre-adjusted timings for each operational limit specified and the gamma table, if present, can have a large number of entries. This means the amount of information returned varies in length and can actually require several Kbytes of information to be returned by the monitor.

More recently, VESA published another standard reporting format for describing the capabilities of a monitor: the Extended Display Identification Data (EDID™) Standard. This format is more compact.

Having a standard format for the information reported is important, but equally important is how a host system obtains this information. Neither the VDIF or EDID specifications specify how this is to be achieved. Also, the specifications do not describe how the information, if and when delivered, will be used.

VESA did develop two methods of host-to-monitor communications, known as DDC1/2B and DDC1/2AB. The first is a simple application of the Philips I^2C protocol for reading VDIF information from the monitor. The second is a superset of the first, and supports the reading of VDIF information and the control of the monitor from a host system. The ACCESS.bus Industry Group, as a part of the *ACCESS.bus Specifications*, published a section on Monitor Device Protocol Specifications for monitors that are compliant with VESA DDC1/2AB.

In some systems, VDIF or EDID data may be returned by the video BIOS. This requires a display adapter capable of communicating with the attached monitor to obtain the necessary information and operating systems that attempt to use the information. This specification provides another mechanism for obtaining this information from the monitor across USB. This is in addition to using USB for monitor control and status. Providing BIOS level support for returning VDIF and EDID information is not necessary if you adhere to this specification.

4. Monitor Class Overview

The *USB Monitor Control Specification* defines the connection between the host system and the monitor using two pipes: the device's default pipe and an interrupt pipe assigned to an interface with HID class coding. An example of an implementation of the overall monitor control architecture is illustrated in Figure 1.

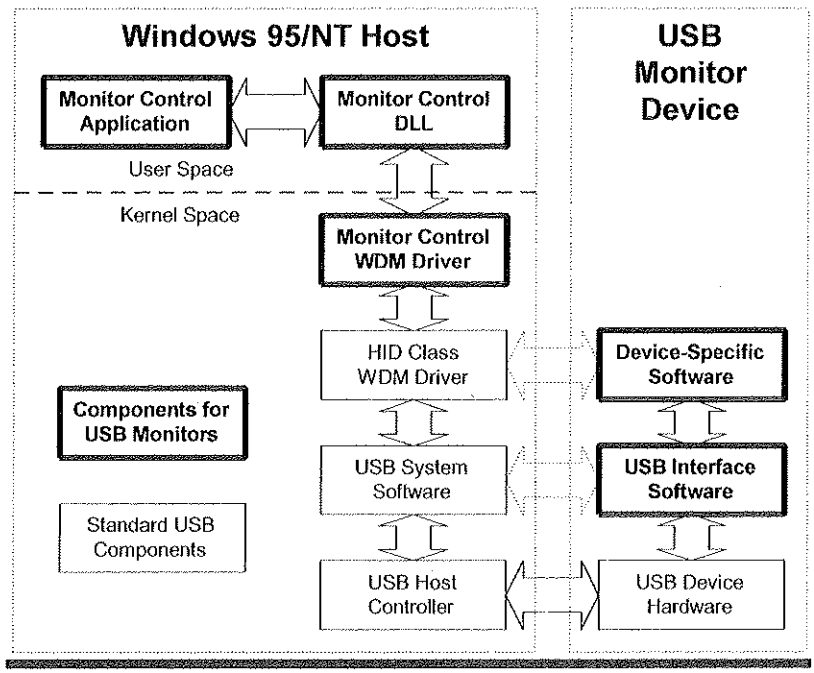


Figure 1 - Example of Monitor Control Architecture

Monitor Control is performed by using the services available to HID class devices. Within the HID class, all class-specific interaction with the device is carried out through data structures called reports. The HID defines three types of reports: Feature, Input, and Output.

While not mandated by specification, Feature reports are typically used to transfer what many operating systems called IOCTL, or I/O control, and status information. Other environments may refer to this type of information as "out-of-band" signaling.

Devices produce data and consume data provided by the host. Devices pass information to the host, typically as asynchronous notifications, using Input reports. The host uses Output reports to pass data to the device. These reports roughly correspond to what most systems call Read and Write data.

