WHITE PAPER

AMD Alchemy™ Au1200™ Processor LCD Controller

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Abstract

The AMD Alchemy™ Au1200™ processor LCD display controller delivers new technology that offers design flexibility and application scalability to the developers of portable multimedia devices and other consumer electronics devices such as cellular phones. The LCD controller provides developers with full 32-bit RGB/alpha capabilities in each of four prioritized overlay windows that require no frame buffer modification to reposition; gamma correction for matching video displays with graphics; a global background color that aesthetically unifies display panel contents while helping to minimize processing demands; a four-color alpha-capable hardware cursor; and an 8-Kbit palette RAM frame buffer that is well-suited to display information in portable device sleep modes.

Overview

As multimedia capabilities increase in the consumer electronics market, the demand for improved conventional LCD controllers grows. Dependable, flexible, and robust graphics/video display capabilities are crucial to both the utility and aesthetic appeal of portable electronics devices.

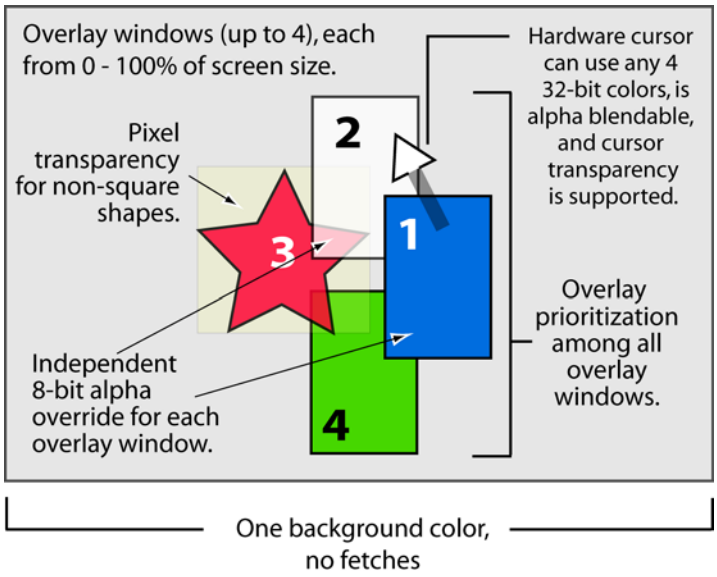
The Au1200™ processor on-chip LCD controller represents new thinking about display characteristics and capabilities. LCD controllers typically use a single frame buffer to render the entire screen image. In view of the diverse needs of developers, this monolithic scheme has been abandoned, and in its place an entirely new LCD controller has been created with characteristics that contribute to the versatility of the Au1200 processor.

Au1200™ Processor LCD Controller Characteristics

By providing four discrete overlay windows and one dedicated background color, this new LCD controller lends its superior capabilities to the most modest of display devices or to the most intense demands of high-quality personal media players (PMPs) and other multimedia-rich products.

Each of the four overlay window features independent 8-bit alpha override; priority assignment in relation to other overlay windows; unprecedented fluidity in window x/y repositioning - accomplished with one register write, and double buffering support. The single background color eliminates repeated memory fetches that would normally be required to fill a potentially large area of the display, and is instead accomplished with a single write operation.

Figure 1. LCD Controller Display Characteristics



The LCD controller also provides a 32x32 four-color user-defined hardware cursor that supports alpha fades and transparency, as shown in Figure 1.

LCD Panel Compatibility

The 32-bit LCD controller in the Au1200 processor is capable of driving both active (TFT) and passive (STN) LCD panels through multiplexed signal pins. Color palette support is accomplished with an on-chip 256 entry 24-bit palette. TFT 24-bit mode allows display of up to 1,777,721 simultaneous colors. The controller drives a wide array of LCD panels, encompassing industry standard one 8-bit gray scale or four 24-bit color by implementing user-programmable vertical and horizontal synchronization signals, bias signals and pixel clock rates.

The controller performs basic memory-based frame buffer to LCD panel data transfer using a dedicated DMA controller with double buffering support. A variety of frame buffer formats, independent of LCD panels, are supported, including those listed in Table 1.

Table 1. AU1200™ Processor LCD Controller Frame Buffer Formats

Description	Memory Width	Format
1bpp	1	I:1
2bpp	2	I:2
4bpp	4	I:4
8bpp	8	I:8
16bpp (5/6/5)	16	R:5 G:6 R:5
24bpp (0/8/8/8)	32	P:8 R:8 G:8 B:8
32bpp w/ alpha (8/8/8/8)	32	a:8 R:8 G:8 B:8

I - Intensity, P - padding, R - red, B - blue, G - green, a - alpha

The controller will support 32-bit input formats, and supports LCD RGB/alpha operation. Usability of the Au1200™ processor has been maintained for lower-end applications by providing spatio-temporal dithering (frame rate modulation) that supports the still-popular STN type LCD panels.

