SPWG

Standard Panels Working Group
Quarterly Newsletter

January 2004 Volume 1, Issue 2

Second SPWG Newsletter

This is the second 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 and Paul Salisbury, two 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 v3.0 Nearing Formal Release

Version 3.0 of the SPWG specification is getting to a point that will enable its formal publication. To this end, in early December, as part of Extended Battery Life Working Group (EBL-WG) collaboration with the SPWG, Paul traveled with a representative from the EBL-WG to Asia and visited with 21 different companies for the purpose of reviewing the SPWG v3.0 specifications. Their purpose was to assure that inputs from all major players in the notebook PC industry (LCD makers, notebook PC manufacturers, notebook PC brands, and other component and support companies) had an opportunity to directly provide their inputs about the SPWG standards.

Additionally the SPWG has now held two conference calls about the spec and over the past months we have been involved in many other face-to-face, phone and e-mail conversations with numerous SPWG endorsees and other interested parties. We believe that the latest SPWG v3.0 draft is an excellent representation of these many meetings and inputs and that it adequately captures the interests of the notebook PC community as a whole. We think that we are getting close to a "final" version and encourage all parties (both SPWG endorsees and those companies that have not yet endorsed the SPWG standardization effort) to review and provide any further inputs.

An open conference call has been scheduled for all interested parties for Wednesday, January 14, 2004 7:00 pm CST, with the hope of reaching agreement on the specifications so that companies can begin the implementation phase of the SPWG v3.0. Any interested parties may join the call:

Telephone number: 916-356-2663, Bridge: 3, Passcode: 3113723

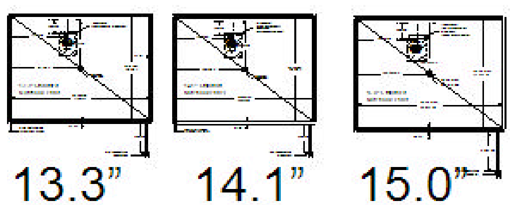
For Asian participants, the call is on Thursday, Jan 15, 2004, 9:00 a.m. Taiwan time, 10:00 a.m. Japan/Korea time.

Differences between SPWG v3.0 and SPWG v2.0

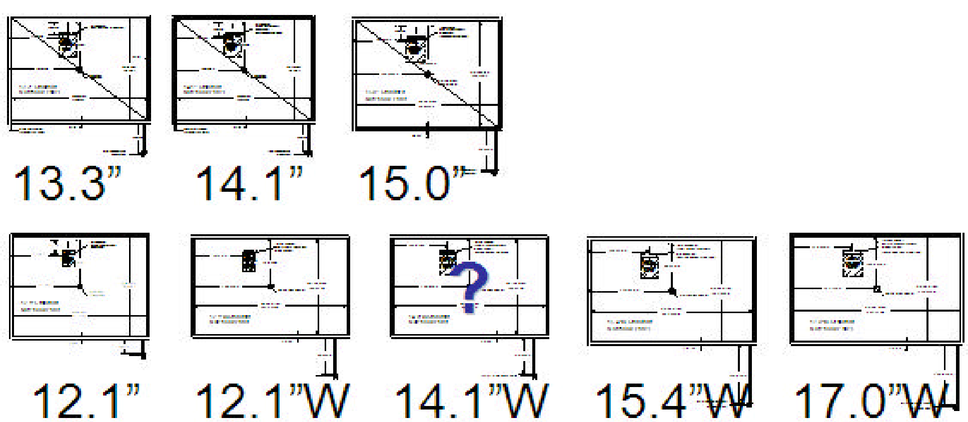
Version 3.0 of the SPWG standards for LCDs used in notebook PCs is considerably enhanced to that of Version 2.0, reflecting both changes in the notebook PC industry as well as a renewed focus to include more things in the standardization effort. This section highlights these several differences:

Panel Size

- Version 2.0:



- Version 3.0:



Panel Style

- Version 2.0: Style A (Thick Panels) and Style B (Thin Panels)
- Version 3.0 Style B (Thin Panels) only. V3.0 also enables even thinner panels.

Panel ID

- Version 2.0: EEDID minimized
- Version 3.0: EEDID maximized, including Week of Mfg, SMBUS Inverter Values, Mfg P/N & LCD P/N, and LVDS Channels

Resolution and Aspect Ratio

- Version 2.0:

Resolution	Pixels	Aspect Ratio
XGA	1024 x 768	4:3
SXGA+	1400 x 1050	4:3
UXGA	1600 x 1200	4:3

- Version 3.0:

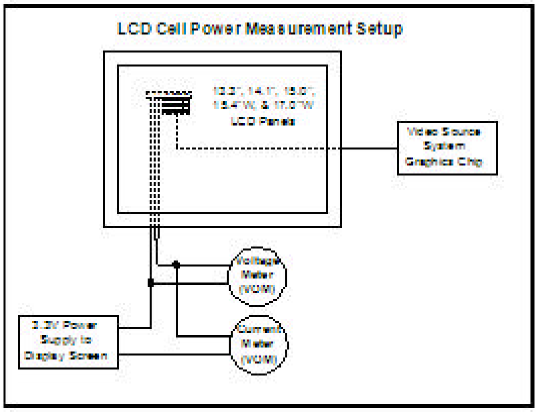
Resolution	Pixels	Aspect Ratio
XGA	1024 x 768	4:3
SXGA+	1400 x 1050	4:3
UXGA	1600 x 1200	4:3
WXGA	1280 x 800 1440 x 900	16:10
WSXGA+	1680 x 1050	16:10
WUXGA	1920 x 1200	16:10
QXGA	2048 x 1536	4:3

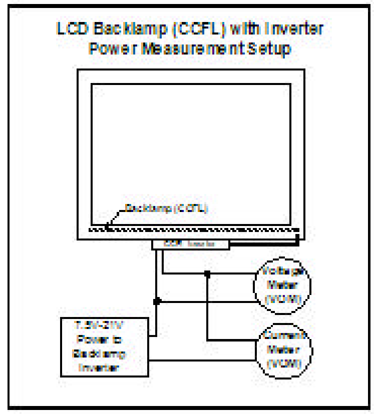
Panel Optical Measurement

- Version 2.0: Not addressed
- Version 3.0: Processes are well defined.

Panel Power Measurement

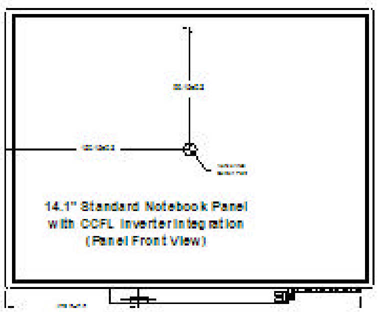
- Version 2.0: Not addressed
- Version 3.0: Power measurement is defined.

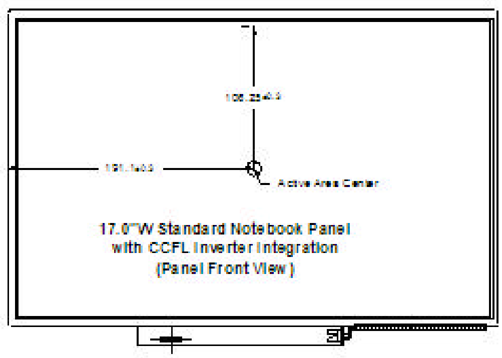




Panel Inverter Integration

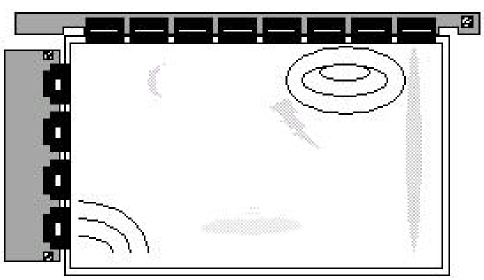
- Version 2.0: Not addressed.
- Version 3.0: Inverter Integration Defined.

