Standard Panels Working Group
Quarterly Newsletter

October 2004 Volume 1, Issue 4

Fourth SPWG Newsletter

This is the fourth quarterly newsletter related to the activities of the Standard Panels Working Group (SPWG). The newsletter is being released to help assure industry-wide awareness about the continuing efforts to standardize the displays used in notebook PCs. Mark Fihn, Paul Salisbury, and Larry Mabe three of the original people most directly involved in the creation of the SPWG, are writing this newsletter in an effort to help assure an open communication about future standardization efforts and to sustain the successes the SPWG has enjoyed to date. *Any opinions expressed in this newsletter are entirely those of the authors, and any errors or omissions are unintentional.* Our goal is to provide a clear and open communication about the benefits and problems associated with the SPWG and to identify and help implement additions and improvements to the SPWG effort. Guest articles, opinions, or rebuttals are welcome from any source. There are no subscription fees associated with this newsletter; likewise no advertisements will be accepted.

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SPWG to Hold Meetings in Taiwan, Korea, and Japan

SPWG coordinators Mark Fihn and Paul Salisbury will be holding a series of meetings in Taiwan, Korea, and Japan from November 3-13. The purpose of these meetings will be to discuss additional standards efforts, respond to questions about the current specifications, and to assure a continuous and broad flow of information throughout the notebook PC industry with regard to display standardization. Details about these meetings can be found on the SPWG website, www.spwg.org.

SPWG Begins Work on v3.5 Standard

One of the primary purposes of the November meetings in Taiwan, Korea, and Japan will be to discuss the implementation of SPWG v3.5. The hope is that this revised specification can be implemented very quickly, prior to the end of 2004. As such, the v3.5 discussions will be rather limited, with only two items considered

1. Addition of 14.1"W panels
2. Changes to Power Sequence Diagrams

Additional items may be considered, but will be deferred if they appear to be a reason for delaying the introduction of the v3.5 release. More information about these items is included in this newsletter.

SPWG Seeks Inputs for v4.0 Standard

In addition to the v3.5 implementation, at the November meetings, we will introduce several new areas of interest to various SPWG member companies. The discussions will include

1. Possible New sizes (10.4", >17.0")
2. Panels for Tablet PCs
3. Support for 8-bit color
4. RGBW
5. Pixel Defect Classification System
6. Improved FOS Performance Measurement/Definition
7. Test/Measurement/Verification Handbook

Other items are entirely open for discussion and consideration. Several of these items are discussed in more detail in this newsletter.

Broadening of the SPWG to Other Applications?

Based on the tremendous success of the SPWG, several industry groups representing other applications that use LCDs have inquired to the SPWG coordinators about helping create a standards group similar to that of the SPWG. To date**, the coordinators have declined all invitations to help in other applications.** We believe that the success of the SPWG has to do with the limited focus of the effort – directed entirely toward the displays used in notebook PCs. Particularly since the coordinators all have a background in the field of notebook PCs, with little practical working experience related to other applications, we believe that our energies are best directed to continuing with our focus on the displays used in notebook PCs.

The membership of the SPWG is also focused on notebook PCs. While many of the SPWG's members are involved in numerous other applications as well, for SPWG-like activities to be successful in other applications, the individuals involved in most cases would need to be different. And of course other companies would also need to become involved – creating a hodge-podge of communications and meeting interactions that would almost certainly be confusing and create coordination inefficiencies.

Larry Mabe Added as SPWG Coordinator

Mark Fihn and Paul Salisbury are very pleased to announce the addition of Larry Mabe as an additional coordinator for the SPWG. When the SPWG was created in 1999, Larry was the primary engineer at Compaq responsible for bringing about the v1.0 and v2.0 releases of the standard. With HP's acquisition of Compaq, support for the efforts of the SPWG diminished and Larry was assigned to other projects, but his enthusiasm for the SPWG endured. Larry recently resigned from HP, and we are pleased that he has agreed to again help coordinate the ongoing activities of the SPWG. Larry has been involved in the display industry for the past 25 years. After evaluating display technologies and subsystems for fighter aircraft at McDonnell-Douglas, he was involved in developing the military's first, active-matrix LCD-based display. For the past 10 years, Larry worked as the primary display engineer for Compaq's/HP's notebook programs, where among other things, he was responsible for introducing the first XGA (1024x768) panels into notebook PCs. Larry can be contacted at larry@spwg.org.

SPWG Establishes Advisory Council

As the scope of the SPWG efforts continues to expand, an increasing array of interests and questions has resulted in the need for us to establish an Advisory Council. These volunteer advisors have agreed to support the efforts of the SPWG, helping both with technical questions and with regional communications and support. Members of the Advisory Council bring a wide range of experience in the notebook PC industry and/or the displays industry. In hopes of avoiding any bias, all current Advisors are unaffiliated with a company that has a vested interest in the choice of displays used in the notebook PC industry. We expect to add other advisory council members in the coming months.

Paul Boynton has been at NIST for the past 22 years. Initially, he worked in the area of DC-low frequency standards. For the past ten years, he has been with the Display Metrology Project at NIST, of which he is the project leader. His interest is in the development and evaluation of electronic display measurement procedures, diagnostics, and standards. Mr. Boynton serves as a technical expert for the ISO TC159/SC4/WG 2 (Visual display requirements), the IEC TC 110/PT 62341-6 (Measuring methods of organic light-emitting displays) and the VESA Display Metrology Task Group. He is a member of the Society for Information Display, and serves on their Standards and Definitions Committee. He is a member of the Council for Optical Radiation Measurements (CORM), and serves on their Electronic Displays Technical Committee. He has also served as a member of the American National Standards Institute (ANSI)/ Photographic & Imaging Manufacturers Association (PIMA) IT7-3 committee on electronic projection.

Eishi Gofuku is currently an invited scientist at Japan's prestigious National Institute of Advanced Science and Technology (AIST). He provides engineering connoisseurship and optimized business models for the institute to help enable startup companies to bring technologies to market. He leads several on-going top-down management programs. Prior to AIST, Gofuku-san worked for 17 years at Mitsubishi Electric (R&D, design, strategic planning, and customer support). In the later half of his tenure at Mitsubishi, his efforts were focused on creating new products and markets for LCD panels. Gofuku-san also heads a custom consulting firm (Flat Panel Solutions, Inc.) in Japan. He holds degrees from the Nagoya Institute of Technology and Osaka University and was awarded a Ph.D. in applied chemistry from the University of Tokyo. His broad-based expertise covers components, driving schemes, human perception, and 3D electro-magnetic analysis in the field of FPD technology.

John W. Orr recently left Dell after working for more than four years with their notebook PC development teams, industry standards groups, and LCD vendors to help lead the industry to market with LCDs at 14.1" (1600x1200 pixels), 15.0" (1600x1200 pixels), and 15.4" (1920x1200 pixels), among others. John's background includes stints as Technical Marketing Engineer with Crucial Technology, (a division of Micron Semiconductor Products), Senior Systems Design Engineer at Hamilton Hallmark, (an Avnet Company), Carroll Touch, (a division of AMP, Inc.), and Audio Visual Computer Applications, Inc. John also worked in the Program/Project Management Office of the Navy's Embedded Computer Systems Group. John received his Bachelor of Science degree in Electrical Engineering from Mississippi State University and a Master of Science degree (in Science and Technology Commercialization) from the University of Texas at Austin.

Jutta E. Rasp is founder and one of the principals of the German-based sourcing and consulting company (Flat Panel Display), which takes advantage of her broad range of technical knowledge and experience in the marketing and sales of flat panel displays. Jutta's last assignment as Director Europe and Director Global Sales OLED for DuPont Displays continues a background that includes experiences as an R&D physicist at Daimler-Benz AG, head of technical development for the Spanish LCD manufacturer Crystaloid, and management of the European activities for Samsung's TFT-LCD sales & marketing group. She also created a flat panel division for EBV Elektronik and WBC, two leading European electronic component distributors and heading the marketing department of the flat panel display service company Display Products Technology. Additionally, Jutta had been an active member of the SEMI Standard forum for flat panel displays, working towards global standardization of vocabulary for production, quality control, quality assurance and specification content of flat panel displays and flat panel display systems. Ms. Rasp holds an M.Sc. in Physics and has additionally concluded studies in chemistry, electronics, marketing and coaching techniques.