Building on this foundation, the USB Monitor Control Class uses Feature, Input, and Output reports to transfer data with HID Class Get_Report and Set_Report requests.

As part of the initialization of a monitor Control Panel application, the virtual controls the monitor supports must be determined to update an on-screen representation of the monitor controls. This information is described in Section 6.2.2 "Report Descriptor" in the *USB Device Class Definition for Human Interface Devices (HID) Specification.* The presence of a particular virtual control in the HID Report descriptor indicates the control is supported by the monitor. The HID Report description language also describes the maximum legal value for the virtual control.

When a video adapter changes the video mode, monitors often require different settings for virtual controls to deal with differences in the supplied video signal. Monitors typically provide preset values for a number of recognized video modes. When a particular mode is recognized by the monitor, it automatically changes the virtual controls to preset values associated with that mode. The end-user may then adjust the individual virtual controls to tune the performance of the monitor to an individual's preference.

Some monitors allow end-user customized settings to replace the pre-set values for the selected video mode. When the monitor receives a request from the host to write the Settings control, the monitor saves the current settings of all virtual controls as the values to be used whenever the monitor senses the current video mode.

Monitor control applications should note that not all video modes have a unique set of pre-set values for a monitor's virtual controls. Writing to the Settings control may result in a change to the values used for more than one video mode. At this time, the *USB Monitor Control Class Specification* does not provide support for determining which set of pre-set values is currently selected. Adjustments may only be made to the currently selected set of pre-set values for virtual controls.

When the monitor receives a request from the host to write ENUM_1 to the Settings virtual control, the monitor saves the current settings of all virtual controls as the values to be used whenever the monitor senses the current video mode.

Some monitors may allow factory default settings for the currently selected set of pre-sets to be restored. If so, the monitor restores factory defaults when a write of ENUM_2 is sent to the Settings virtual control. For compatibility, if this capability is not supported, the monitor simply responds as if it completed the request successfully.

5. Monitor Class Reference

This section is intended to be used as a reference for Monitor Descriptors, Requests, and Reports.

5.1 Monitor Descriptors

USB monitors are HID class devices. Therefore, they use the same set of descriptors as any HID device. These include all of the standard descriptors: device, configuration, interface, endpoint, and string descriptors. They also use a HID Descriptor associated with the interface containing the interrupt endpoint and a Report Descriptor as defined in the *Device Class Definition for Human Interface Devices (HID) Specification*.

5.2 Monitor Requests

USB monitors support standard USB requests, as appropriate for the monitor's implementation. USB monitors also utilize the HID class-specific requests Get_Report and Set_Report. USB monitors do not use any of the other HID class-specific requests, for example: Get_Idle, Set_Idle, Get_Protocol, and Set_Protocol.

HID class drivers do not provide any method of providing further extensions to HID class-specific requests. Because the USB monitor driver is intended to use a HID class driver for communications with the USB monitor device, the *USB Monitor Control Class Specification* does not have any class-specific requests. Defining such requests would have required that a monitor driver bypass the HID class driver and interact directly with the USB system software on the host. Such behavior would violate the spirit of a layered software architecture.

5.3 Monitor Reports

This section describes the reports supported by USB Monitor Control Class devices. All reports follow the definition of HID class reports of the same type. There are three types of reports:

- Feature
- Input
- Output

All types of reports may be specifically requested through the device's default pipe using a standard HID class request, Get_Report. Feature and Output reports may also be sent to the device using the standard HID class request, Set_Report. Input reports may also be received via the interrupt pipe for asynchronously reporting purposes.

Feature reports are used to get or set monitor device characteristics. Some Feature reports may only be appropriate for device-to-host transfers or get operations. Other Feature reports are used to change the configuration of the monitor.

Output reports are used to send commands to a monitor using controls that are write only (for example, Degauss). Input and Feature reports are used to report the current setting of a particular aspect of a configuration of a monitor. Controls defined in Feature reports that may be modified by external events should also be defined in an Input report. As previously noted, Input reports may be requested via the default pipe or sent to the host by the device when that particular aspect changes.