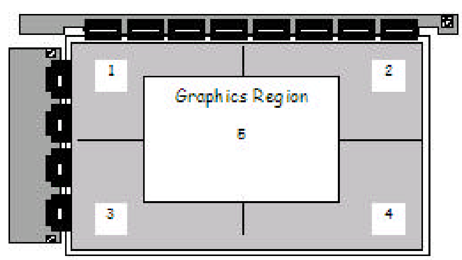




Panel Screen Cosmetics

- Version 2.0: Not addressed.
- Version 3.0: Screen Cosmetics Defined.





Panel Minimum Reliability

- Version 2.0: Not addressed
- Version 3.0: Minimum Reliability Defined.

Environmental Test	Test Conditions
Operating Life - High Temp.	Temp.= +50°C, Dynamic. 250 Hours
Operating Life - Low Temp.	Temp.= 0°C, Dynamic, 250 Hours
High Temp. Storage Life - Non-Operating	Temp.= +65°C, Non-Operating, 250 Hours
Low Temp. Storage Life	Temp.= -25°C, Non-Operating, 250 Hours
Torsion Test	Panel Twisted to defined limits
High Temp & High Humidity Operating Life	Temp.= +40°C, Dynamic, Humidity 95% (Non-Condensing), 250 Hours
RCF (Repetitive Compressive Force)	20mm, 80 durometer plunger, 5000 cycles
Shock - Non-Operating	220g's, 2.0 ms, Half Sine Wave ± 3 Axis (+X, -X, +Y, -Y, +Z, -Z) 3 Shocks per Direction
Vibration - Non-Operating	1.5 Grms, 30 min/side, PSD Spectrum Break Points, 26 Hz G2/Hz=0.316, 50 Hz G2/Hz=0.007, 222 Hz G2/Hz=0.0018, 500Hz G2/Hz=0.0001
Temp. Cycle - Operating	0°C to+40°C, Ramp ≤20°C/min, Duration at Temp. = 30min, Test Cycles = 160
Temp. Cycle - Non-Operating	-25°C to +65°C, Ramp ≤20°C/min, Duration at Temp. = 30min, Test Cycles = 160

www.spwg.org

The www.spwg.org has now seen hits from more than 5000 separate IP addresses since its launch in late August. The goal of the site is to keep an updated flow of information about the activities of the SPWG. The latest draft version of the SPWG v3.0 specification is now on the site and available for review by any interested party. Also, check out several new articles and presentations related to the SPWG on the News/Press page.

Differences between SPWG v3.0 and VESA SIG Draft

Both the SPWG and a Special Interest Group (SIG) at VESA are working on what appear to be similar standardization efforts. There are numerous differences, however, between the two specifications. This comparison is not all-inclusive, but describes the primary differences between the two efforts. We discuss many of these differences in more detail during the remainder of this newsletter.

Size and Resolution

- The SPWG specification addresses:
  - 12.1" panels at 1024x768 and 1400x1050 pixels
  - 12.1" Wide panels at 1280x800, 1440x900, and 1680x1050 pixels
  - 13.3" panels at 1024x768 and 1400x1050 pixels
  - 14.1" panels at 1024x768, 1400x1050, and 1600x1200 pixels
  - 15.0" panels at 1024x768, 1400x1050, 1600x1200, and 2048x1536 pixels
  - 15.4" Wide panels at 1280x800, 1440x900, 1680x1050, and 1920x1200 pixels
  - 17.0" Wide panels at 1280x800, 1440x900, 1680x1050, and 1920x1200 pixels
- The VESA SIG specification addresses:
  - 12.1" panels at 1024x768 pixels
  - 15.4" Wide panels at 1024x768 pixels (undoubtedly a mistake that will be corrected)
  - 17.0" Wide panels at 1024x768 pixels (undoubtedly a mistake that will be corrected)

Connector Pin-outs

- The SPWG specification for 12.1" panels uses SPWG 2.0 style "A" pin-outs, since they are commonly used in 12.1" panels on the market today.
- The VESA SIG specification for 12.1" panels uses SPWG 2.0 style "B" pin-outs, which are not used on any panels today.

Active Area Dimensions

- The SPWG specifications call out active area dimensions and tolerances that cover the slight differences caused by masking at different resolutions.
- The VESA SIG specifications generally describe active area dimensions that are too small and tolerances that are too tight to meet all available resolutions.

Y-axis Dimensions

- The SPWG specification identifies y-axis dimensions that are manufacturable by all major LCD suppliers.
- The VESA SIG specifications generally call out y-axis dimensions that cannot be met by all of the major LCD manufacturers.

Color

- The SPWG specification addresses 6-bit color mapping
- The VESA SIG specification defines both 6-bit and 8-bit color mapping. The draft spec, however, describes an interface connector and pin-outs that only supports 6-bit color.

Mounting Hole Screw Depth

- The SPWG specification identifies a 2.3-2.5mm (min-max) screw-hole depth. The specification also identifies module dimensions for displays that may be developed without screw-hole mounting.
- The VESA SIG specification identifies a 2.5mm max screw-hole depth. This depth eliminates some LCD manufacturers from being able to make compliant panels.

Backlight Connector Location

- The SPWG specification keeps the backlight connector location at 11mm from the right bottom corner in order to enable backwards compatibility with existing offerings. For the emerging 12.1"W and 14.1"W panels, the location is moved to 30mm to enable better hinge management.
- The VESA SIG specification moves the backlight connector location for 12.1", 15.4"W, and 17.0"W panels to 30mm from the right bottom corner, making the spec incompatible with existing designs. Note also that the VESA SIG specification did not resize the CCFL wire length to account for the changed offset.

Connector Tolerances

- The SPWG specification shows connector location tolerances of +/-0.5mm to better enable FPC solutions.
- The VESA SIG specifications show connector location tolerances of +/-1.0mm, which is difficult for system makers that use FPCs.

Signal Timing

- The SPWG specification identifies signal timing as defined by the VESA CVT, 1.1,4/9/2003.
- The VESA SIG specification does not address signal timing.

EDID data

- The SPWG specification identifies EDID data formats necessary for notebook PCs.
- The VESA SIG specification does not address display identification data.

Integrated Inverter

- The SPWG specification optionally identifies location, placement, connector and mounting factors associated with module designs that integrate the inverter.
- The VESA SIG specification does not address this important industry trend.

