Application Note
Interface Solutions for Planar's EL Displays

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A. EL INTERFACE OVERVIEW

The majority of Planar's EL display products use an interface consisting of the following digital inputs:

- VS, to indicate the start of a frame of data
- HS, to indicate the start of a row of data
- VCLK, to clock in the pixel data
- VID, the pixel data

The "VID" can be either a single input, two inputs, four inputs, or eight inputs depending on the display model and, in some cases, the mode setting of the display. Thus the data for either one, two, four, or eight pixels is clocked in on every active clock edge.

Most common is the 4 bit interface, where there are 4 bits of parallel data per clock. This 4 bit interface was first used, and continues to be used, in the monochrome LCD industry, though the LCD terminology is typically different (e.g., FRM = VS, LP or LOAD = HS, CP = VCLK).

The 1 and 2 bit interfaces are similar to the 4 bit interface but with slight timing differences and with fewer bits of pixel data clocked in per clock.

The 8 bit interface is based on a dual panel scheme popularized in the early days of large passive LCDs, where data for four pixels in the upper half of the displayed are clocked in simultaneously with data for four pixels from the bottom half of the display.

All models except the EL320.240 FA3 and EL640.480 AA1 are monochrome. For the multicolor FA3 and AA1, 4 bits per pixel are required to define the pixel color.

The EL240.128.45 has a built-in Epson S1D13305 video controller IC. The interface of the S1D13305 is designed to connect to an 8 bit microprocessor bus which is used to pass data and commands to the display.

B. SUMMARY OF EL INTERFACES BY DISPLAY FAMILY

The table below summarizes the EL interface type for each EL product family. Refer to the appropriate Operations Manual for details on each product's interface timing and requirements. (For product Operations Manuals, see: http://www.planar.com/Support/Support_By_Product/Embedded/EL/index.html)

Display Family	1 bit	2 bit	4 bit	4 bit color	8 bit dual	Other/Notes
EL160.80.50			X			
EL160.120.39			X			
EL240.128.45						Microprocessor interface
EL240.128.45 INT			X			
EL320.240.36			X			
EL320.240.36 HB			X			
EL320.240 FA3 (Mulitcolor)				X		Accepts CMOS AMLCD VGA or QVGA timing
EL320.256 F Series	X	X				
EL480.240 PR			X			
EL512.256 H Series	X	X				
EL640.200 SK			X		X	
EL640.400 C Series	X	X				Also accepts CMOS VGA "feature connector" timing
EL640.480 AF					X	
EL640.480 AG					X	
EL640.480 AM					X	
EL640.480 AA1 (Multicolor)				X		Also accepts CMOS VGA "feature connector" timing

C. INTERFACE SOLUTION CATEGORIES

There are several ways to generate the required interface signals:
- Embed a video controller IC in your custom board and use your microprocessor or PC bus to communicate with the video controller IC
- Select a microprocessor that contains an integrated flat panel controller
- Use a video board that can drive EL displays
- Select a Single Board Computer that has the required flat panel video outputs
- Use a video converter board (e.g., an LVDS to EL converter board if LVDS video is already available)

D. SUMMARY OF INTERFACE SOLUTIONS

Below is a summary of interface solutions available for EL displays.

Most of the solutions for 4 bit interfaces would work for 1 or 2 bit interfaces by ignoring unused bits if care was taken during software development to insert null data into the unused bit locations.

The following list is not exhaustive and other solutions exist. Also note that most of these solutions have not been verified by Planar.

1. Embedded Controller ICs

Epson S1D13705 (supports 1, 2, 4, and 8 bit interface products and FA3)
    The S1D13705 is a controller IC that can display text and graphics. The IC interfaces to a microprocessor or PC I/O via a standard 8 bit Intel 8080 or Motorola 6800 bus. The IC can display layered text and graphics, scroll the display in any direction and partition the display into multiple screens. It also stores text, character codes and bit-mapped graphics data in external frame buffer memory.
http://www.epson.jp/device/semicon_e/product/lcd_controllers/index.htm

Epson S1D13700 (supports 4 bit interface products and FA3)
    The S1D13706 is a controller IC that can display text and graphics on both monochrome and color displays. The IC interfaces to a microprocessor or PC I/O via a standard 8 bit Intel 8080 or Motorola 6800 bus.
http://www.epson.jp/device/semicon_e/product/lcd_controllers/index.htm

RAiO RA8835 (supports 4 bit interface products)
  Designed as a drop-in replacement for the now obsolete Epson S1D13305 and similar to the S1D13700 and S1D13705, the RA8835 is a controller IC that can display text and graphics and interfaces to a microprocessor via a standard 8 bit bus. (See the note at the end of this paper for a discussion of a RA8835 discrepancy.)
http://www.raio.com.tw/E%20version/e_product.8835.htm

Asiliant 65545 (supports 1, 4, and 8 bit interface products)
  Formerly made by Chips and Technologies, this IC interfaces to a PCI, VL, or ISA bus and provides full text and graphics control.
http://www.asiliant.com/products.htm

<u>Amulet Technologies AGB64LV01-QC</u> (supports 1, 2, and 4 bit interfaces)