Within each report type, report IDs are unique. Report IDs may be re-used between report types. For example, there is only one Input report that uses ID 0. There may also be a single Feature and a single Output report that also uses ID 0. Report IDs are arbitrary and implementation-dependent.

5.3.1 Individual Monitor Reports

The controls that are contained in a particular report are implementation-dependent. Host-based software, typically a HID class device driver, is responsible for determining which report contains values for a particular monitor control.

A monitor manufacturer decides how many individual reports their monitor uses. It is possible to implement a monitor with one Feature report, one Input report, and one Output report. However, it is typically more efficient to provide multiple reports to partition the information exchanged between the host and the monitor into smaller more cohesive units. For more information, see the *USB Device Class Definition for Human Interface Devices (HID) Specification.*

5.4 Power Management

USB Monitors manage power drawn from the bus as defined by the USB Specification (suspend/resume). USB Monitors may implement USB Interface Power Management as described in the USB Common Class Specification. USB Monitors implementing USB Interface Power Management control manage power for the entire display device.

If a USB Monitor has multiple control channels for power management (i.e. DPMS and USB Interface Power Management), the monitor should adjust power consumption to the lowest power consuming state requested. For example, if USB Interface Power Management has selected the D1 power state and DPMS has selected the D2 power state, the monitor should be placed in the D2 power state. (For power state definitions, see the USB Common Class Specification).

5.5 Top-Level Collection

In order to identify a HID class device as a monitor, the device's HID Report Descriptor must contain a top-level collection with a usage of Monitor Control from the USB Monitor Usage Page. For more information, see the *USB Device Class Definition for Human Interface Devices (HID) Specification.*

6. Appendices - Usage Pages

USB Monitors use four usage pages assigned by the HID Class Working Group for usage IDs. The pages are:

Page	Description
0x80	USB Monitor
0x81	USB Enumerated Values
0x82	VESA Virtual Controls
0x83	Reserved

6.1.1 USB Monitor Usage Page

The USB Monitor Usage page contains USB Monitor usage values that are unique to USB connectivity.

Value	Virtual Control	Description
00h	Reserved	Reserved for future use.
01h	Monitor Control	USB Monitor Control HID Device.
02h	EDID Information	
03h	VDIF Information	
04h	VESA Version	The version of the VESA Monitor Command Set specification used by this device. If this field is set to zero (0), the monitor uses the virtual control usage values defined in this document. If this field is non-zero, it is a Binary-Coded Decimal (BCD) value representing the version number of the VESA Monitor Command Set specification used to define the monitor's virtual control and command usage values.

6.2 Monitor Enumerated Values [Usage Page]

A number of monitor controls use values that are or may be non-contiguous. For example, by VESA definition, an Input Source Selector control has values that range from zero to twenty-eight.

However, many monitors may not implement all of these inputs. If a monitor only provided DB-15HD/VGA1 and S-Video1 inputs, only the enumerated values one and sixteen would be valid.

Due to the nature of the HID class report description language, a defined usage value would typically have to be created for each value that might be returned. This would require a lot of new usage values to be defined; it would also require that either VESA change the mapping between constant (usage value) and

meaning, or a separate usage page would have to be assigned to the values returned by every control that could have non-contiguous values.

To simplify the handling of non-contiguous controls, USB monitors use the Monitor Enumerated Values [Usage Page] for values that would map between zero and a number of non-contiguous values. Each potentially non-contiguous control is defined as an array with a set of values from the Monitor Enumerated Values [Usage Page]. For an Input Source Select control, ENUM_1 represents DB-15HD/VGA1 and ENUM_16 represents S-Video1.

It should be noted that the HID protocol actually communicates the index into the array of legal values when indicating the value of an array control. System software on the host for HID devices typically maps the index value back to a usage value. Continuing with our Input Source Select control that supported DB-15HD/VGA1 and S-Video1, the HID Report Descriptor would define an Input Source Select control as an array and the array could have one of two values: ENUM_1 or ENUM_16. The HID Report descriptor would indicate the Logical Minimum for the control is one and the Logical Maximum is two. To indicate the input source is DB-15HD/VGA1, the control would return one (the index of the first value in the array). To indicate the input source is S-Video1, the control would return two (the index of the second value in the array).