Chien-Erh (C. E.) Wang spent the past two years as head of DisplaySearch's operations in Taiwan, focused on developing market research about the flat panel display industry in both Taiwan and China. His leadership helped to develop critical relationships with Taiwan's LCD manufacturers, component manufacturers, and press relations throughout Asia. Prior to that, C. E. worked for Chi Mei Optoelectronics for four years as head of strategic planning, four years as a research manager for International Data Corporation (IDC) and two years as a specialist for Apple Computer Taiwan. C. E. holds a Bachelor of Science degree in International Business Management from the prestigious National Taiwan University.

Chris Williams is an Electronics Engineer and has operated within the UK Displays industry since 1974. He is a co-founder of Logystyx UK Limited, a consultancy company that provides extensive services to government, industry and universities within the field of flat panel displays. Chris is also a Director of Ceravision Ltd, a specialist high brightness light source manufacturer and Advis Ltd, a tier 1 aerospace displays company. Chris has also co-founded the UK Displays Network Limited, a networking company designed to support companies and institutions across the science base, manufacturing, systems integration and end user sectors of the market.

14.x" Wide Aspect Ratio Panels

The below article is reprinted from the January 2004 issue of this newsletter in order to help clarify some of the questions about a 14.x" Wide solution for notebook PCs. We think it's predictable that wide aspect ratios will come into play somewhere in between the existing 12.1"W and 15.4"W panels currently available in the market. For the SPWG v3.0 specification, there was too much uncertainty about which solution, (14.0" at a 15:9 aspect ratio or 14.1" at a 16:10 aspect ratio), would be widely adopted in the market. Although the 14.0" solutions have been introduced, as we reported last January, we continue to believe that the 16:10 solution will ultimately prove to be the solution of choice, and so we believe that it should become the industry standard, as we are now proposing in the draft SPWG v3.5 documents.

Incidentally, it should be noted that Sony recently introduced a system with a 13.3" panel in a 1366x768 format. This format is wider than either the 16:10 or 15:9 formats, and is therefore a relatively small panel in terms of surface area.

12.1" W	1280 x 800	65.80 sq in
12.1"	1024 x 768	70.28 sq in
13.3" W	1366 x 768	75.57 sq in
13.3"	1024 x 768	84.91 sq in
14.0" W	1280 x 768	86.47 sq in
14.1" W	1280 x 800	89.35 sq in
14.1"	1024 x 768	95.43 sq in

We believe that not only is Sony's new format unnecessarily confusing, but that it is simply too small when compared to the 12.1"W models. Remember that 13.3" panels in a 4:3 aspect ratio were unable to find a niche in the market as a "tweener" product between 12.1" and 14.1" panels. Likewise, we believe that it will be very difficult for a 13.3"W panel to successfully find a differentiable position between 12.1"W and 14.1"W panels.

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We have given considerable attention to the possibility of adding a 14.1" panel in a wide aspect ratio to the SPWG specification. At least two manufacturers have expressed a strong desire to see this standard established as a 14.0" diagonal in a 1280x768 pixel format. Apparently one major notebook PC brand has plans to introduce such a product in the not too distant future.

Unfortunately, we do not believe that notebook PCs with 14.0" panels at 1280x768 pixels will be a successful implementation – even with the strength of the brand that is planning to support it. Our reasoning is based on several factors:

1. **Moving "down" in size doesn't work.** Historically, the examples of when a brand has attempted to introduce a smaller size than the prevailing dominant size have all failed. A few years ago, IBM attempted to introduce 13.7" panels in a 5:4 aspect ratio. They were unable to successfully position this smaller diagonal size against the emerging 14.1" size. Similarly, 13.0" STN panels were similarly unable to find successful positioning against 13.3" TFT LCDs, even with a substantial price difference. More recently, 10.0" panels in a wide aspect ratio were unsuccessful in finding a niche against the more dominant 10.4" size, (but note that 10.6" panels in a wide aspect ratio have been relatively successful).

2. **14.0" at 1280x768 is not optimized for most fabs**. According to our calculations, 14.0" at 1280x768 is a good choice for only 5 or 6 third/fourth generation fabs, (at 620x750 and 610x720). The only manufacturers with fabs at this size are AUO, CMO, QDI, BOE/Hydis, and Toppoly. While these companies might consider it useful to fill capacity at 14.0" at a 15:9 aspect ratio, the problem is that there are so many more fabs that are better optimized to build 14.1" panels at a 16:10 aspect ratio. By our analysis, fabs sized at 550x650, 550x670, 590x670, 650x830, and

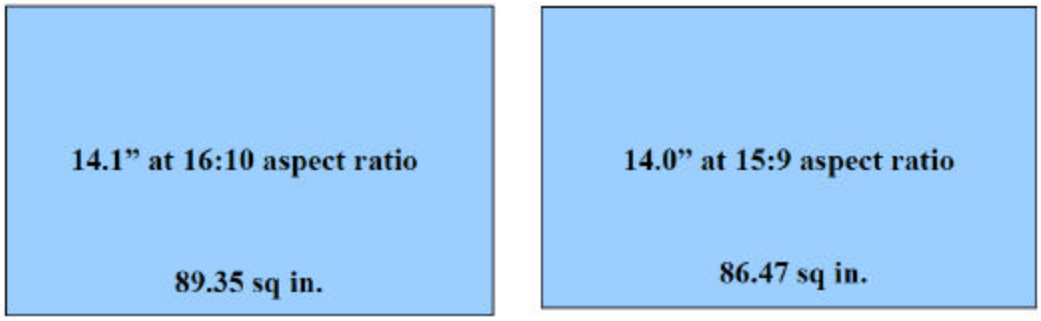
680x880 are all better positioned to make 14.1" panels at 16:10 than 14.0" panels at 15:9. We count about 16 fabs at these sizes – represented by 12 different LCD manufacturers. If wide aspect ratios do become popular at the 14" level (as we expect), then it is almost certain the 14.0" at 15:9 will lose out to 14.1" at 16:10. Note that based on our calculations, 600x720 and 730x920 fabs are unlikely to build either 14.x" models, as producing 15.4" panels at a 16:10 aspect ratio is a better use of the fab.

3. **16:10 is "standard" for notebook PCs.** At 12.1", 15.4" and 17.0", notebook PCs makers have already settled on a 16:10 aspect ratio. When Apple introduced 15.2" wide aspect ratios, Mark published widely that although Apple was to be applauded for their decision to introduce wide aspect ratios to notebook PCs, but that Apple's choice of 15.2" panels in a 15:10 aspect ratio was a mistake. The reasons Mark believed Apple was making a mistake are identical to the reasons that we believe 14.0" at 15:9 will be a mistake. Note that Apple has now broadly adopted the 16:10 aspect ratio.

4. **1280x768 is "too wide"**. One of the major reasons that 16:10 makes sense is that it is an optimal balance between the 3:2 format of DVDs and the 17:11 aspect ratio associated with two side-by-side pages. The wider 15:9 form factor does not leave enough room for a toolbar when running DVDs, and does not enable two side-by-side pages to be viewed full-page without screen real estate.

5. **14.0" at 1280x768 is "too small".** Many will argue that there is very little difference between the two panels. And as shown in the below figure, there is very little visual difference between the two.

14.1" at 16:10 vs. 14.0" at 15:9



Although the visual differences are minor, the fact is that the 14.1" panels are more than 3% larger in terms of total surface area than the 14.0" panels. In fact, the 14.0" panels are less than 2% bigger in total surface area than are 13.3" (4:3) panels. In other words, it seems that the 14.0" panels are hoping to find a niche that was previously filled by the 13.3" panel size – a size that could not sustain a differentiable position between 12.1" and 14.1" panels.

6. **1280x768 has no "upgrade" path.** One of the big problems with a 1280x768 pixel format is that there is no existing upgrade path. At a 4:3 aspect ratio, notebook PC makers have the opportunity to interchangeably configure systems at 800x600, 1024x768, 1400x1050, 1600x1200, or 2048x1536. At a 16:10 aspect ratio, manufacturers can similarly interchangeably configure systems with panels at 1280x800, 1440x900, 1680x1050, or 1920x1200. But at 1280x768, there is no obvious upgrade path, and any such path will require the development of new pixel formats, and probably a new class of LCD drivers, which would only be usable at this size.