When used with external video sources, the LCD controller accepts external clock signals from devices like TV tuner chips, to support video sync of source data, such as NTSC or PAL.

Window Manipulation

Visibility of each overlay window for display effects can be achieved with less code and less processing power. The LCD controller allows displayed images to be faded in/out via an 8-bit-per-window alpha blend, without having to write display change information for an entire frame buffer. Instead, the 8-bit alpha value in the overlay window's register controls these window characteristics.

Gamma Correction

The brightness of displayed video in relation to displayed graphics can be easily modulated by the on-chip gamma correction features of the LCD controller.

Mini Frame Buffer / Palette RAM

The LCD controller provides developers with a mini on-chip frame buffer (8192 bits) that is scalable by a factor of 2 or 4. The mini on-chip frame buffer can be employed when power conservation is paramount, delivering useful display information even when the chip is in low power/sleep mode. For example, using the mini frame buffer, an LCD panel could display time or reminder message information even in a handheld electronic device’s inactive mode.

Use Models

Employing four separately prioritized overlay windows each capable of alpha fades, the ability of this LCD controller to render display information is limited only by the developer's imagination. The LCD controller offers other superior features. Because it is integrated seamlessly with the Media Acceleration Engine and a core processor that is unburdened by software transcoding, it can render high-quality D1 video while displaying user interface controls that exhibit quick response characteristics.

Example: Wide Screen Video

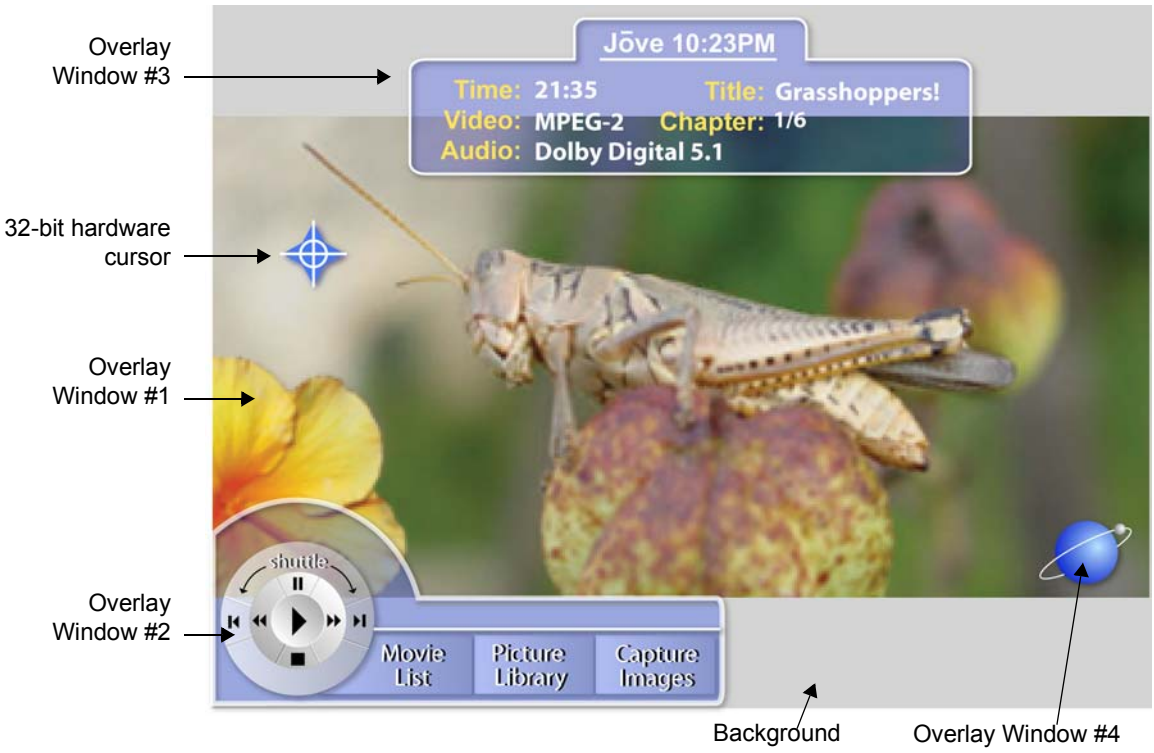
Figure 2. LCD Controller design helps reduce system workloads.

Figure 2 represents an 800x600 screen size with the background color set to dark gray. Because this full screen background color requires no fetches to memory, this new LCD controller design immediately reduces system workload for this display by 33%.

Example: Wide Screen Video and U/I Playback Controls

Figure 3 represents the same 800x600 screen size. Separate overlay windows display: an MPEG2 movie; system status information; a user interface panel; and the manufacturer's insignia. The hardware cursor appears at top left. Its visibility status can be set to override all overlay windows, and cursor transparency is supported.