Value	Virtual Control	Description
00h	ENUM_0	No value selected, ignore
01h	ENUM_1	First enumerated value.
02h	ENUM_2	Second enumerated value.
03h	ENUM_3	Third enumerated value.
...	ENUM_x	x enumerated value.

Enumerated values use constants that are equal to the enumeration value they represent. The HID protocol uses the value zero (0) to indicate that no value is currently selected for an array field and this maps to the use of ENUM_0 for all non contiguous controls.

6.3 VESA Virtual Control Usage Page

Virtual Control Panel (VCP) op-codes values are assigned by VESA. At the time this specification was written, VESA was to issue an updated set of op-codes as defined by the *VESA Monitor Command Set Specification*. These values are similar to those used in the *ACCESS.bus Monitor Device Protocol Specifications*.

The USB Monitor Usage page contains a control called VESA Version. This static control identifies the revision of the *VESA Monitor Control Command Set Specification* used by the monitor for specifying usage values for monitor controls. Until the final VESA specification is released, the VESA Version shall be set to zero (0), and the following VESA Virtual Control Usages shall be used by USB Monitors. These controls are a subset of previous VESA virtual control definitions. It is expected that the VESA document will maintain the usage values of these controls and extend this list to include additional controls. All values not defined in the following tables are reserved for future use:

Contiguous Controls

Value	Virtual Control	Description
10h	Brightness	The black level luminance of the display.
12h	Contrast	The ratio between the maximum and minimum luminance values.
16h	Red Video Gain	The level of maximum luminance of red pixels. Setting sensitivity of the RED luminance output.
18h	Green Video Gain	The level of maximum luminance of green pixels.
1Ah	Blue Video Gain	The level of maximum luminance of blue pixels.
1Ch	Focus	Adjusts the apparent spot size.
20h	Horizontal Position	Moves the image toward the right side of the display.
22h	Horizontal Size	The distance between the left and right sides of the image.
24h	Horizontal Pincushion	Increasing (decreasing) this value causes the right and left sides of the image to become more (less) convex.
26h	Horizontal Pincushion Balance	Moves the center section of the image toward the right or left side of the display.
28h	Horizontal Misconvergence	Increasing (decreasing) this value will shift the red pixels to the right (left) across the image and the blue pixels left (right) across the image with respect to the green pixels.
2Ah	Horizontal Linearity	Shifts the density of pixels from the left and right ends to the center of the image.
2Ch	Horizontal Linearity Balance	Increasing (decreasing) this value shifts the density of pixels from the left (right) side to the right (left) side of the image.
30h	Vertical Position	Increasing (decreasing) this value moves the image toward the top (bottom) of the display.
32h	Vertical Size	The distance between the top and bottom of the image.
34h	Vertical Pincushion	Increasing (decreasing) this value causes the top and bottom sides of the image to become more (less) convex.

Value	Virtual Control	Description
36h	Vertical Pincushion Balance	Increasing (decreasing) this value moves the center section of the image toward the top (bottom) of the display.
38h	Vertical Misconvergence	Increasing (decreasing) this value shifts the red pixels up (down) across the image and the blue pixels down (up) across the image with respect to the green pixels.
3Ah	Vertical Linearity	Increasing (decreasing) this value shifts the density of scan lines from the ends (center) to the center (ends) of the image.
3Ch	Vertical Linearity Balance	Increasing (decreasing) this value shifts the density of scan lines from the top (bottom) end to the bottom (top) end of the image.
40h	Parallelogram Distortion (Key Balance)	Increasing (decreasing) this value shifts the top section of the image to the right (left) with respect to the bottom section of the image.
42h	Trapezoidal Distortion (Key)	The ratio between the horizontal size at the top of the image relative to the horizontal size at the bottom of the image.
44h	Tilt (Rotation)	Increasing (decreasing) this value rotates the image (counter) clockwise about the center point of the image.
46h	Top Corner Distortion Control	The distance between the left and right side at the top end of the image.
48h	Top Corner Distortion Balance	Increasing (decreasing) this value moves the top end of the image to the right (left).
4Ah	Bottom Corner Distortion Control	The distance between the left and right side at the bottom end of the image.
4Ch	Bottom Corner Distortion Balance	Increasing (decreasing) this value moves the bottom end of the image to the right (value).
56h	Horizontal Moiré	Adjusting this value controls the horizontal picture moiré cancellation.
58h	Vertical Moiré	Adjusting this value controls the vertical picture moiré cancellation.
6Ch	Red Video Black Level	The level of minimum luminance of red pixels. DC offset of the lowest level RED.
6Eh	Green Video Black Level	The level of minimum luminance of green pixels.
70h	Blue Video Black Level	The level of minimum luminance of blue pixels.