Panel Performance Measurement and Cosmetic Guidelines

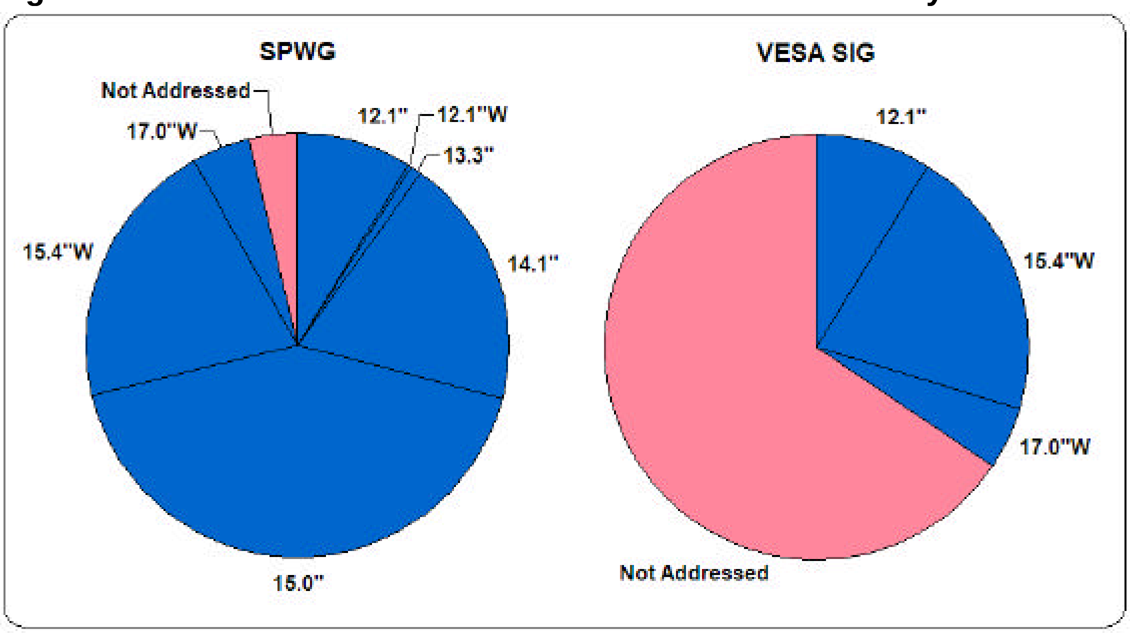
- The SPWG specification identifies how notebook PC displays should be measured in terms of various performance and cosmetic factors. Included are guidelines related to luminance, contrast ratio, uniformity, color gamut, color gamma, viewing angle, response time, residual image, screen cosmetic evaluation, and panel reliability. These guidelines are not performance specifications, but are measurement standards that will enable both LCD makers and system makers to offer comparative measurement to their respective customers.
- The VESA SIG specification does not address any of these needs.

While there are many differences between the VESA SIG's efforts and the SPWG efforts, most of them are the result of a much broader focus by the SPWG. THE VESA SIG effort really only deals with the basic mechanical factors associated with mounting the LCD into the display housing.

Still, there is one big fundamental difference in the approach taken by the VESA SIG and the SPWG in terms of the mechanical designs. For the 12.1"W, 15.4"W, and 17.0"W panels that the VESA SIG is proposing, the spec is not compatible with existing designs. Due to changed backlight cable positions, in particular, the proposed VESA SIG specifications require system-level modifications, such that the adoption of standardized panels is unlikely to take place for a year or more after release of the specification. The proposed SPWG specification, conversely, tries to utilize existing designs, enabling forward compatibility and a much quicker adoption of the proposed standards.

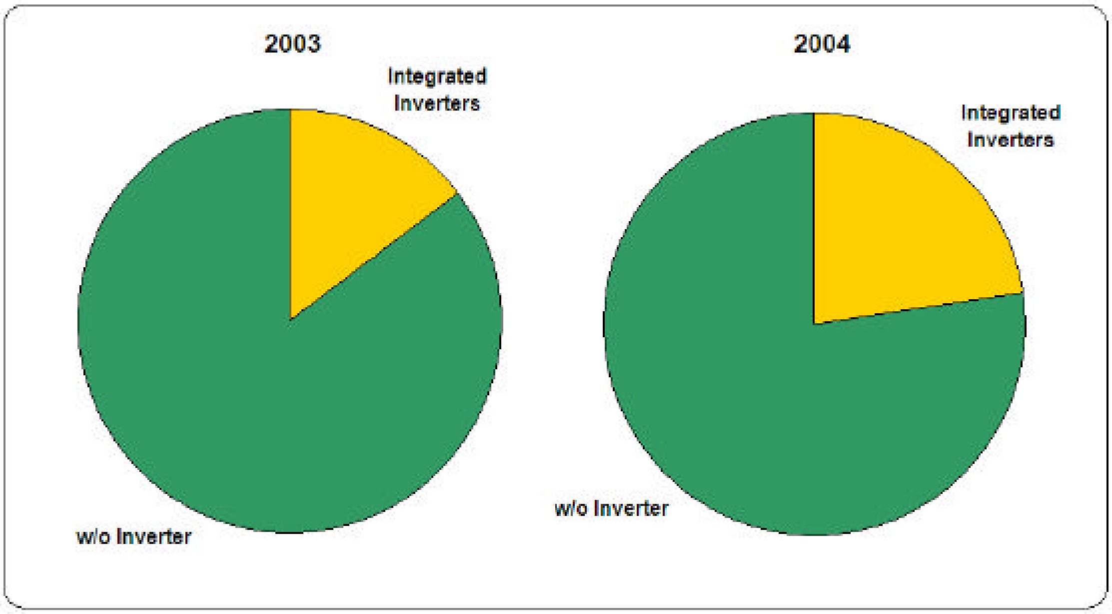
We additionally want to reinforce that the SPWG v3.0 specification covers a much broader swathe of the notebook PC industry than does the VESA SIG specification. According to our perception of 2004, the SPWG specification could apply to 96.7 % of the total LCDs built for the notebook PC industry, but the VESA SIG spec only addresses 34.5% of the market in 2004. This comparison is represented in Figure A, below.

Figure A: SPWG v3.0 vs. VESA SIG Market Share Possibility in 2004



Moreover, we think it's important to recognize that a significant portion of the panels shipped into the notebook PC market in 2004 will include integrated inverters, which is not addressed in any way by the VESA SIG draft specifications. Even considering the possible 34.5% penetration of the market available to the VESA SIG specification, since the spec fails to address the growing penetration of integrated inverters, (expected to be up to almost 23% of the market in 2004, as depicted in Figure B below); the actual penetration by the VESA SIG specification is even smaller.

Figure B: Expected penetration of Integrated Inverters in notebook PC market



Lessons Learned…

While the SPWG effort has been remarkably successful, with almost 60% of all notebook PCs now incorporating SPWG-compliant panels, but still there are a few lessons we've learned from mistakes made in the past. Perhaps the two biggest mistakes are:

1. **Taiwan's notebook PC manufacturers needed to be involved earlier**. The initial SPWG effort inadequately involved the actual manufacturers of notebook PCs. The companies that actually install the LCDs in the notebook PC can best realize many of the benefits of standardization. Companies who don't build notebook PCs themselves, are much less sensitive to inventory interchangeability, production test and installation procedures, and production line qualification issues. Such issues dominate the design decisions of the OEM manufacturers. Since OEMs are expected to make more than 70% of all notebook PCs in 2004, (vs. only about 50% in 1999), it is more important than ever to assure the involvement of the Taiwanese and Korean notebook PC manufacturers. The original SPWG effort was somewhat slowed because the Taiwanese manufacturers were not significant players in the creation and implementation of the SPWG standards. We have worked hard to make sure all of Taiwan's notebook PC makers are fully knowledgeable about the ongoing activities of the SPWG.

2. **The initial SPWG efforts failed to specify the position of the inverter.** As a result, many "SPWG-compliant" panels in fact did not adhere to the specification, with violations having to do with the backlight cable length. Although pigtail solutions could have easily solved this problem and enabled the utilization of truly SPWG-compliant panels, some display engineers chose to develop customized solutions – basically invalidating most of the advantages associated with standardization. Although pigtails are a simple solution to this problem, by defining the position of the inverter, it's much easier for design groups to abide by the display standards.