After considering these various factors and interviewing numerous display manufacturers, we do not believe that 14.0" panels at a 15:9 aspect ratio have a viable long-term future. We question the wisdom of any plans to introduce this form factor in the notebook PC market, and therefore we are not recommending that any effort be made to define SPWG-compliant panels, for what is likely to be a short-term solution.

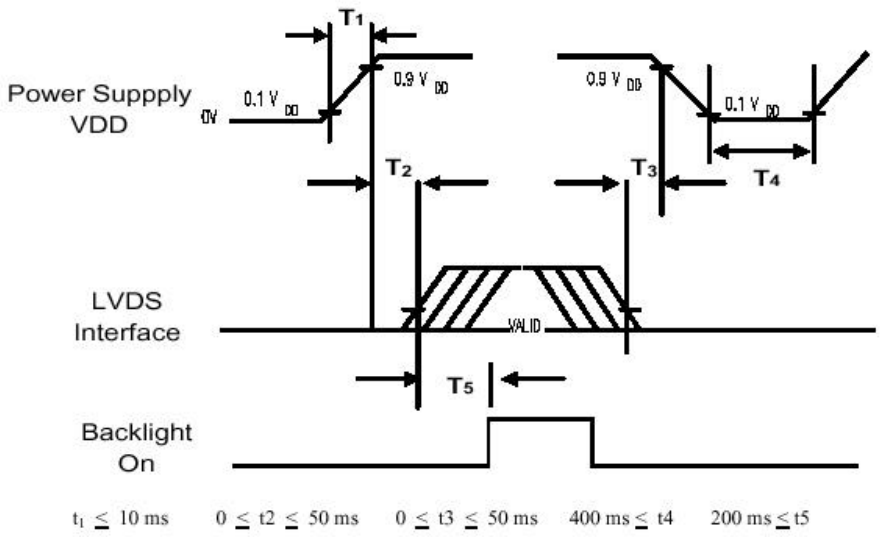
Timing Corrections in the SPWG v3.0 Specification

Thanks to inputs from representatives at Honeywell, we discovered two mistakes in the original publication of the SPWG v3.0 timing specifications. Since mid-April 2004, the corrected versions of the specification have been posted to the website. If you downloaded an earlier version, but have not updated, we suggest using the current document

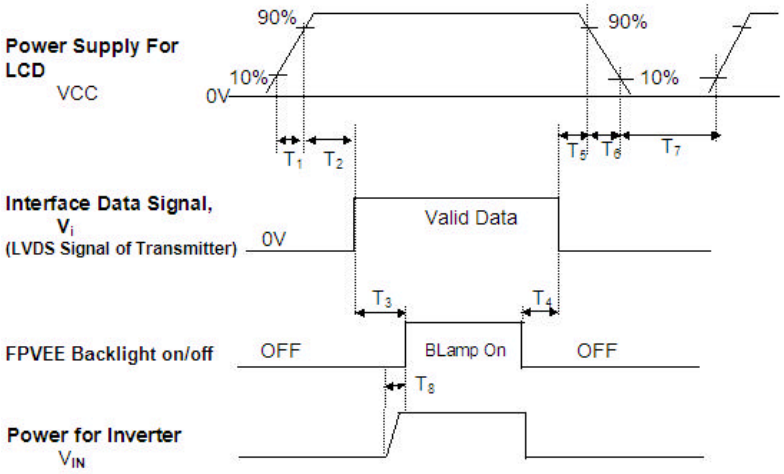
Panel Power Sequence Diagrams

In SPWG v3.5, we plan to modify the timing charts that we published in SPWG v3.0. In the v3.0 specification, we changed the format of the charts from the format used in the SPWG v1.0 and v2.0 documents, and this change created some confusion due to some differences in the power sequence timing. Although the data conveyed is the same in either format, to retain consistency, we plan to adjust the diagrams, as suggested below. Should any parties have a concern about this proposed change, please communicate to Mark, Paul, or Larry.

SPWG 2.0 "T" Value Format for Panel Power Sequence



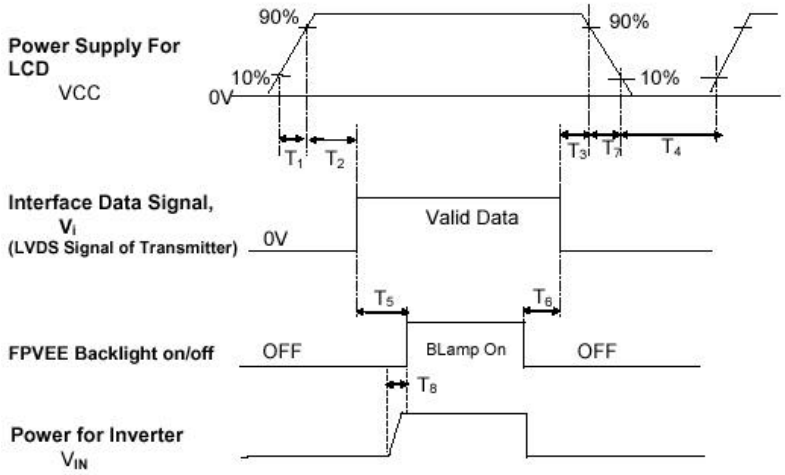
SPWG 3.0: "T" Value Format for Panel Power Sequence



Power Sequence Timing

Parameter	Value			Units
	Min.	Typ.	Max.	
T1	0.5	-	10	(ms)
T2	0	-	50	(ms)
T3	200	-	-	(ms)
T4	200	-	-	(ms)
T5	0	-	50	(ms)
T6	0	-	10	(ms)
T7	200	-	-	(ms)
T8	10	-	-	(ms)

SPWG 3.5: Proposal for "T" Value Format for Panel Power Sequence



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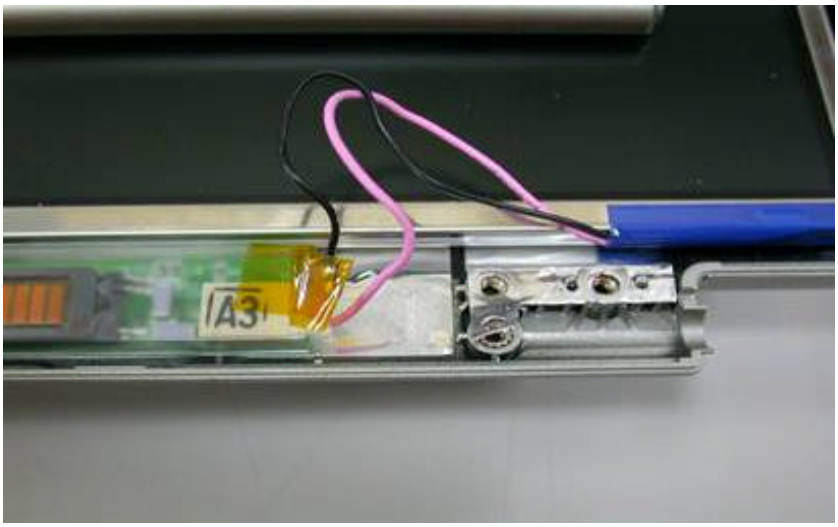
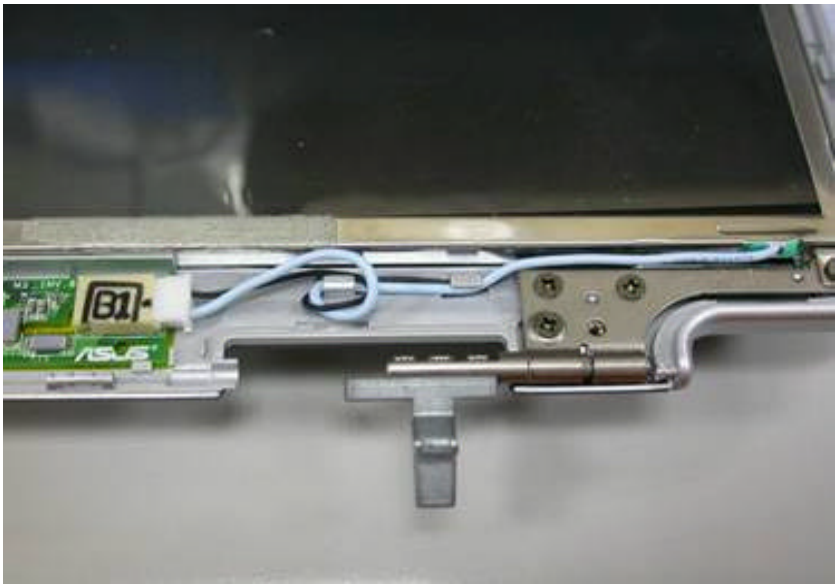
T2	0	-	50	(ms)
T3	0	-	50	(ms)
T4	200	-	-	(ms)
T5	200	-	-	(ms)
T6	200	-	-	(ms)
T7	0	-	10	(ms)
T8	10	-	-	(ms)

Problems with CCFL Wire Length Specifications

The most glaring deficiency of the SPWG v1.0 and v2.0 specifications was related to the CCFL wire length specification. Although LCD manufacturers had no particular issue with the wire length, they prefer to build all LCD modules with the same wire length, a requirement for true interchangeability.