Non-contiguous Controls (Read/Write)

Value	Virtual Control	Description
5Eh	Input Level Select	Changing this value chooses a different video input voltage for the display. Format is *reference white above blank*, *level of sync. below blank*: ENUM_0 None selected ENUM_1 0.700, - 0.300 (1.00 Vpp) ENUM_2 0.714, - 0.286 (1.00 Vpp) ENUM_3 1.000, - 0.400 (1.40 Vpp) ENUM_4 0.700, - 0.000 (0.70 Vpp)
60h	Input Source Select	Changing this value selects a different video input source: ENUM_0 None selected ENUM_1 DB-15HD/VGA1 ENUM_2 DB-15HD/VGA2 ENUM_3 DB-15HD/VGA3 ENUM_4 BNC/RGB1 ENUM_5 BNC/RGB2 ENUM_6 BNC/RGB3 ENUM_7 EVC1 ENUM_8 EVC2 ENUM_9 EVC3 ENUM_10 MAC1 ENUM_11 MAC2 ENUM_12 MAC3 ENUM_13 RCA/ Composite Video1 ENUM_14 RCA/ Composite Video2 ENUM_15 RCA/ Composite Video3 ENUM_16 S-Video1 ENUM_17 S-Video2 ENUM_18 S-Video3 ENUM_19 SCART-Composite1 ENUM_20 SCART-Composite2 ENUM_21 SCART-RGB ENUM_22 SCART-S-video ENUM_23 Tuner1 ENUM_24 Tuner2 ENUM_25 Tuner3 ENUM_26 YUV1 ENUM_27 YUV2 ENUM_28 YUV3
CAh	On Screen Display	ENUM_0 None selected ENUM_1 OSD is disabled to appear ENUM_2 OSD is enabled to appear

Value	Virtual Control	Description
D4h	StereoMode	Changing this value selects the video mode with respect to 2D or 3D: ENUM_0 None selected ENUM_1 Mono Mode ENUM_2 Enable Field-Sequential Right Eye First ENUM_3 Enable Field-Sequential Left Eye First ENUM_4 Enable 2-Way Interleaved Right Eye First ENUM_5 Enable 2-Way Interleaved Left Eye First ENUM_6 Enable 4-Way Interleaved, Display Stereo Buffer 0 (even scan lines) ENUM_7 Enable 4-Way Interleaved, Display Stereo Buffer 1 (odd scan lines) ENUM_8 Enable Side-by-Side Interleaved

Non-contiguous Controls (Read-only)

A2h	Auto Size Center	ENUM_0 None selected ENUM_1 Disabled ENUM_2 Enabled
A4h	Polarity Horizontal Synchronization	ENUM_0 None selected ENUM_1 Negative ENUM_2 Positive
A6h	Polarity Vertical Synchronization	ENUM_0 None selected ENUM_1 Negative ENUM_2 Positive
A8h	Synchronization Type	ENUM_0 None selected ENUM_1 Separate ENUM_2 Digital Composite ENUM_3 Composite on Green
AAh	Screen Orientation	ENUM_0 None selected ENUM_1 Landscape ENUM_2 Portrait
ACh	Horizontal Frequency	Horizontal frequency in Hertz
AEh	Vertical Frequency	Vertical frequency in 0.01 Hertz

Non-contiguous Controls (Write-only)

01h	Degauss	Writing a non-zero value to this control causes the monitor to start a self-timed degauss cycle. The monitor automatically completes the cycle without further action by the host. If a zero value is written to this control, the monitor ignores the write and does not start a degauss cycle. The monitor does not alter any of its other control or status values in response to any write to this control.
B0h	Settings	This control saves or restores the settings of a monitor's virtual controls for the current video mode. The controls that are affected are implementation specific. ENUM_0 None selected (ignored by monitor) ENUM_1 Store current settings ENUM_2 Restore factory default settings ENUM_3 Restore user-saved settings