A combination 8 bit microprocessor, flat panel controller, and graphics library. Comes with software for easy display programming and easy conversion of HTML, JPEG and TIF formats into flat panel images. Controlled via an RS232 interface. Note: Amulet's GUI is available as an IP block for use in Atmel's CAP7 ARM processors; also see Amulet's offering in the video board section below.
http://www.amulettechnologies.com/products/chips.html

2. Embedded Microprocessors with on-board Controller

<u>Cirrus Logic EP7312</u> (supports 4 bit interface products)

The Cirrus Logic EP7312 is a microprocessor designed for ultra-low-power portable and line-powered applications such as portable consumer entertainment devices. The core-logic functionality of the device is built around an ARM720T processor with 8 Kbytes of four-way set-associative unified cache and a write buffer.
http://www.cirrus.com/en/products/pro/detail/P139.html

<u>Sharp LH7A404</u> (supports 4 and 8 bit interface products)

The LH7A404 microprocessor, powered by an ARM922T, is a complete System-on-a-Chip that satisfies the performance and integration requirements of emerging internet- and multimedia-centric applications.
http://www.sharpsma.com/Page.aspx/americas/en/part/LH7A404/

<u>Sharp LH79520</u> (supports 1 and 4 bit interface products and FA3)
The LH79520 microprocessor, powered by an ARM7, is a complete System-on-a-Chip that contains an on board Flat Panel Controller.
http://document.sharpsma.com/files/LH79520_AN_interfacing.pdf

<u>Freescale MPC823E</u> (supports 4 bit interface products and FA3)
The MPC823E contains dual processors—a PowerPC core and a communications processor integrated in the same IC—and has a builit-in display controller and a variety of interfaces including USB and Ethernet.
http://www.freescale.com/webapp/sps/site/prod_summary.jsp?nodeId=0162468r
H3bTdGJk194204&code=MPC823E

3. Video Boards

Amulet Technologies CB-GT570 (supports 1, 2, and 4 bit interface products)
This is a video card that has an RS232 interface. Comes with software for easy display programming and easy conversion of HTML, JPEG, and TIF formats into flat panel images. Has a built-in 4 wire resistive touch screen controller.
http://www.amulettechnologies.com/pdf/_brochure_ds/cbgt570.pdf

Alpha Point AP988300 (supports 1 bit and feature connector interface products)
This is a single board RS232/RS485 flat panel display controller.
http://www.alpha.fi/products/EL_products/ap988300/index_eng.shtml

Reach SLCD (supports 4 bit interface products and FA3)
This controller board provides a complete Graphical User Interface for embedded systems. The input to the SLCD is RS232 or CMOS level inputs.
http://www.reachtech.com/display/slcd.html

Advanced Digital Logic MSMVGA-LCD104 (supports 1, 4, and 8 bit products)
Uses a C&T 65545 controller IC built into a PC/104 form factor board. Interface to the board is a PC/104 8 or 16 bit bus.
http://www.adlogic-pc104.com/products/peripherals/datasheets/msmvga.pdf

Digital View ALR-1400 (supports FA3)
Converts analog VGA or DVI video into flat panel digital video.
http://www.digitalview.com/controllers/products.php

Earth LCD CNT-EV-AD2 (supports FA3)
Converts analog VGA video into flat panel digital video.
http://store.earthlcd.com/CNT-EV-AD2-CNTEVAD2

Octagon 5420 (supports 1, 2, 4, and 8 bit interface products)
This is a video card that connects to an old-style ISA bus and can drive both analog VGA and Planar EL products.
http://www.octagonsystems.com/products/5420.aspx

4. SBCs and PC/104 Solutions

WinSystems PCM-FPVGA (supports 4 and 8 bit interface products and FA3)

      The PCM-FPVGA from WinSystems is a PC/104 video module containing a C&T 65545 controller. WinSystems provides kits that include adapter boards to interface directly to many Planar EL displays.

http://pc104.winsystems.com/products/pc104/pcmfpvga.html

Advantech PCM-3370 (supports 8 bit interface products and FA3)

      The PCM-3370 from Advantech is a PC/104-Plus CPU module. Note that the VIA Twister T chipset used for the PCM-3370 will no longer be available in 2008. Advantech's support for this product is unknown.

http://www.advantech.com/products/Model_Detail.asp?model_id=1-FFT6C

RTD Embedded Technologies CM110HR (4 and 8 bit products, AA1, FA3)

      The CM110HR is a PC/104 video module that uses a C&T 65545 controller and supports a variety of Planar displays.

http://www.rtd.com/PC104/UM/video/cm110.htm

F&S Electronic Systems NetDCU3 (supports FA3)

      The CM110HR is an SBC with a 66 MHz PowerPC and a flat panel digital output.

http://www.fs-net.de/Home_Eng/Products/NetDCU/netdcu.html

VersaLogic VSBC-6 (supports 1, 4, and 8 bit products)

      The VSBC-6 is an SBC based on a 266 MHz Pentium processor with flat panel support using an Asiliant 6550 controller.