Unfortunately, different notebook PC companies located the backlight inverter in differing locations, resulting in a situation where LCD makers were asked to build LCD modules that in all ways were equivalent, except for the CCFL wire length. Although many companies adhered to the SPWG wire length specifications, many notebook system design teams, for one reason or another, chose to ignore the LCD module specification in order to incorporate their own particular inverter placement. To avoid cable length issues, the LCD makers were asked to deviate from the SPWG specification with regard to the CCFL wire length. Some examples of wire length issues are pictured below:





It is desirable for the cable length to be as short as possible. Longer cables create issues associated with cable routing, but more importantly, they also degrade power efficiency due to parasitic capacitance. The cable, however, should not be too short, as then problems related to insertion and retention can result.

One of the primary goals of the SPWG v3.0 was to define the physical location of the inverter, particularly the inverter connector. This would create a situation where the wire length was also defined. The goal of the SPWG v3.0 specification is actually to encourage the inverter to be included as an external component to the LCD module assembly – incorporated by the LCD manufacturer rather than the notebook PC manufacturer. In this way, not only could the question of wire length be entirely eliminated, but also then each LCD manufacturer could actually optimize panel brightness/power consumption in a way attuned to their own technological design. Integrating the inverter would not only improve performance, but would also reduce problems in the field, as well as helping to reduce cost.

Some questions, however, have been raised about the wire lengths identified in the SPWG v3.0 specification. Although we prefer to sustain the existing specification, we are willing any inputs about modifying the current spec if it serves to improve performance or simplify the production process. Inputs are encouraged from any interested parties.

SPWG Connector Listing

For the past several months, we have continuously updated the list of connectors that might be utilized within the SPWG specifications. The number of connector companies that have joined the SPWG continues to grow, and we will work to keep this listing updated at the www.spwg.org website for your continual reference purposes. Connector companies are encouraged to keep us updated about any changes or additions related to their product offerings.

We want to emphasize that this listing is not an assurance of quality, fitness for purpose, nor should it be considered as permission or transfer of any company's intellectual property rights. We think that all LCD manufacturers and notebook PC manufacturers must independently verify their use of appropriate SPWG-compliant connectors.

Inverter Connector Problem: Opportunity for Suppliers

We recently learned that the inverter connector specified in the SPWG v3.0 document might not meet lead-free requirements. The connector, Honda's LVC-D20SFYG, is quite convenient due its size and pin count, but failure to meet lead free requirements is a problem for many notebook PC companies. Unfortunately, Honda (which is not a member company of the SPWG) has not been responsive to our inquiries about a compatible lead-free alternative. Accordingly, we believe it is necessary to redefine the inverter connector specified in the SPWG v3.0 document and we invite all connector suppliers to suggest alternatives. Ideally, the proposed solution will be compatible with what we've already specified, but if a smaller connector, (in physical size, number of pins, and/or reduced cost), can be identified, we will be open to modifying the current specification accordingly. This change may take place within the SPWG v3.5, time permitting, or otherwise within the SPWG v4.0.

www.spwg.org

The **www.spwg.org** has now seen hits from more than 14,000 separate IP addresses since its launch in late August 2003. The goal of the site is to keep an updated flow of information about the activities of the SPWG. Not only is the SPWG v3.0 specification available for download on the site, but also a great deal of supporting information and historical background data is included. A complete list of endorsing companies is also identified on the site.

RGBW

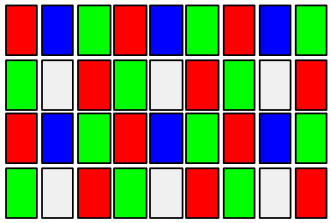
Several companies have been experimenting with alternative pixel formats, with favorable results that lead us to expect that some such alternatives will soon be introduced. Of particular interest is the RGBW format, which has been demonstrated by SPWG members Clairvoyante and Samsung. The RGBW format provides several distinct advantages over the more traditional RGB striping used in notebook PCs.

Power Savings Advantage. The white subpixel enables light to pass from the backlight without penalty of light-loss at the color filter. The white subpixel has three or more times the brightness of the colored subpixels. Test results indicate that this can result in approximately 50% to 100% higher brightness than an RGB Stripe panel with the same resolution. System integrators can therefore gain substantial improvement in brightness, power consumption, or both.

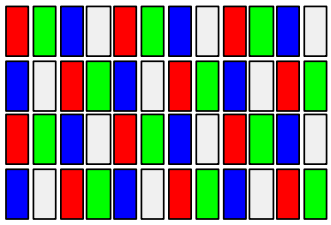
Resolution Advantage. The implementation of subpixel rendering unquestionably improves font readability and arguably improves graphics imagery as well. The perceived gains in resolution are substantial, without the cost of increased driver count and more subpixels. Moreover, the ability to utilize square subpixels rather than rectangular subpixels, (or at least rectangles with smaller aspect ratios) enables subpixel rendering to operate in either portrait or landscape orientations, which is increasingly an advantage considering the emergence of convertible-style Tablet PCs.

Color Advantage. Clairvoyante argues persuasively that the additional white pixels, when used with their Gamut Mapping Algorithm, serve to substantially improve the color gamut of an RGBW LCD

PenTile RGBW 6 Subpixel Repeat. Clairvoyante recommends that the most efficient design, for very high resolution, is when half of the blue subpixels are replaced with white, as shown to the right. This makes sense in that the human vision system has less resolution in blue. However, this layout must be used with a high color temperature backlight to ensure that enough blue light is available to keep the panel at a desired white color when all of the subpixels are turned on to full value. Since the white area is only 17%, the brightness increase is approximately 40% or more for the same conditions.



PenTile RGBW 8 Subpixel Repeat. Another efficient design from Clairvoyante, shown to the right, is characterized by a repeat cell of eight subpixels with one-to-two (1:2) aspect ratio. This layout has less edge boundaries that give rise to liquid crystal disinclinations, and thus has higher contrast than an LCD based on the RGB Stripe. This layout has 25% white area, and assuming the color filter transmission is 30%, it can have approximately 50% to 100% higher brightness than an RGB Stripe panel with the same resolution. The brightness gain is actually a function of the aperture ratio percentage of the TFT array and the gain is higher as aperture ratio decreases. Note that each color is on a square grid at 45°. This layout requires only one row of subpixels to draw a single white line, and only two subpixel columns.



Design Considerations for RGBW PenTile layouts. According to Clairvoyante, the implementation of RGBW PenTile technology requires minimal changes to the overall process. Regardless of layout, the biggest change with RGBW systems is the color filter changes required to include a clear pixel. Since it is usually desirable to maintain a constant cell gap, the clear pixel must be filled with transparent material. It has been found that standard overcoat material can be used to fill the “empty” subpixel so that acceptable cell gap variation is obtained.

Another design issue for the 8-subpixel repeating PenTile layout is crosstalk. Normal dot inversion on an “even modulo” subpixel layout i.e. one with same color subpixels repeated on even numbered columns or rows can lead to crosstalk for solid color fields against a gray background. This results from a +-+-

alternating polarity for, driver output. The simplest solution to this problem is to create source driver outputs that vary ++--++--. Line inversion is another method to reduce crosstalk in TFT-LCDs; for the PenTile layouts, a 2-line inversion is preferred; that is, polarity is inverted every two lines, instead of the standard one line.

