AMD Alchemy™ Au1200™ Camera Interface Module

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Abstract

The industry impetus to add image acquisition functions to portable consumer electronics devices is rising, and the relatively low cost and low power consumption of CMOS and CCD image sensors will remain attractive imaging solutions for the foreseeable future. These devices require a specific interface for sourcing their data streams to embedded processing/display environments that users expect – increasingly – to be portable.

The low-power, high-performance AMD Alchemy™ Au1200™ processor provides an on-chip Camera Interface Module (CIM) with an 8-, 9-, or 10-bit data bus for glueless connection to a variety of image data sources, primarily CMOS/CCD image sensors and CCIR 656 data streams.

On-chip image processing from the CIM is accomplished via a hardware Media Acceleration Engine that relieves the MIPS32™ core of virtually all image processing loads. The MAE performs autonomous handling of raw image data streams (including Bayer pattern demosaic of CMOS/CCD data routed to the innovative on-chip LCD display controller), and all image scaling and color-space conversions.

The CIM enables developers to offer PMP (personal media player) products that are endowed with image acquisition features such as still-image “target-and-capture” functions, and input, processing, and display of NTSC/PAL data – at minimal cost.

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Introduction

The ability to capture digital still pictures is a feature that consumers often expect in hand-held electronic media players and communications devices. AMD Alchemy engineers have designed a Camera Interface Module (CIM) that is fully integrated with the image processing capabilities of the Au1200 processor and provides access to low-cost image acquisition features that enjoy a significant market interest.

The CIM will typically connect off-the-shelf, inexpensive CMOS or CCD image sensors to the Au1200™ processor using an 8-, 9-, or 10-bit parallel interface. The data source must provide horizontal and vertical synchronization signals for capturing the data.

The CIM can also interface with NTSC or PAL data sources that use CCIR656 signaling. In this case, the frame and line sync controls are to be embedded within the data stream using header words. This allows for a reduced pincount design and less board-level routing.

The CIM also provides for the input of raw data.

CIM Features

- Supports several industry standard CMOS/CCD interfaces
- 8-, 9-, or 10-bit parallel data bus
- Supports external Pixel Clock rates up to 33MHz
- Supports data capture using horizontal and vertical line syncs
  - Available GPIOs for additional control signals
- Supports data capture using embedded Start of Active Video (SAV) and End of Active Video (EAV)
- Support for both packed (RAW) and planar data formats
- Three 16 x 32-bit FIFOs
- Leverages LCD controller hardware and MAE scaling/filtering and color space conversion:
  - Hardware-based Bayer pattern demosaic for CCD/CMOS data
  - Hardware-based scaling and filtering for all image display data
  - Hardware-based color space conversion for all image display data

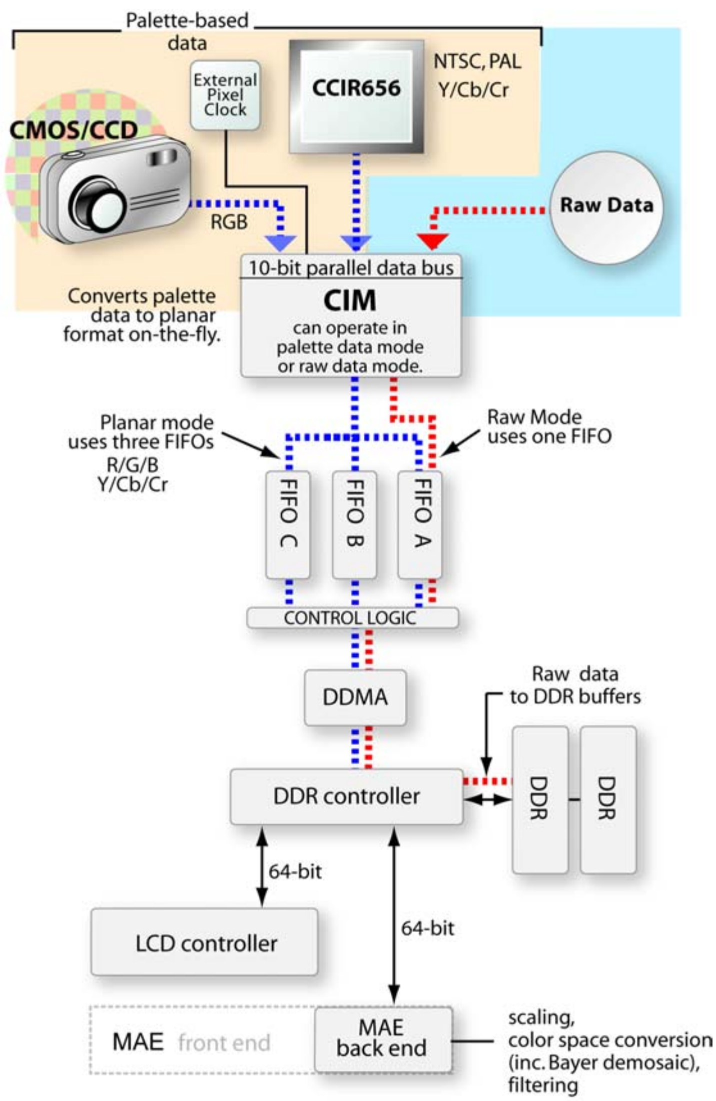
Because digital image source size impacts the entire image sensor solution, the CIM is designed to support any frame size that can be captured with a 33MHz maximum pixel clock rate.