Engineering vs. Procurement?

This article was published in the last issue of the SPWG newsletter. By request, we are repeating it, both to highlight again the advantages of the SPWG effort, as well as the importance of procurement managers taking a more active role in the standardization effort. Standardization is not just an engineering function…

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Most companies seem to view the development of industry standardization as a function that is exclusively under the responsibility of the engineering department. With the single exception of Mark's involvement in the original SPWG effort, (at which time he was in Dell's procurement organization), the development of the original SPWG specification was largely under the purview of LCD engineers.

While certainly spec documents should be developed by qualified engineers, standardization efforts are likely to be much more effective if they are developed in concert with company procurement representatives.

1. Although standardization simplifies the engineering qualification process, the primary benefits of industry standardization are seen by the procurement side:

    a. Second-sourcing flexibility
    b. Lower pricing and improved negotiation leverage
    c. Inventory minimization
    d. Simplified end-of-life supply management
    e. The ability to upgrade
    f. Cross-platform interchangeability
    g. Ease of Serviceability
    h. Remote Test/Diagnostics
    i. Ability to focus on price/performance

2. The creation of standards is much more than just the release of a specification. It requires a coordinated process to evangelize about the advantages of standardization – internally and to external suppliers and industry participants. In many situations, buyers are in the best position to manage this evangelism process since they are primarily responsible for managing supplier relationships. Without involvement of procurement organizations in the standardization effort, there is a risk that the standards will be relaxed – either at the internal engineering level or at the supplier level.

3. Procurement managers are trained to negotiate for compromises that allow win-win situations. Engineers, on the other hand, are trained to find the best solution and to continuously experiment and invent to find the best possible solution. In other words, in a standards setting situation, if engineers are the primary people involved in establishing the standard, there is always a risk that the scientific method will break down the consensus-building process.

4. As more and more notebook PC brand production moves to third party manufacturers, the major brands are shifting engineering resources to the third party manufacturers as well. This means the role of the buyer is becoming more and more important in determining supplier selection and commodity features, (which is another reason favoring standardization).

In other words, brand procurement managers are encouraged to take a more active role in the standardization process, helping to assure timely implementation of such specifications. This suggestion clearly does not mean that engineers should not be involved in the standardization process, just that it's important for both engineering and procurement to work closely together in the development of consensus-building strategies related to industry standardization.

Last Conference Call Summary

The last conference call related to the SPWG v3.0 specification was held on December 16 (Dec 17 in Asia) and was joined by representatives from approximately 22 companies, including representatives from 6 LCD manufacturers, 4 notebook PC OEMs, 3 notebook PC brands, 3 LCD connector manufacturers, and several other interested parties.

Paul started the conference call by explaining that the SPWG effort attempted to sustain backwards compatibility. He also explained the methodology for including integrated inverters in the SPWG spec. He emphasized the value of identifying cosmetic definitions and reliability suggestions in the SPWG spec, while encouraging continued improvements in front-of-screen performance.

Questions were raised about the dual efforts of the SPWG and VESA. Paul and Kamal Shah from Intel (representing the EBL-WG), advised about plans to propose the SPWG specs to VESA. Particularly since so many SPWG endorsing companies are non-VESA members, this process would enable VESA to be more appropriately represented by the entire notebook PC industry. In addition to broad support from notebook OEMs, LCD manufacturers, and component makers, the SPWG effort is supported by the EBL-WG, a broad-based group of key notebook PC brands and OEMs. Both SPWG endorsing companies and EBL-WG member companies would need to approve, before the SPWG specs would be submitted to VESA. When asked about support from Dell, HP, and IBM, Paul and Kamal also clarified that both Dell and IBM have been actively helping the SPWG effort, and in fact both companies participated in the conference call. All are in agreement that it doesn't make sense to have two separate specs, but that the SPWG efforts are more representative of the notebook PC industry than are the VESA efforts. "Why 'fix' something that isn't broken, was the general consensus".

Incline provided numerous inputs about the spec from a serviceability perspective, and also identified several minor typographical errors. (The latest spec makes all appropriate corrections and clarifications). Representatives from Quanta also pointed out some minor typos.

There was considerable discussion about the offset for the backlight cable. Prior versions of the SPWG identify an 11mm offset. The VESA group is proposing a 30mm offset in order to make hinge designs simpler. In order to assure backwards compatibility, Paul explained that the SPWG spec sustains the 11mm offset for existing panels sizes, but for panel sizes not yet into mainstream production, the SPWG spec supports the 30mm offset.

There was considerable discussion about inverters and how to measure raw input voltage. Paul explained what is included in the SPWG spec, to general acceptance.

There was some discussion about the possibility of including touchscreens (related to Tablet PCs) in the SPWG spec. The general consensus was to leave touchscreens out of the discussion for the time being.

IBM raised several questions, particularly about the need for integrated inverters and about some of the cosmetic specs. Paul explained that the integrated inverter specification is optional, for those companies that are not yet interested.

Chimei and Dell questioned Paul about the proposed panel power sequencing, particularly in relation to some of the new battery designs being introduced. Discussion resulted in some changes to the specification.

Some questions were raised about the connector specifications. MiTAC asked if there were any size limitations related to the connector. Paul explained the specification and added a discussion about locking connectors.

Paul also explained that the v3.0 specification no longer supports the SPWG Style A mounting, and that the v3.0 spec identifies how to support panels that are so thin that mounting screws are not possible. In such cases, the screw locations are simple reference locators.

Paul reviewed all panel sizes, and discussions pointed to issues related to the 14.1"W panels, (discussed in detail later in this newsletter).

There was some discussion about 17.0"W mounting. Paul summarized the SPWG position, enabling a single mounting solution for multiple pixel formats.

Another conference call will be held in mid-January to discuss the latest draft document. All SPWG endorsees and ELB-WG members will be invited to participate. Any interested parties are invited to review the latest draft version and submit any inputs to Paul or Mark.

14.1" Wide Aspect Ratios

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).

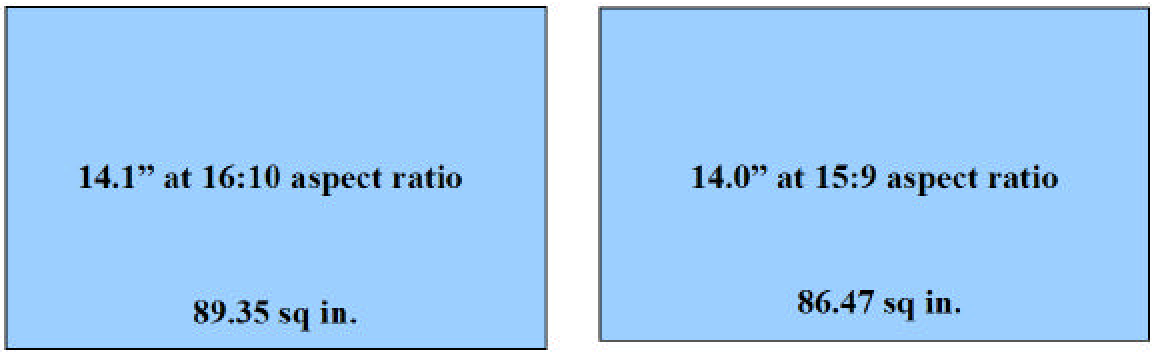
2. **14.0" at 1280x768 is not optimized for most fabs**. According to our calculations, 14.0" at 1280x768 is a good choice for only 5 or 6 third/fourth generation fabs, (at 620x750 and 610x720). The only manufacturers with fabs at this size are AUO, CMO, QDI, BOE/Hydis, and Toppoly. While these companies 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% smaller 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 find 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.