Figure 3. LCD Controller Use Model: PMP Movie With Playback Controls



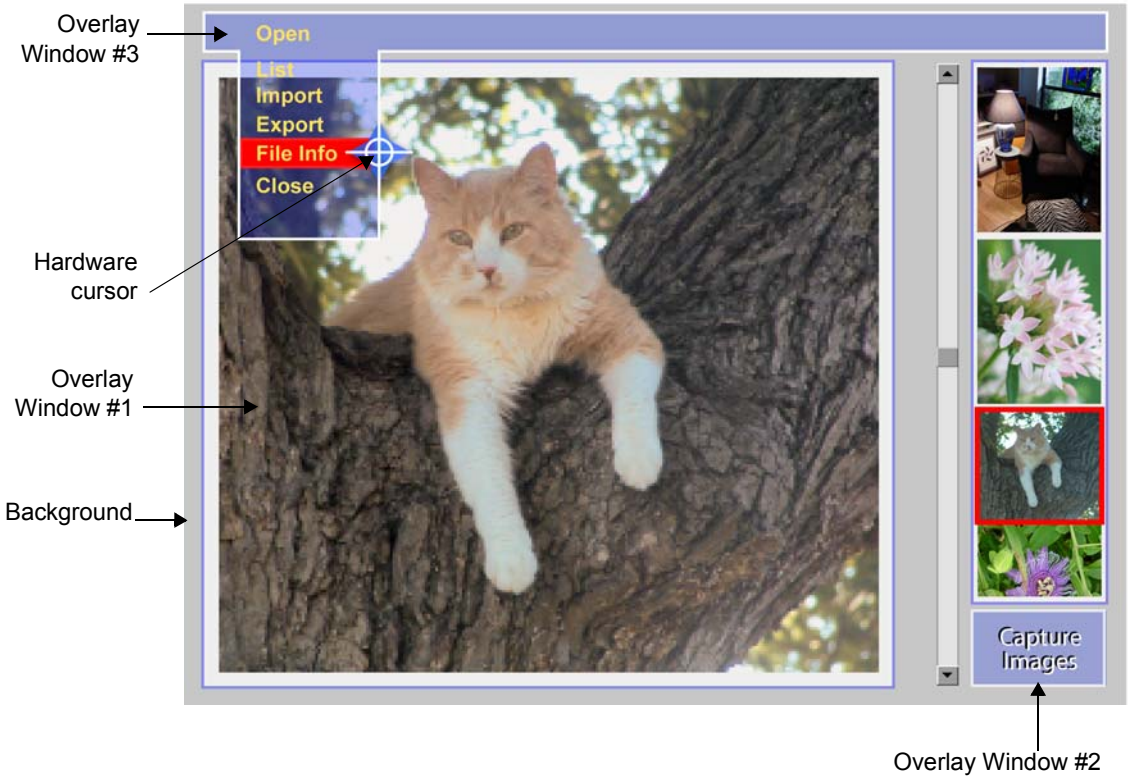
- The Background (gray areas) is set once, and requires no further fetches to memory.
- Overlay Window #1 is dedicated to the 16:9 format 800x400 video that is fed by the Media Acceleration Engine to the LCD controller, with very little work done by the core.
- Overlay Window #2 shows a popup user interface control panel, alpha-faded. Its overlay visibility status is prioritized over the Background and Overlay Window #1 (movie panel).
- Overlay Window #3 contains status information displayed in alpha-faded transparency. It overlays window #1 and the Background.

- Overlay Window #4 displays the manufacturer's insignia as a transparency, assigned visibility status so that it overlays the lower right-hand corner of Overlay Window #1.

Example: Basic Media Player Photo Browser Interface

Figure 4 represents an image browser displayed on a full LCD screen (800x600). The gray Background color uses the 24-bit color stored in the screen background register of the LCD Controller. In this example, Overlay Window #1 is used to display images stored in this personal media player use model. Overlay Window #2 contains a scrolling list of thumbnail images. Overlay Window #3 contains a function menu. The x/y origin of each overlay window can be moved anywhere on the screen with one write to that window's register.

Figure 4. LCD Controller Use Model: Image Browser



Example: On-chip Frame Buffer

This picture represents the idle state for a PMP that has an alarm clock feature. The LCD controller's palette RAM can also be used as a small on-chip frame buffer to display a small image (in this example, the alarm time) so that it does not have to continuously be fetched from memory. The palette RAM size is small, 8192 bits, but provides continuously-displayed information at serviceable resolutions. This use of palette RAM supports LCD displays during very low power states. Further sizing flexibility is built in with the overlay window scaling feature: larger image sizes can be achieved by employing built-in x and y scaling by factors of 2 or 4.

Figure 5. Palette RAM makes displays available during low power states.