TFT array design is relatively straightforward for either of the PenTile RGBW layouts proposed. Subpixels are larger than RGB stripe of equivalent resolution so TFT size may have to be adjusted. Since the aperture ratio is larger for PenTile arrays, it may be possible to relax some tolerances without greatly impacting brightness; this can result in increased TFT array yield.

Implications RGBW poses for the SPWG. Since RGBW provides some very intriguing opportunities to improve brightness/battery life, while improving the perception of resolution, at little or no additional cost, we expect that such advantages will result in the increasing implementation of RGBW solutions. Clearly the best implementation of RGBW would require no changes to the physical interface connector or the dimensional layout of the LCD module. As such, we are strongly interested in helping assure that the development of RGBW solutions comes within the mechanical parameters already laid out within the SPWG specifications.

There will need to be some additions/changes to the SPWG specifications, however, to assure compatibility with RGBW displays.

Additional primary colors. To include RGBW, the SPWG should include room for additional primaries, up to six, or maybe up to N colors (N being a finite counting number) in the colorimetry and gamma measurement specs. Showing it as N number would be an easy way of not endorsing any particular color system and would enable the SPWG to avoid a constant updating process as new color systems are developed.

EDID reference. The EDID could have a field that allows specification of the subpixel architecture. Alternatively, the model number could be used by software to perform a look-up as to the subpixel architecture. According to Clairvoyante, their RGBW Gamut Mapping Algorithms and subpixel rendering algorithm is placed in the TCON, such that the standard connector, pin out, and timing are compatible. But software needs to be able to read the EDID to find out which subpixel architecture and gamma is required to operate the panel.

Pixel structure. The current SPWG specification limits the spec to and RGB Stripe architecture. This could be updated by showing a drawing that does not show a given subpixel structure, but rather shows the locations of addressable "logical pixels" as squares. The architecture and method of rendering would then be a matter of competitive advantage, (which is one of the primary goals engendered by the SPWG).

Some will argue that it's too early in the product development of RGBW panels for the SPWG to consider standardization. While this may be correct, we are eager to find ways in which the SPWG spec helps to enable the development of new and improved technologies, rather than being a barrier to the entry of such new efforts. Accordingly, we hope to reword the SPWG v4.0 document so that variable pixel formats, with multiple primary colors can be introduced within the existing SPWG structure.

Resolution Considerations

One of the biggest issues that the displays industry has faced is how to meaningfully communicate about resolution. Historical references to various graphics arrays have resulted in such a hodge-podge of acronyms (VGA, SVGA, XGA, SXGA, SXGA+, WXGA, WXGA+, QXGA, WQUXGA, etc, etc) that even the most knowledgeable displays engineers rarely know what the acronyms actually represent. In fact, the variations are now such that different companies refer to different pixel formats with the same acronym. Particularly as we consider the emergence of alternative pixel formats, such as RGBW, traditional format acronyms quickly lose all meaning, such that a more meaningful representation of resolution needs to be established.

Throughout the computer industry, component manufacturers have learned that the best way to represent improved component performance is through numerical references.

- CPU manufacturers understand that most users simply cannot relate to technical characterizations about CPU technology. In fact, even most engineers cannot correctly explain what a gigahertz is… But, even unsophisticated users can readily understand that a 2.4GHz system is "better" than a 2.1GHz system.
- HDD manufacturers, likewise have convinced us that 60gigabyte drives are better than 30gigabyte drives, even though most users have no real concept of what a gigabyte is…
- Memory manufacturers have similarly been able to sell us megabytes simply based on numerical values.
- Optical storage components such as CD and DVD (and their multiple combinations and variations), have not even bothered trying to sell the consumer a technical term – just an "X" – but we know immediately that an 8X drive is superior to a 6X drive. (Whether that claim is true or not is irrelevant – it's an easily understood reference that the displays industry simply lacks).
- Software companies have long used numbers to announce enhanced versions or new releases. For example, it's easy to understand that OS10 is an improvement over OS9.1, (while it's not so readily obvious to the consumer that XP is the next generation following Windows 2000).
- Printer and scanner companies have long used dot per inch (DPI) to represent print quality. It's clear to most people that 1200 DPI provides better image quality than 600 DPI.
- Digital Camera companies have successfully used the mega-pixel as a means by which to educate the user about the capture capability of the camera. Even casual users can readily understand that a 4-megapixel camera is likely to capture a better image than is a 2-megapixel camera.

In the displays industry, displays are really sold based on only one parameter – the diagonal size of the panel. And even this simple measurement has been confused. CRTs are measured based on the diagonal measurement of the surface area of the tube (which is frequently a curved surface with a considerable amount of glass that is not charged. As such, the actual viewable area of a 15" CRT is frequently less than 14". The use of the diagonal measurement is further confused by the fact that differing aspect ratios represent different surface areas. (It's very difficult to convince many people that a 15.4" display in a 16:10 aspect ratio is actually a smaller display than a 15.0" display in a 4:3 aspect ratio).

The CRT industry confused matters more by introducing the idea of dot pitch to help describe image quality. Unfortunately, when using dot pitch, better image quality is described by a smaller number, which is a counter-intuitive way to communicate. (Dot pitch is a measurement that must have been determined on a golf course)…

VESA has attempted to come up with a better system of referring to display resolution, but unfortunately it still does an inadequate job of addressing the issue. VESA's newly suggested method includes panel size, a letter to indicate a wide aspect ratio, and a number to describe megapixels. Although calculating megapixels is clearly an improvement over the meaningless acronyms currently used, VESA's proposal fails to identify different aspect ratios, fails to provide any comparative indication of image quality and it fails to consider the emergence of alternative pixel structures in which the total number of pixels does not really identify the panel's resolution.

We need a definition related to resolution that allows objective comparisons of panels to identify their effectiveness at rendering images. This is not a simple problem, but we believe it so important to help enhance the understanding of display performance, that we want to include such a definition in the SPWG v4.0 specification.

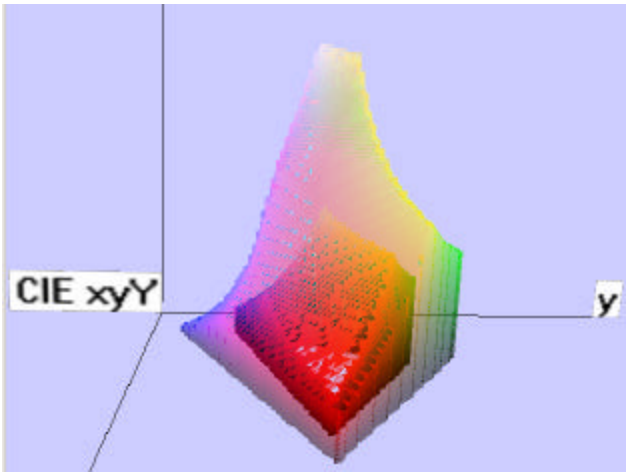
Rather than referring to resolution in terms of addressable points of columns x rows, which fails to account for the effects of sub-pixel rendering, perhaps resolution is better defined as the number of monochromatic lines pairs at full MTF in the full plate that are possible without chromatic aliasing. This

would be the "Modulation Transfer Function Limit". If an LCD had RGB stripe architecture and was 1024 x RGB x 768, the MTFL would be 512 x 384. A PenTile L1 panel with half the number of subpixels horizontally would have the very same MTFL. Having such a spec would allow users to know how to compare different layouts, which will be particularly important for RGBW, since different RGBW layouts may also have different MTFL.

Unfortunately, this is only part of the story, since it does not consider panel size. Pixel count or MTFL is only part of the image quality equation – panel size is also a major determinant of image quality. As more pixels (in any pixel format) are put into a smaller space, image quality improves. As such, we are considering proposing resolution in terms not just of MTFL, but also a measure within a square inch. A measure of MTFL per square inch will enable a specification that reasonably compares resolution regardless of pixel format, sub-pixel rendering, or panel size.