At this moment, we do not include a 14.0” (15:9) or 14.1” (16:10) panel in the SPWG v.3.0 specification, although we recommend that a 14.1” (16:10) version be added. We are looking forward to the continued feedback on this important discussion.

Confusion Related to Integrated Inverters

We've noticed four distinct areas for confusion related to the inclusion of an option for integrated inverters in the v3.0 SPWG specifications.

1. **Meaning of "integrated".** Our use of the term "integrated" has caused some confusion, and perhaps a better term would be "matched". Although we expect that eventually the inverter will actually be manufactured as integral part of the LCD module itself, our reference to "integrated" is to suggest that the LCD manufacturer take responsibility for assembling the inverter with the LCD module in a way that best assures optimal performance. We believe that display performance is best managed by the display manufacturer and not by the notebook PC assembly house.

2. **"Integrated" vs. "Standardized" Inverters.** Quite a bit of confusion related to inverters has been created by pressures from one major notebook PC brand. This one company has been pressing LCD makers to make "standardized" inverters. Unfortunately, standardized inverters are only an effective solution if there are common lamps. Since each LCD maker employs different backlighting solutions in their module assembly, it becomes very difficult to have multiple LCD makers supporting such a standardized inverter solution. Moreover, it is very unlikely that standardized inverters can be effectively employed as an industry-wide standard, since each notebook PC manufacturer has developed their own power management strategies. And since inverter performance varies considerably depending on the inverter manufacturer, and since inverter performance is in a constant state of improvement, a standardized inverter solution is likely to limit improvements in inverter technology. In fact, the approach taken by this one notebook PC brand is almost certain to create an entirely customized solution for this one company – hardly something that should be considered a "standardization" effort. Accordingly, we are not in favor of standardized inverters. It appears that the efforts of this one company are dying anyway, due to very strong opposition from all LCD manufacturers.

3. **Question of "favoritism".** We have been advised that our suggested integrated inverter solution may "favor" some companies. While it's almost certain that any design we choose would be simpler for some companies to implement than other companies, our suggestion is based on interviews with many companies and in no way is meant to provide an advantage or disadvantage to any company. If indeed, the proposed SPWG v3.0 design gives any company a particular advantage, we are hopeful that reviewers will help us to identify a more balanced approach. Our basic position is that integrated inverters as a part of the SPWG specifications provides advantages to the entire notebook PC community. Moreover, it should be remembered that the usage of integrated inverters is optional under the proposed specification. The specification only defines a means by which inverters can be integrated into the LCD module in a standardized way.

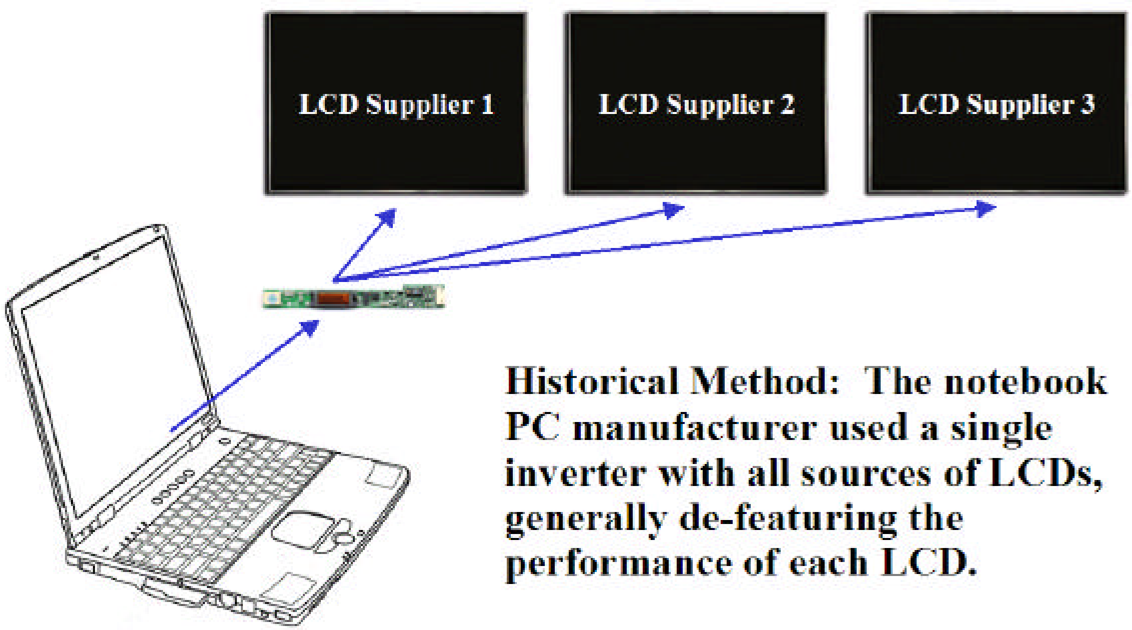
4. **"There's no reason for integrated inverters".** In the past couple of months, several people have suggested that there is no good reason to integrate inverters into the LCD module. After questioning, we identified that all of these critics come from a background related to LCD monitors. Although we believe there are also advantages to matching the LCD and the inverter with regard to LCD monitors, the primary advantages are best realized by notebook PCs. LCD monitors are not concerned about battery life, so a matched LCD/inverter solution is of little importance. Moreover, the service advantages associated with the interchangeability of LCD modules are much more important for notebook PCs than for LCD monitors.

Although there is some confusion related to integrated inverters, we believe that it is critically important to bring inverters to the SPWG standard, as discussed below.