http://www.versalogic.com/Products/DS.asp?ProductID=75

Applied Data Systems BitsyXb (supports 1, 4, and 8 bit products)

      The BitsyXb is an SBC based on a Marvell PXA270 processor which has flat panel support. Demo kits are available which drive most of Planar's EL displays.

http://www.applieddata.net/SBC/BitsyXb.asp

5. Miscellaneous Solutions

LVDS to EL interface (supports 4 and 8 bit interface products)
Able Design has developed an LVDS to EL interface card which supports Planar's 4 bit and 8 bit EL displays. The interface card converts 4 channel LVDS video data into the data format required by Planar's EL displays.
http://www.able-design.de/

Planar's EL Development Kit
Consists of a video board, EL display, cabling, and 12V AC/DC converter. Can be used in demo mode to display bmp files when connected to a PC's parallel port, or can be used in engineering mode with the engineer's microprocessor or I/O card communicating with the on-board Epson S1D13700 controller. Kits are available for the following EL display families: EL160.80.50, EL160.120.39, EL240.128.45, EL320.240.36, EL320.240.36 HB, EL640.200 SK.

ASIC solution
Some Planar customers have developed embedded proprietary ASICs to drive their EL display. This solution is engineering intensive and requires relatively high volumes in order to justify the cost of the ASIC design.

E. INTERFACE CONSIDERATIONS

The brightness of an EL display is directly proportional to the frame rate at which the panel is driven. In most EL products (those without a frame buffer) the panel frame rate is the same as the VS frequency. Thus for maximum brightness, the implementer must take care to select a solution that can provide a VS frequency near the specified maximum frame rate. See the EL product's manual for maximum frame rate.

Some displays have frame buffers that allow high panel frame rates—and thus high brightness—regardless of the input VS frequency. The following models have frame buffers (thus for these models the brightness is not related to VS frequency): EL320.240.36 HB, EL320.240 FA3, EL640.200 SK (4 bit mode only), EL240.128.45, and EL640.480 AA1.

A potential side effect with frame buffers occurs when the incoming pixel data has been frame dithered or spatially dithered in order to provide gray scale functionality. (Some video controllers can generate limited gray scale on monochrome displays by either moving a pixel around periodically [spatial dithering] or by turning the pixel on only during a portion of the active frames [frame dithering.]) The asynchronous relationship between the frame buffer and

the gray scale dithering scheme can cause objectionable visual artifacts such as flicker.

Note that gray scales generated by frame dithering can cause visual artifacts even on displays that do not contain frame buffers. Typically the user can generate two or three levels of gray scale via frame dithering without significant visual artifacts, depending on the frame rate. With higher display frame rates, the visual artifacts are less severe. Also, avoiding large blocks of gray scale areas will make the visual artifacts more tolerable.

F. NOTE on RAiO RA8835

Though designed as a drop-in replacement for the now obsolete Epson S1D13305, the RA8835 exhibits a timing anomaly: the first 3 clock widths on the XSCL (VCLK) are shorter than the rest: e.g., only 100ns long before changing to 200ns-300ns (see Figure 1 below). This created a timing issue on a test display such that the first few sets of data were not displayed. Slower Vclk rates or different register parameters may be required to allow the RA8835 to be used without side effects.
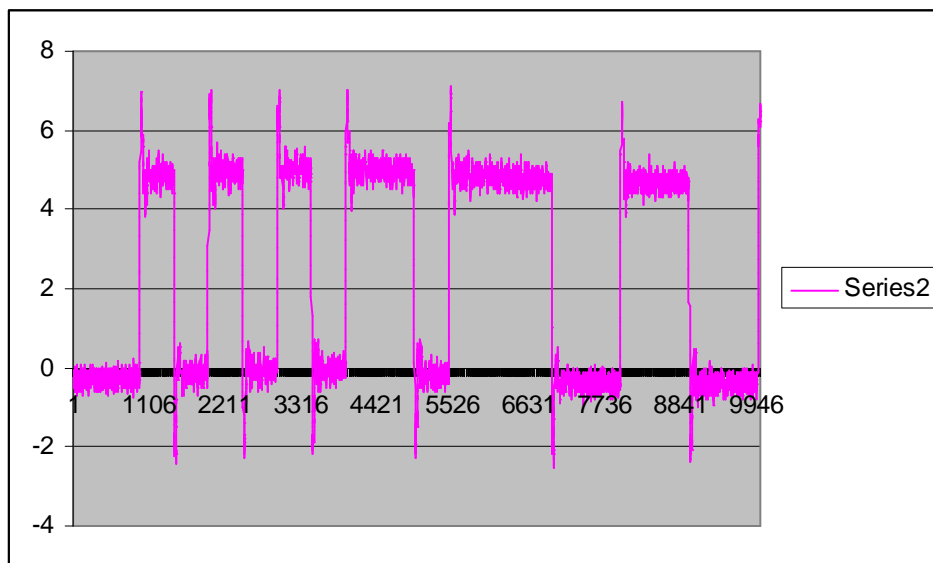
Figure 1—RA8835 VCLK at start of

If improving the timing is not effective it is also possible to fill the first 3 sets of data with null data and increase the horizontal pixel count by 12.

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