Color Considerations

Another possible factor that needs consideration by the SPWG is related to how we measure color. The typical CIE color chart is a 2D chart and does not consider the factor of brightness in relation to color. Perhaps a measurement of the color/brightness gamut volume (a 3D measurement) would be more appropriate, particularly when considering such things as RGBW. The addition of a white pixel significantly increases the brightness of the panel when displaying non-saturated colors. This in turn allows highly saturated color primaries without significantly reducing the display brightness. As a result, these saturated colors in an RGBW panel may be brighter than an equivalent resolution RGB panel as shown in the figure to the right. In this figure, the RGB brightness-color gamut is visible inside the transparently rendered RGBW gamut. This is a math-intensive calculation, but perhaps provides a better comparative measure of panels using differing structures and should therefore be considered within the SPWG v4.0 specification.



Emergence of “Glare” Panels

Given the rise in popularity associated with glare panels, particularly in Japan, perhaps a measure of glare and non-glare should probably be included in the SPWG v4.0 measurement specifications so as to enable a comparative measure from panel to panel.

Display Standards Verification

Once a standard is published, there is frequently a need for verification and assessment about compliance to the standard. In the standards associated with the displays used in notebook PCs, there are very few standards organizations that go beyond the level of voluntary compliance. Particularly in the area of front-of-screen performance, there are huge holes in the industry enabling specsmanship to rather misleading levels. In March 2004, we proposed the creation of SPWG Verification and Assessment Centers. To date, we have not done much to implement these centers, primarily because we have not been able to provide the potential organizations with a visible revenue stream. We think this will come, but we also have identified the need to create a test handbook for the successful implementation of such a verification and assessment center.

SPWG Verification and Assessment Centers. In the areas of luminance, contrast ratio, brightness uniformity, color gamut, color gamma, viewing angle, response time, residual image, power measurement, and cosmetic evaluation, the SPWG v3.0 specification identifies common ways for the notebook PC industry to compare performance. Recognizing that a lack of consistent compliance to standards is an obvious hole related to display-related standards, the SPWG recently proposed to create verification and assessment centers for the purpose of encouraging best practices and consistency with regard to the SPWG v3.0 standards.

Should these Verification and Assessment Centers actually be created, the SPWG can then provide a double service. On the one hand, the SPWG offers standards giving internationally agreed requirements for the displays used in notebook PCs. On the other hand, when it is necessary to assess and to show whether or not requirements are being met, the SPWG can help guide the activities of the Verification and Assessment Centers.

The SPWG suggests that the proposed Verification and Assessment Centers will provide benefits for component and LCD manufacturers, notebook PC companies, consumers, as well as for the enhancement of the notebook PC market in general.

- For conscientious component and LCD manufacturers, having their products assessed and verified as conforming to SPWG v3.0 Specifications would allow them to distinguish themselves from less reputable suppliers.
- For notebook PC companies, the proposed Verification and Assessment Centers would help assure panel interchangeability. Additionally, panel performance could be more easily compared from one manufacturer to the next, simplifying in-house test and qualification processes.
- Consumers would benefit from verification and assessment because it can provide them with a better basis for desirable performance characteristics.
- The notebook PC market generally benefits by enabling engineers to more fully focus on improving display performance, with unambiguous measurement criteria.

Considering the advantages of verifying compliance to the standard and publication of meaningful third-party performance comparisons between panels offered to the market, one of the things we hope to accomplish within the SPWG v4.0 is the creation of a handbook relating to the test procedures and operations associated with the SPWG specifications.

12.1” Dimensional Concerns

Representatives from Tottori Sanyo, one of the members of the SPWG, have suggested that some of the dimensions in the v3.0 specification are difficult to meet. In particular, they desire to make the y-dimension of the module somewhat larger, about 0.2mm.

If indeed the current SPWG specification fails to meet industry expectations, then the spec should be changed. We would like input from other LCD manufacturers about this concern. At this moment, we do not intend to change the specification, but are willing to consider any better solutions.

8-bit Color Considerations

The time is approaching where 8-bit color may be utilized in notebook PCs. Although 6+2 bit dithering solutions seem adequate for notebooks, as notebooks are used increasingly on the desktop, linked to flat panel monitors, that 8-bit color will increasingly be demanded. The SPWG is searching for optimal interface solutions utilizing 8-bit designs. Our preferences will be to use the existing interface connectors. This item will be discussed at some length during the upcoming November meetings.

Information Display: "LCD Panels Need More Class"

Well known to the displays industry, columnist Alfred Poor published an article entitled "LCD Panels Need More Class" in the June 2004 issue of Information Display magazine, (published by SID), regarding the issue of pixel defect specifications for TFT LCDs. (The article is reprinted by permission in the news/press section of the spwg.org website).

In the article, Mr. Poor argues persuasively that the LCD industry needs a system by which panels can be appropriately classified in terms of pixel defects. He suggests there is a need for "Class A, Class B, Class C, etc., panels to be defined. Mr. Poor's article also specifically suggests that the SPWG's v3.0 specification, which addresses how to define pixel defects, needs to go on to the next step and actually quantify the defects into a meaningful classification system.

According to Mr. Poor, "The time to provide consumers with a useful classification system of LCD products based on pixel-defect policies is now, before the flow of complaints becomes a flood that damages the reputation of the entire industry".

Based in part on Mr. Poor's suggestions, the SPWG has decided to develop a pixel defect classification system. This system will be included in the upcoming SPWG v4.0 specification.

Display Interfaces: Book Mentions SPWG

A recently published book by Hewlett Packard's Bob Meyer, called *Display Interfaces: Fundamentals and Standards*, includes a brief summary about the SPWG. Unfortunately, the references in the book to the SPWG's background are inaccurate. The reference in the book states:

> "Formed in 1999 by seven notebook computer and display manufacturers (Compaq Computer Corp, Fujitsu, Hewlett-Packard Co., Hitachi, IBM Corp., NEC, and Toshiba), the SPWG's intent was to standardize not only the electrical interface and physical connector, but also the panel dimensions and mounting hardware. Conformance to the SPWG specifications permit notebook computer manufacturers to use multiple sources for a given display… The first SPWG specification set standards for medium-sized, medium-format notebook displays: 10.4 inch, 12.1 inch, and 13.3 inch diagonal panels, of the "SVGA" and "XGA" (800 x 600 and 1024 x 768, respectively) formats, using a single (4 data pairs) LVDS channel. The SPWG 2.0 specification, released in 2000, provides similar standards for larger panels (up to 15.0 inch diagonal, and up to the "UXGA", or 1600 x 1200, format) using a dual-channel (8 data pairs) interface".

For clarification purposes, the correct information is as follows:

- Three companies – Dell, Compaq, and IBM, initiated the SPWG effort. HP joined shortly after the group was established, but was never an active participant in the process, joining only one of the face-to-face meetings. Toshiba joined just prior to the final release of the SPWG 1.0 specification. Fujitsu and NEC never formally participated in the SPWG effort, either as an LCD manufacturer or a notebook PC company. Hitachi's LCD group has supported the SPWG effort since shortly after the SPWG v1.0 specification was first released.
- The SPWG v1.0 specification did not establish standards for 10.4" or 12.1" panels, nor was SVGA included in the spec, as suggested in Mr. Meyer's book. The spec was written for 13.3", 14.1" and 15.0" panels at 1024 x 768 pixels.
- The SPWG v2.0 specification enabled thinner panels at higher resolutions to be utilized within the v1.0 mechanical parameters, giving notebook PC makers a choice of using single-channel or dual-channel LVDS.

SPWG/VESA Confusion

In late August 2003, shortly after the SPWG launched efforts to update the SPWG v2.0 specification, VESA announced plans to add the SPWG v2.0 document to the VESA website. Since we encourage the broadest possible dissemination of the SPWG standard as possible, we did not object to the fact that VESA changed the document by removing all mention of the SPWG, and did not appropriately credit the historical and ongoing efforts of the SPWG in any way.

The SPWG released its v3.0 specification in February 2004, which included numerous changes to the v2.0 specification. Unfortunately, VESA has not updated their website with the updated v3.0 specification. Since VESA has left the v2.0 specification on their website, many in the industry have expressed confusion about which spec to use. (The v2.0 specification on the VESA website has several known errors which have been updated in the v3.0 specification). The SPWG v3.0 is now the correct document, and VESA should certainly remove the outdated document.