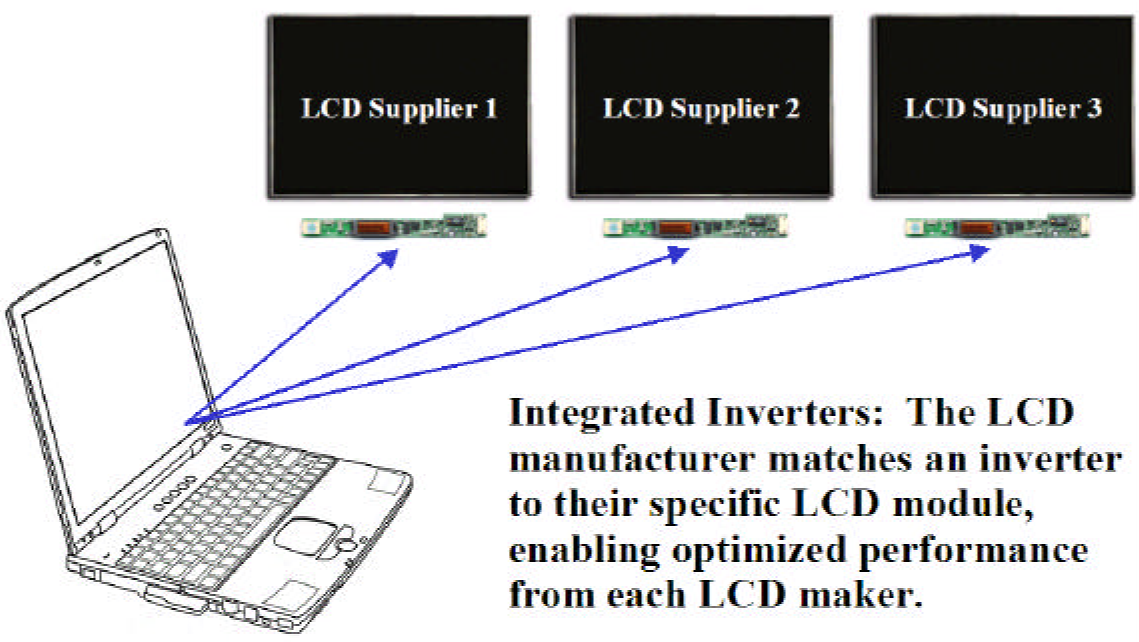
The Importance of Integrated Inverters

Integrated inverters are almost unquestionably the way of the future for notebook PCs. We believe that any notebook PC company that is not currently (or does not have plans to) match inverters with LCD modules is missing a huge opportunity. Perhaps the best way we know to simultaneously reduce display power, improve display quality, simplify display serviceability, assure design interchangeability, and reduce overall system costs, is to integrate displays and inverters. We are devoting a substantial section of this newsletter to discuss this very important aspect of the SPWG specification.

Historically, inverters have been designed and developed independently from the LCD. In fact, somewhat surprisingly, LCD makers and inverter makers rarely, if ever, communicated with one another. The result was a situation where a relatively inexpensive device (the inverter) controlled the performance of a very expensive LCD device, with little interaction between the two groups. The situation has been made worse by the fact that the notebook PC makers have desired to simplify their production processes by installing a single inverter, regardless of the LCD used. This results in a situation where the performance of the LCD is not matched to the inverter being used, such that power efficiency is not optimal for any particular system. This historical situation is shown in the image below.



We think that a much better method, which is gaining favor in the notebook industry, is for the LCD manufacturer to match their LCD with an inverter designed to their specifications. The notion of integrated inverters is shown in the figure on the next page. Note, by the way, that the "standardized inverter scenario discussed in the previous article would look the same, except that rather than matching LCDs and inverters, each inverter would be the same, with each LCD manufacturer then trying to design their LCDs around a low-cost inverter. We think this approach is backwards, and that instead inverters should be designed to showcase each of the high-dollar LCDs.



There is an historical example that we can study related to display electronics. In the early 1990s, the displays for all notebook PCs included two PCB assemblies, the inverter and a DC-DC converter. Both PCBs were about the same size and cost about the same (around $15 at the time). The DC-DC converter was gradually eliminated as chip technologies took over this function and was incorporated into the module assembly. Several observable factors came about as a result of the integration of the DC-DC converter into the LCD module. Costs quickly were pulled out of the bill of material, such that today there is very little cost associated with the DC-DC conversion function. It used to be that the DC-DC converter was a relatively common failure item for the notebook PC. Today, this failure mode has been essentially eliminated. The DC-DC converter previously took up quite a bit of real estate within the LCD assembly. Today, the DC-DC converter takes up almost no space.

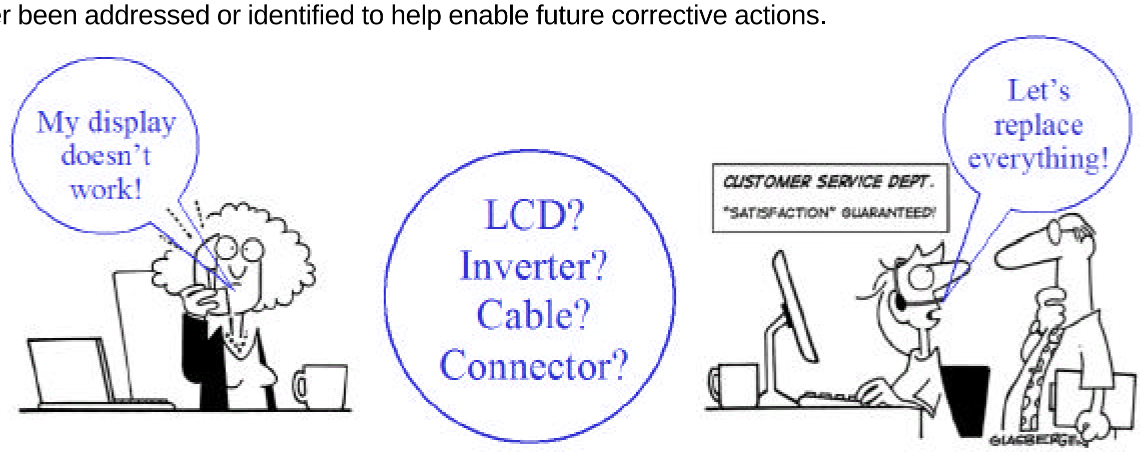
Integrated inverters are increasingly being considered for numerous reasons, many of which are similar to the historical factors that contributed to the complete integration of the DC-DC converter. We highlight a few of the major reasons below in order to highlight the importance of including an option for integrated inverters as part of the SPWG specification.

Reduce display power. A big opportunity exists to improve display power by assuring that each inverter is designed specifically to enable optimal efficiency for each display. This is best managed by the LCD maker, who is positioned to act as the intermediary between the lamp maker and the inverter maker. As such, inverters should be bundled (and perhaps eventually integrated) with the LCD module. The notebook PC maker will buy a fully tested "video sub-system" from the LCD maker that is optimized for power efficiency and that can be installed easily as an SPWG-defined form-factor. This factor is one of the main reasons the Extended Battery Life Working Group (EBL-WG) is interested in working with the SPWG. Simply by enabling a process whereby the inverter can be matched to the display within the SPWG framework is believed to offer some significant opportunities to reduce display power.

Improve display quality. Dell has been using integrated inverters in the majority of its notebooks for the past couple of years. Dell's quality group recently advised that the integrated inverter process has helped to substantially reduce both factory failure rates and field reliability failures. From a quality perspective, the LCD and inverter are now tested together at the LCD manufacturer prior to assembly in the notebook PC. Under the historical method, the inverter and LCD were first tested together as one of the last steps in the notebook PC manufacturing process. By advancing the initial test of the "video subsystem", quality is better assured. But more importantly is the fact that with integrated inverters, the LCD manufacturer takes responsibility for the quality of the entire assembly, including the inverter. With a significant portion of display failures being related to the inverter, the LCD supplier newly has a strong incentive to help improve long-term reliability of the inverter. One LCD manufacturer admitted to being initially skeptical about supplying integrated inverters, but now realizes that display-related quality problems have dropped significantly, with return rates from Dell dropping by almost 50%. Another LCD maker advised that CND returns (cannot duplicate) have dropped by more than 50%. In other words, by combining the inverter with the LCD, the display manufacturer can identify

Simplify display serviceability. The servicing of a notebook PC is a rather emotional process for most users. If a display fails in a desktop system, it's simple for the end-user to replace it with a different display. It's also rather easy in a service phone conversation to identify whether the failure is related to the monitor, the video card, or some other device. In the case of a notebook PC, however, it's frequently very difficult to identify if the field failure is really related to the LCD. It could be related to the inverter, the connectivity solution, the video controller, or some other device. But all that can usually be diagnosed over the telephone is that the display isn't working. And then, unlike with a desktop computer, where a replacement monitor can be plugged in easily, with a notebook PC, the user typically has to send in the entire notebook PC for servicing. This means that the user is without their computer for several days, running the risk of a loss of information. As a result, many users choose the expensive option of having on-site service for the notebook PCs. But this creates a dilemma for the service provider, since they have no way of knowing whether the LCD, the inverter, or some other component is the root problem. There are many examples of on-site service calls for an LCD replacement, but the problem was actually inverter related. If the serviceman were not prepared to replace the inverter, a second service call would be required.