Note Some controls previously defined by VESA were not included in the previous table because it was unclear whether future VESA specifications would continue to use them (for example, color temperature). Should VESA continue to use such controls or define new controls, that organization has the ability to update the set of defined controls and commands independent of USB by simply including them in the *VESA Monitor Control Command Set Specification.*

6.5 Example Monitor Report Descriptions

This appendix provides examples of how the various Monitor reports might be described. These are examples only. Actual implementation will vary in a number of ways from these examples including (but not limited to) the order in which data items are defined and the legal ranges for various values.

The HID class supports a single report descriptor. All of the reports described below are contained in a single HID Report Descriptor.

Please note, the actual values used for item tags are defined by the *USB Device Class Definition for Human Interface Devices (HID) Specification*. This example only identifies values that are not item tags.

```
USAGE_PAGE (Monitor)                          05 80
USAGE (Monitor Control)                       09 01
COLLECTION (Application)                      A1 01
  REPORT_ID (1)                               85 01
  LOGICAL_MINIMUM (0)                         15 00
  LOGICAL_MAXIMUM (255)                       26 FF 00
  REPORT_SIZE (8)                             75 08
  REPORT_COUNT (128)                          95 80
  USAGE (EDID Information)                    09 02
  FEATURE (Data,Var,Abs,Buf)                  B2 02 01
  REPORT_ID (2)                               85 02
  REPORT_COUNT (243)                          95 F3
  USAGE (VDIF Information)                    09 03
  FEATURE (Data,Var,Abs,Buf)                  B2 02 01
  REPORT_ID (3)                               85 03
  USAGE_PAGE (VESA Virtual Controls)          05 82
  REPORT_SIZE (16)                            75 10
  REPORT_COUNT (1)                            95 01
  LOGICAL_MAXIMUM (200)                       26 C8 00
  USAGE (Brightness)                          09 10
  FEATURE (Data,Var,Abs)                      B1 02
  REPORT_ID (4)                               85 04
  LOGICAL_MAXIMUM (100)                       25 64
  USAGE (Contrast)                            09 12
  FEATURE (Data,Var,Abs)                      B1 02
  REPORT_ID (5)                               85 05
  REPORT_COUNT (6)                            95 06
  LOGICAL_MAXIMUM (255)                       26 FF 00
```

```
  USAGE (Video Gain Red)                          09 16
  USAGE (Video Gain Green)                        09 18
  USAGE (Video Gain Blue)                         09 1A
  USAGE (Video Black Level Red)                   09 6C
  USAGE (Video Black Level Green)                 09 6E
  USAGE (Video Black Level Blue)                  09 70
  FEATURE (Data,Var,Abs)                          B1 02
  REPORT_ID (6)                                   85 06
  LOGICAL_MAXIMUM (127)                           25 7F
  USAGE (Horizontal Position )                    09 20
  USAGE (Horizontal Size )                        09 22
  USAGE (Vertical Position )                      09 30
  USAGE (Vertical Size )                          09 32
  USAGE (Trapezoidal Distortion)                  09 42
  USAGE (Tilt)                                    09 44
  FEATURE (Data,Var,Abs)                          B1 02
  REPORT_SIZE (2)                                 75 02
  REPORT_COUNT (1)                                95 01
  LOGICAL_MINIMUM (1)                             15 01
  LOGICAL_MAXIMUM (3)                             25 03
  USAGE (Input Source Select)                     09 60
  COLLECTION (Logical)                            A1 02
    USAGE_PAGE (Monitor Enumerated Values)        05 81
    USAGE (ENUM 1)                                09 01
    USAGE (ENUM 4)                                09 04
    USAGE (ENUM 6)                                09 06
    FEATURE (Data,Ary,Abs)                        B1 00
  END_COLLECTION                                  C0
  REPORT_SIZE (6)                                 75 06
  FEATURE (Cnst,Var,Abs)                          B1 03
END_COLLECTION                                    C0
```