Meanwhile, in August 2004, almost a year after VESA formed a group to study notebook panels, they released specifications for a limited number of panels (12.1", 12.1"W, 15.4"W, and 17.0"W). Unfortunately, the SPWG had already released specs for these same panels more than 6 months previously. In fact, the SPWG specifications are much more detailed than the VESA specifications, making the latecomer VESA specs just a subset of the SPWG specs. Unfortunately, VESA also introduced several minor changes to the SPWG's specifications, which do not seem to add any significant value. The result, sadly, has been some considerable confusion in the notebook PC industry. It should also be noted that the initially released VESA specs have some significant errors that do nothing but add further confusion.

It's not entirely clear why VESA choose to create slightly different specifications than what were already established by the SPWG. The SPWG coordinators had clearly and repeatedly communicated to VESA officials about an interest in creating a cooperative industry-wide standard that incorporated the interests of not only VESA's members that have an interest in notebook PCs, but also the SPWG membership – the majority of which are not VESA members, and also the interests of the EBL-WG group. To date, VESA officials have chosen not to respond to the SPWG overtures for cooperation. Again, in August 2004, immediately after VESA announced their new specification, Mark Fihn from the SPWG contacted Ian Miller, the Chairman of the Board of Directors at VESA, and requested an opportunity to meet in front of the Board of Directors to discuss how the SPWG and VESA might cooperate and thereby eliminate some of the confusion in the marketplace. Mr. Miller advised that he would check to see if the VESA Board was interested in working with the SPWG. At the time of this writing in late October 2004, more than two months later, VESA has still not expressed any interest in cooperation.

In September 2004, VESA newly announced plans to create a Special Interest Group (SIG) related to the use of inverters. The VESA announcement advises that this investigation would be for notebook PCs, LCD monitors, and LCD TVs, but that their initial focus would be on notebook PCs. (We believe that due to the variability of needs in the LCD monitor and LCD TV markets – particularly related to the use of multiple bulbs – that it will be very difficult to implement standards for inverters in these applications. This seems to be borne out by the fact that both the Chairman and Vice-Chairman of the VESA SIG are employed by Dell's notebook PC display engineering group and have nothing to do with LCD monitors or LCD TVs). In any case, since the SPWG has already published specifications related to notebook PC inverters, it looks like we're going to face additional confusion. Moreover, since VESA failed to consider inverters in their notebook specs, it's likely that VESA will need to adjust the notebook spec when inverters are added, which will likely cause further disruption and confusion in the market.

Several SPWG member companies are also members of VESA – we would like to encourage companies with dual membership to urge VESA's Board of Directors to consider the best interests of the entire industry and agree to meet with SPWG members to determine a cooperative path to a meaningful standard. To date, our direct efforts to establish such a cooperative approach have unfortunately been met with silence from VESA.

Differences Between SPWG/VESA Specifications

One of the biggest differences between the SPWG v3.0 specification and the VESA notebook display specifications is related to cost. Non-VESA members must pay to get the VESA specification. VESA membership fees are based on annual corporate sales revenues:

	SPWG	VESA	
Membership Fees	$0	$1,400	($0-1 million)
		$2,800	($1-5 million)
		$4,200	($5-50 million)
		$7,000	($50+ million)
Charges for Specifications	$0	$500	(plus $20 shipping U.S. $75 shipping Intl

Aside from the significant difference in fees, there are some notable differences between the SPWG and VESA specifications themselves. Since VESA claims intellectual property and insists on confidentiality with regard to its specs, we cannot provide detailed information, but we do offer several generalizations:

1. **Time.** The SPWG v3.0 document was published less than 6 months after the effort was announced. Although a much sparser document, the VESA specifications were published almost a year after the program started. The timely creation of specs is important in any industry, but particularly in high technology. Slow implementation delays the opportunities gained from standardization while lagging change in the industry.
2. **Content.** The VESA documents covers 4 panel sizes and address only a limited portion of the specifications related to the displays used in notebook PCs. The SPWG document covers 7 panel sizes and addresses a broad range of electrical, mechanical, power, interface, and performance metrology standards, all related to the displays used in notebook PCs.
3. **Structure.** The SPWG v3.0 document is a single document covering all aspects of the display specifications for notebook PCs. VESA issued a separate document for each of the 4 panel sizes covered. While this difference may seem to be minor, multiple documents create difficulties in sustaining consistency as documents are amended over time. Indeed, there are numerous minor inconsistencies between VESA's initially released specs. Moreover, the VESA document structure introduces a substantial amount of redundancy and waste:

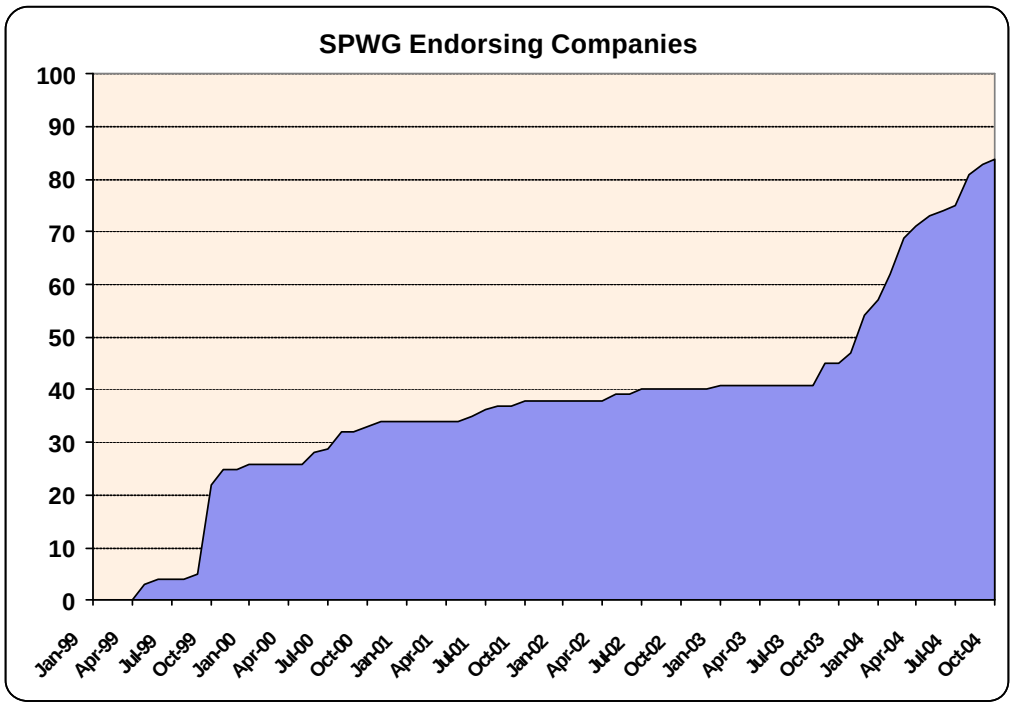
	SPWG	VESA
Number of documents	1	4
Total number of pages	56	53
Total number of blank pages	0	3
Total number of introductory pages	3	16
Total number of repeated pages	0	36
Actual pages of differentiated specs	**53**	**13**

4. **Participation Limitations.** Participation in the VESA process is limited to members. In the early stages of spec development, VESA sometimes creates SIGs that have an open participation, but which nevertheless requires NDAs and a non-voting status. The SPWG encourages open industry participation in the standards process from any interested party and has no confidentiality or exclusionary requirements.
5. **Involvement.** None of the individuals credited by VESA as significant contributors to the specs were involved in the original SPWG efforts. In fact, very few of the contributors to the VESA spec are known to be actively involved in the notebook PC industry. Most listed contributors came from the computer monitor industry – which has a much different set of concerns than does the notebook PC industry. While other people may have been involved in the creation of the VESA spec that were not recognized by VESA, it's important to note that VESA failed to benefit from the history of questions, issues, and inputs from the SPWG's focused involvement in the standardization of displays used in notebook PCs.