What happens in many situations is that service provider replaces the LCD, the inverter, and the connectivity solution – without really knowing which one was failed. By replacing all three of the primary culprits, the serviceman can much more quickly solve the problem and reduce the time spent on the service call. Amazingly, at most companies, since the inverter and the connectivity solution are very low-dollar items, they are thrown away as being "non-repairable". The result is that a "good" LCD is returned to the LCD supplier, the LCD supplier finds no problem (CND), and there the root quality problem has never been addressed or identified to help enable future corrective actions.



Integrated inverters don't completely solve the problems associated with servicing notebook PC displays that have gone bad, but they do simplify the service process and help to assure a closed loop quality feedback system with the LCD manufacturer taking responsibility for improving any problems found.

In sum, in addition to improving performance, integrated inverters will inevitably lead to improved quality and serviceability, since the LCD maker is responsible for any warranties on the entire video sub-system. Eventually, the other advantages of the SPWG (enumerated above) will also come into play with regard to the inverter so as to further improve supply-chain logistics, pricing, and inventory management.

It should also be noted that the SPWG enables companies to build in service-related diagnostics. The standardized connector pin-out and panel ID capabilities provide considerably more information to the on-line service technician. In many case, updated firmware can be uploaded via Internet-based service operations and sometimes eliminating the need for an expensive service call.

Better assures interchangeability. An SPWG display module with an integrated inverter enables display interchangeability. Compliant panels can be interchanged with same-size panels at different resolutions or from multiple suppliers. Regardless of the connectivity solution, the video controller, the hinge mechanism, or the display housing, SPWG-compliant panels are fully interchangeable. This level of interchangeability helps reduce inventory risks, enhances serviceability, makes design decisions much more predictable, and enables all parties in the process to focus on improving display performance parameters.

While “plug-and-play” is probably not the correct way to think of SPWG-compliant panels with integrated inverters, because the display is unlikely to be a user-interchangeable component, the solution will still enable notebook PC manufacturers tremendous flexibility and ease of design and manufacturing. For the first time, with the implementation of SPWG-compliant displays with integrated inverters, panels used in a notebook PC built for one brand, can now be interchangeably used in another appropriately designed notebook PC.

Reduce overall system costs. SPWG-compliant panels currently sell for about $5 per unit less than an “equivalent” non-SPWG panel. This gap varies on supply-demand factors, and is sometimes as much as $8-10. The lower prices are justified because of larger production runs, volume component parts pricing, and the reduced handling costs of managing multiple custom part numbers.

Integrated inverters are likely to further reduce costs. Not only will there be secondary savings associated with the quality, serviceability, and interchangeability factors discussed earlier in this article, but it is likely that by matching the inverter and the display that there will be optimized component management that will further reduce prices.

In sum, integrated inverters address numerous key problems faced by notebook PC manufacturers. The concept of integrated inverters is not new, (with almost 15% of all the LCDs used in notebook PCs shipping with integrated inverters in 2003 and close to 25% expected to ship with integrated inverters in 2004). Accordingly, we believe it is essential to include some factors related to integration of inverters into the SPWG specifications.

Question of Color

One area that might need more discussion is related to color. Today, it is believed that 100% of all notebook PCs use display with 6-bit drivers. The video controllers enable an additional 2-bits via dithering, creating a 6+2-bit solution that effectively results in 16.7 million colors.

In the LCD monitor environment, many displays employ 8-bit drivers (and a few even employ 10-bit drivers). In the case of LCD monitors, the video card is part of the computer chassis and it’s impossible to predict what video card will be utilized or if adequate dithering solutions will be enabled. As such, 8-bit drivers are used to assure full color. In the case of notebook PCs, it’s not certain if 8-bit drivers provide any real advantage.

Fairchild Semiconductor recently released a solution that will support 8-bit color for notebook PCs. It is believed that the Fairchild solution will be supported by the SPWG specification, although there needs to be more study about whether there may be an impact to the timing sequences. This area needs more discussion – basically, should the SPWG spec support 8-bit color? Is an 8-bit solution different than a 6-bit solution? Will such differences impact panel interchangeability? Please send Paul or Mark any inputs.

Connectors

This section shows a cross-reference list of the connectors that are claimed to be compliant to the SPWG specifications. The listing is not completed, pending verification and updates from some of the endorsing companies to the SPWG. We will work to keep this listing updated at the www.spwg.org website for your continual reference purposes.

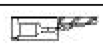
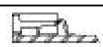
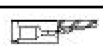
We want to emphasize that this listing is not an assurance of quality, fitness for purpose, nor should it be considered as permission or transfer of any company's intellectual property rights. We think that all LCD manufacturers and notebook PC manufacturers must independently verify their use of appropriate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

SPWG Compliant Connectors

20-pin Interface Connector
(HRS DF19L-20P-1H or equivalent)

Type	Image	DDK	FCI	Hirose	Honda	I-PEX	JAE	JST	KEL	LG Cable	Starconn	Sunridge	UJU
Receptacle				DF19L -20P-1H		20268 -020E-03		SM20B -LDBGS-10B					IN-20 -OA100
Receptacle (1.0mmH)				DF19K -20P-1H		20268 -020E-01				GT100-20P -LS-SMT			
Receptacle, bottom				DF19KR -20P-1H						GT100-20P -LS-SMT-R			

30-pin Interface Connector
(JAE FI-Xx30Sx-HF-xx or equivalent)

Type	Image	DDK	FCI	Hirose	Honda	I-PEX	JAE	JST	KEL	LG Cable	Starconn	Sunridge	UJU
Receptacle				MDF76K -30S-1H		20327 -030E	FI-X30S -HF	SM30B-LDYGS-10		GT101-30S -H16	093C30 093G30	FPD-PIX -30-01	IN-30-BB100 IN-30-BA10
Receptacle, bottom				MDF76LR -30S-1H			FI-XB30S -HF10	SM30B-LDYGS-10C		GT101-30S -HF10	093B30	FPD-PIX -30-02	IN-30-OC100 IN-30-OA10
Receptacle, bottom, reverse							FI-XB30SR -HF11	SM30B-LDYGS-R10D		GT101-30S -HR11		FPD-PIX -30-03	IN-30-OB100 IN-30-RA10
Receptacle, locking							FI-X30SL -HF	SM30B-LDYGLS-10		GT103-30S -H23			IN-30 -BBL100
Receptacle, bottom, locking				MDF76KBW -30S-1H			FI-XB30SL -HF10	SM30B-LDYGLS-10C		GT103-30S -HF15	093F30		IN-30 -OBL100
Receptacle, bottom, reverse, locking				MDF76LBR W-30S-1H			FI-XB30SRL -HF11	SM30B-LDYGLS-R10D		GT103-30S -HR16			IN-30 -RBL100

2-pin Backlight Cable Connector
(JST BHSR-02VS-1 or equivalent)

Type	Image	DDK	FCI	Hirose	Honda	I-PEX	JAE	JST	KEL	LG Cable	Starconn	Sunridge	UJU
SMT Pin Header								BHSR -02VS-1				FPD-PB -35-2P	BL-02 -BA350

20-pin Inverter Connector
(Honda LVC-D20SFYG or equivalent)

Type	Image	DDK	FCI	Hirose	Honda	I-PEX	JAE	JST	KEL	LG Cable	Starconn	Sunridge	UJU
SMT-Type for single or super thin coaxial					LVC -D20WFYG	20327 -020E							

Notes: 1). Listing in this cross-reference list does not imply any rights to another company's intellectual property.
2). This list does not assure fitness for purpose, and is for reference purposes only.
3). This list is not be complete, listing only SPWG-specified connectors and SPWG endorsing connector manufacturers. Watch for updates.