Operating Modes

The CIM operates in either one of two modes to provide flexible interfacing with different sources of image data.

- In ***Planar*** mode, the CIM formats the data in planar RGB or YCbCr, then writes color component data into three corresponding FIFOs.
- *Raw* mode allows raw data to be written without any formatting. Data is written to a single FIFO.

Figure 1. CIM Data Flow Diagram



Planar Mode

Planar mode supports Bayer and YCbCr input data streams. It reformats the data from its packed input format into three planar output streams, one stream for each color component.

The process of planarizing palette data streamlines further processing of color space information in Media Acceleration Engine hardware. This reformatting step eliminates core processing loads for color space conversion.

- **Bayer Demosaic**

  Because the CIM will receive image data packaged in a Bayer mosaic pattern from most CMOS and CCD image sensors, the CIM can be configured to reformat Bayer pattern RGB data into planar format so the on-chip Media Acceleration Engine can demosaic the data stream for the LCD controller. This automated step frees developers from the need to write additional code for handling demosaic processes.

- **YCbCr Data**

  YCbCr data received from sources such as analog NTSC/PAL signals can also be reformatted as planar data, to take advantage of the scaling/filtering capabilities of the Media Acceleration Engine.

Raw Mode

Any digital stream can be written in raw format directly to memory. A single FIFO buffer is available for raw data caching. No data formatting or processing takes place. In this mode the data captured on the interface is written out without any modifications.

MAE Backend Support

For more information about the MAE, or the LCD Controller see their respective sections in this white paper suite.

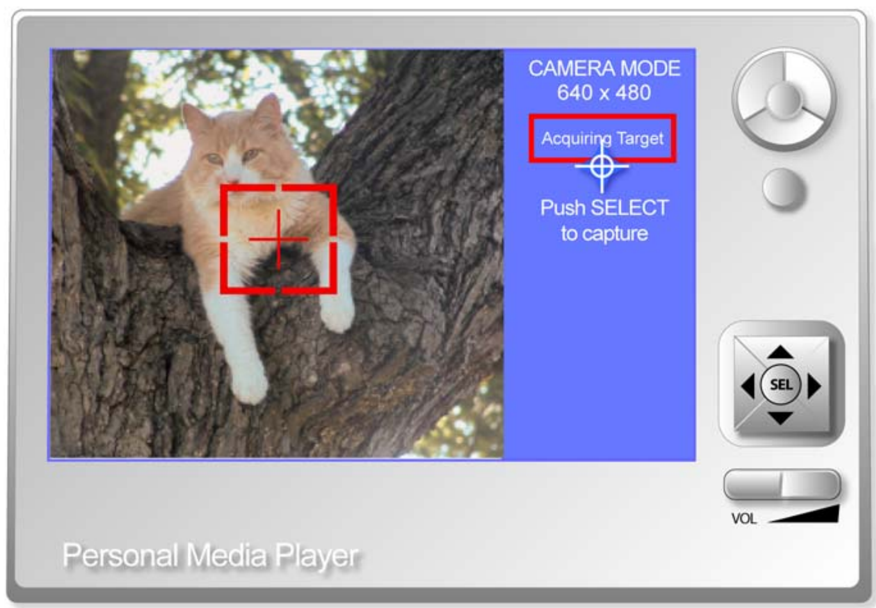
The Media Acceleration Engine (MAE) back end can be used for scaling, filtering and color space conversion of the planar data that is output from the CIM. This includes YCbCr planar, YCbCr 422 packed, and Bayer planar data formats. The scaling and color space conversion processes take place in the MAE back end hardware without adding any significant load to the core. Scaling and color space conversion processes produce RGB display data that can be output via the LCD controller overlay windows.

PMP Still Capture / Target Acquisition

In this Camera Interface Module use model, a PMP features a “point-and-click” still camera, using data input from a CMOS image sensor housed in the player. Two separate CIM operations support this feature:

- First, to enable the user to capture the desired image, a target acquisition feature displays image data received from a CMOS sensor source. The CIM planaraizes the data in 8-bit mode for the MAE back end, where data is scaled, filtered, and converted to RGB color space data that is displayed in the LCD panel. Users will appreciate the high frame rates that the Au1200 processor supports for this feature.
- Second, when the user presses the “capture” button, the CIM is configured to capture the current frame of data. This data is written to memory where it can be converted to a format (JPEG, etc.) for storage (for example, an IDE drive).

Figure 2. Personal Media Player with CIM-based Image Ccapture.



Because the CIM is capable of handling large image sizes, in most handheld display applications the incoming image will be scaled down to the resolution of the handheld screen size. This characteristic can be exploited in a variety of similar use models.

PMP with NTSC/PAL Feature

An NTSC or PAL image source can gluelessly connect with the CIM. Because the Au1200 processor is designed to be the heart of a personal media player, hardware designers may want to offer consumers the ability to view analog TV.

This could be accomplished by including a TV tuner chip in the PMP design - or to design the player to accept NTSC/PAL signals via a data source that is external to the PMP. Either instance will require use of an external pixel clock.

Figure 3. PMP with NTSC/PAL TV Tuner

Analog TV data must first be converted from YCbCr color space to RGB color space. The CIM can convert YCbCr data to planar format on the fly, and utilize the color space conversion and display scaling abilities of the MAE back end hardware at up to 30 fps, depending on image source size and display frame size.