6. **Errors.** We will be the first to admit that it's very difficult to write a detailed technical specification without any errors. The VESA specification, however, has some blatant errors, apparently the result of sloppy drafting and editing. Most obvious is that the VESA spec inverts the pin orientation in the 20-pin solutions; one orientation for the 12.1" panel and the opposite orientation for the 12.1"W panel. We note several other errors as well…
7. **Technology Exclusion**. Unless there is some specific reason to do so, standards should not exclude any particular technology. Open standards attempt to embrace all competitive technologies. We note that some tolerances in the VESA spec are looser than in the SPWG spec, which in general is a good thing. But, in the case of the position of the I/O connector, where the VESA spec is looser than the SPWG spec, we fear that the looser spec excludes the use of FPCs as an interconnect option. FPCs are rigid and there can be very little tolerancing associated with the location of the connector. Although coax wire harnesses are used dominantly in the market, for some circumstances, FPCs still may provide performance or cost advantages and should not be excluded from the standard.

Growth of the SPWG

The SPWG was formed in mid-1999. At the time that the SPWG v1.0 was announced in October 1999, there were 22 endorsing companies to the organization. By the time SPWB v2.0 was announced in September 2001, 37 companies were supporting the standardization effort. When the SPWG v3.0 was released in February 2004, 61 companies supported the effort. As of October 25, 2004, 84 organizations backed the SWPG effort, double the support from a year earlier. Numerous additional companies are expected to join in the near future.



New SPWG Endorsees

Since our last newsletter in March 2004, 16 new companies have joined the SPWG. Endorsement of the SPWG efforts is a simple show of support for the standardization efforts related to the displays used in notebook PCs. There are no fees or membership requirements associated with such endorsement. It is expected that endorsing companies will be sincere in their efforts to help further the industry-wide efforts to improve LCD supply chain efficiencies and the price/performance benefits that result from standardization. Endorsing companies get the opportunity to actively participate in the standardization process. Any company that newly wishes to join the SPWG is encouraged to do so by contacting Mark Fihn, Paul Salisbury, or Larry Mabe.

New member companies include:

BiTEK (Beyond Innovation Technology Co., Ltd) is a professional IC design house based in Taiwan. The company engages in the business of IC design, research, development and sales, focused on supporting the market in Taiwan, Korea, Mainland China, South East Asia and Japan. BiTEK integrates the LCD CCFL backlight controller, video processor, video decoder, touch panel driver, high-speed interface, software, BIOS and drivers, and designs ASIC design for special applications and offers system integration services. Steve Chuang, head of sales & marketing at BiTEK stated, "Being one of the major CCFL controller suppliers, BiTEK surely would like to participate in SPWG activities".

BizLink, based in Fremont, California is a connector design and manufacturing company that suppliers electronic, electrical and fiber optic interconnection products to a broad range of industries, including computer, networking, consumer electronics, and telecommunication. According to Bill Kuypers, Director of Marketing, "In an effort to provide cost effective standardization and universal compatibility to the display market place, while countering sole sourced and non-compatible solutions, BizLink fully supports and endorses the activities and direction of the SPWG".

Clairvoyante licenses their PenTile Matrix subpixel rendering technology to LCD panel manufacturers. The company claims that optimized pixel layouts and image processing algorithms can deliver 4X resolution, increased brightness and lower power consumption at less cost. Clairvoyante reportedly has signed license agreements with 10 of the largest panel makers.

Clevo has been manufacturing notebook PCs, Tablet PCs, LCD PCs, and other IT products since 1983. The Taiwan-based company primarily manufacturers for smaller brands, utilizing their own design concepts rather then building products based on the designs of large brand customers. Clevo operates notebook PC factories in Taiwan and China.

Displaylabor is the Display Lab at the University of Applied Sciences in Pforzheim, Germany. Prof. Dr. Karlheinz Blankenbach advises that "Displaylabor offers a wide range of activities in the field of Electronic Displays: applied research and development, consulting, applications, talks, lectures (also in-house), measurements, ... We have experience in booth hard- and software".

DFF Dr. Joerg Winkler of the German Engineering Federation explained that the "DFF - the German Flat Panel Display Forum - is proud to endorse the SPWG. As a networking and communication platform for the European FPD industry and research institutes we strongly believe that joining efforts in standards making processes will benefit the whole FPD Community, cut costs, and reinforce competitiveness". The main goal of DFF is to promote the establishment of competitive production capacities for Flat Panel Displays in Germany.

The **University of Dundee** is widely regarded to be one of the originators behind TFT LCD technology, and to this day remains a leader in the academic research associated with active-matrix

technologies. The University of Dundee is also the lead school associated with the British DisplayMasters program, a masters degree focused entirely on developing engineers in display technologies and their commercial implementations.

Foxconn is the registered trade name for Hon Hai Precision Industry Co., Ltd. Based in Taiwan, Foxconn has grown to be a $6 billion company, focused on providing mechanical solutions and is the largest manufacturer of connectors for use in PCs in Taiwan, and a leading manufacturer of connectors and cable assemblies in the world. The company also manufactures enclosures, primarily for desktop PCs and PC servers. Foxconn has recently branched into manufacturing connectors for communications and consumer products.

Honeywell is a multi-national firm whose primary businesses are related to measurement, automation, and control. John Schmidt, a technical staff engineer at Honeywell's Displays Center of Excellence, remarked that "Honeywell is proud to endorse SPWG's standardization activities. SPWG's work improves the display industry's competitive business environment, resolves industry-shared technical issues, and enables display system designers and integrators to develop innovative, and unique products built upon well defined electrical and mechanical display panel interfaces".

Kontron Hamburg was created in 2002 from a merger between Dr. Berghaus and Kontron. Kontron Hamburg is a German firm that specializes in industrial computer technology for visualization and automation. The company's core competence is in the design, development and marketing of flat panel components (controllers, cables etc.) and ultra-flat embedded PCs. CEO of Kontron Hamburg, Dirk Finstel advises, "Kontron supports the SPWG effort to standardizing the mechanical and electrical spec of TFT panels. This will reduce time to market, overall system costs and our customers will benefit from this. All new products of Kontron Hamburg will be designed according to SPWG standards".

L&K Precision Technology is a Taiwan-based manufacturer of precision stamping products and molds, plastic molds and injection products, and computer and communication connectors. The company has historically focused on supplying components for the mobile phone market, but also carries products suitable for use in the displays related to notebook PCs.

Meko is Europe's lead consultancy and market research firm in the area of displays. Bob Raikes, principal at Meko, advises, "Meko supports the standardization work of the SPWG. Meko believes that more can often be achieved by working together than by acting in isolation. Furthermore, we believe the saying that 'Standards Make Markets'. The willingness of the LCD makers to standardize is one of the drivers that has established LCD as the current driving technology in the display market".

Pin Shine Industrial is a Taiwan company focused on bobbins and bases and maintains a diverse line of connector products. Ben Lee, responsible for Sales Engineering advised "Pin Shine Industrial Co. Ltd., is pleased to join the SPWG since its standardization has benefited on lowering development cycle and procurement cost".

SVA-NEC Liquid Crystal Display Co is the newest entrant in the TFT LCD fabrication industry. A joint venture between NEC and SVA, in October 2004, announced the start of manufacturing operations at its new 5th-generation fab located in Shanghai. The facility is the first in China that is capable of handling TFT LCD manufacturing from the initial array and cell process to the final production phase. Reportedly, SVA-NEC's production will start at 22,500 sheets per month, and will expand to 52,000 sheets per month by the end of April 2005.

Veritas et Visus is a new company focused on publishing specialty newsletters covering various aspects of the flat panel display industry. One of the company's newsletters, the *Display Standard,* will be dedicated to covering the efforts of the various standards organizations in establishing standards for

the displays industry. Editor Phillip Hill remarked, “Veritas et Visus, publisher of the Display Standard, a newsletter about display-related standards and regulations, is pleased to support the ongoing efforts of the SPWG”. The first issue of the *Display Standard* will be published in November 2004.

Wacom Technology is the world's leading pen tablet manufacturer and is best known for its Penabled brand of patented cordless and battery-free pen technology. Millions of photographers, designers, artists, and other computer users now own Wacom pen tablets worldwide. Steve Sedaker, Wacom’s OEM Sales Manager advised, “Wacom is pleased to endorse SPWG efforts in LCD industry cooperation. We hope that industry standardization will enable and grow the market for such new product categories as Tablet PC and other computing tablets”.