PSWG (LCD Monitor Standardization Effort)

While the SPWG is focused on standardizing panels used in notebook PCs, a separate working group has been working since early 2002 to similarly create standards for the LCD Monitor market. On March 10, 2003, the Panel Standardization Working Group (PSWG) released its first specification for 15.0" XGA (1024x768) panels, in two version (one with an LVDS interface, and one with an RSDS interface). On September 22, 2003, the group released a spec for 17.0" SXGA (1280x1024) panels with an LVDS interface.

New SPWG Endorsees

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. There are also no obligations associated with endorsing the SPWG, although 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. Note that endorsement of the SPWG is not an indication that any company's products are fit for purpose. Endorsing companies get the opportunity to actively participate in the standardization process. Providing timely inputs and reviewing draft documents, when requested, is critical to the successful implementation of the SPWG standards efforts. Any company that newly wishes to endorse the SPWG is encouraged to do so by contacting Mark Fihn or Paul Salisbury.

DDK Connectors was established in 1963 and became a fully owned subsidiary of Japan's Fujikura Corporation in 1999. With manufacturing facilities in Japan, Thailand and China manufactures cables, cable assemblies and fiber optic components to accompany a wide range of connectors. DDK offers its MSC-series of connectors which the company claims is SPWG-compliant.

The **DisplayMasters MSc Programme** is a unique masters degree program in the UK that trains students to participate knowledgeably in the growing displays industry. Chris Williams ardently supports the SPWG efforts, in his words: "As Chairman of the Industrial Steering Committee for the DisplayMasters MSc Programme in Display Technology, Systems & Applications, I would like to confirm that my academic and industrial colleagues and I wholeheartedly endorse the good work you are doing with SPWG, and we wish you every success in your endeavours to secure commonality of standards in this important area. In supporting the DisplayMasters Programme run by the Universities of Dundee, Abertay Dundee, Cambridge, Edinburgh, Oxford and Nottingham Trent we have benefited from the involvement of industrial companies around the world in all areas of the displays food chain. In the networking periods that supplement the intensive teaching programme, we have the opportunity to discuss wide-ranging topics with the degree students and the academic and industrial speakers. The questions from the students can be brutally honest, and it remains a difficult task to explain why there are so many different glass sizes, pixel resolutions, and monitor options, for LCD products. When backed up with the industrial problems caused by short term obsolescence as products are overtaken by "next generation" types with no or little backwards compatibility, it becomes increasingly difficult to answer the comment "but- that's stupid" which is the most common response from the students. We support your work, and hope that a successful conclusion may seek to bring order into the present chaotic world of product supply".

FCI Electrical Power is part of the Areva group, a leading European industrial group. FCI has rapidly developed a leadership position as a worldwide supplier of electronic and electrical interconnect systems. The acquisition of Berg Electronics in October 1998 enabled FCI to almost double its capacity and further improve its customer service around the world. In only 12 years a rigorous growth strategy has made FCI into a leading global connector manufacturer.

Incline Global Technology Services was formed in May 2003 as the result of mergers between Display Products Technology (DPT), Incline Inc., and Austin Digital Remarketing (ADR). To support repair services for the flat panel display market, Incline GTS operates repair facilities in Scotland, Ireland, Texas, California, and Taiwan. John Chapman, Incline's Director of Engineering, advised "Incline is pleased to endorse the SPWG goals and written guideline as effective methods of reducing notebook flat panel display design, integration and maintenance costs. Standard electrical interface elements simplify all test requirements and will thereby reduce life cycle maintenance costs. Adoption of the SPWG guideline will represent a substantial, industry wide, improvement in display maintainability".

I-PEX Co., Ltd. (Interconnect and Packaging Electronics) is a Japan-based connector manufacturer. I-PEX offers Board-to-Board, Board-to-Wire and Coaxial Connectors, Flexible Printed Circuits, and Memory Card Sockets. "I-PEX recognizes the leadership of SPWG in standardization of TFT-LCD solution and no doubt that it's the benefit to whole industry of this application". "I-PEX has been the world market leader on LCD panel connection solution in PC applications since 1995 and its market experience and technical capability will contribute to SPWG to achieve the goal".

iSuppli/Stanford Resources has provided management consulting services and multi-client research reports to display developers, manufacturers, and users, as well as to the financial community and industry organizations for more than 25 years. EVP, Paul Semenza recently commented about the SPWG: "Standardization of electrical and mechanical standards for notebook displays enables manufacturers to focus on differentiation that truly benefits the end user - display performance".

Photo Research claims to be the world leader and innovator in high precision, state of the art electro-optical instrumentation and systems. Photo Research has delivered light and color measurement solutions, serving the cathode ray tube ("CRT")/flat panel display ("FPD"), automotive, aerospace, lighting, motion picture, research and development and related industries for over 60 years. The Photo Research Optical Metrology Laboratory (PROML) is a supplier of and service provider to optical radiation standards, calibration and measurement for major manufacturers of instruments, displays, devices and materials. Photo Research is a subsidiary of Excel Technology, Inc.

Portrait Displays is a leading provider of software and measurement applications for display technologies. Portrait's expanded product line includes Pivot® rotational software as well as the newly released Liquid View and Liquid Surf. The Liquid family of products is focused on enhancing the users viewing and utility experience on all display mediums. Portrait recently debuted their latest product line, Display Tune. Display Tune technology provides users a tool set to manage display performance.

Starconn Electronics is rated as on of the top-five connector manufacturers in Taiwan, and is the registered trade name for CHIEF LAND Electronic Co., Ltd. Founded in 1978, Starconn's Marketing and RD/Engineering Vice President, Stephen Liou advises that: "Starconn recognizes that an industry-wide standard of display used in Notebook and LCD panel would be beneficial to end-users and manufactures in supply chain, price and performance. As a leading connector maker in LCD market, Starconn commit to supporting SPWG to create innovative standard product for extra value for customers".

THine Electronics, Inc. is a Japan-based chip-development company specializing in large system integration, used mainly for liquid crystal displays. Based on "fab-less" manufacturing, THine licenses its designs of Analog/Digital mixed signal LSIs for world leading semiconductor and LCD manufacturers. Toshiyuki Sato, Director for Sales Strategy remarked: "THine Electronics, Inc. welcomes the SPWG's effort which will accelerate the standardization of mobile FPD modules in high quality and amore cost effective fashion."

Toppoly Optoelectronics Corp is the newest company to produce displays for notebook PCs. Established in December 1999, Toppoly Optoelectronics Corp. is the first and only dedicated TFT LCD volume manufacturer pioneering in LTPS (Low Temperature Poly Silicon) technology in Taiwan. Toppoly provides the full range of LTPS TFT LCD panels for the applications of information Appliances, Audio/Video and Office Automations, including notebook PCs, based on their glass substrate of 620(H) x750 (V) mm. Vice-President, Ying Chang remarked that "Toppoly supports the efforts of SPWG in developing standards for display panels to be used in the notebook industry. We believe that the industry will greatly benefit from such efforts".