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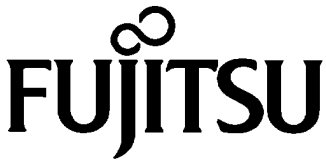
MB86296S <CORAL PA>

PCI Graphics Controller Specification

Revision 1.1

25 September, 2007



<Notes>

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⚠ CAUTION	Burns	There is a danger of burns because the IC surface is heated depending on the IC operating conditions. In this case, take safety measures.

Update history

Date	Version	Page count	Change
28.2.2005	1.0	346	First edition
25.9.2007	1.1	356	Correct MMR Register (RAW > SAW) and some lingual improvements

CONTENTS

1. GENERAL

1.1 Preface

The MB86296S <CORAL-PA> is a graphics controller with a PCI host interface.

Note:

This device has a I^2C interface. Purchase of Fujitsu I^2C components conveys a license under the Philips I^2C Patent Right to use these components in an I^2C system, provided that the system conforms to the I^2C Standard Specification as defined by Philips.

1.2 Features

- Geometry Engine

  The Geometry Engine supports the geometry processing that is basically compatible**1 with ORCHID (MB86292). Display lists generated for ORCHID can be processed. Extensive geometric operation processing such as coordinate conversions or clipping which normally load the CPU dramatically can be reduced using the Geometry Engine. **1 (Floating point setup command is changed or deleted. G_BeginCont command is deleted. GMDR0 CF&DF table mapping is changed ... etc)

- 2D and 3D Drawing

  MB86296's drawing functionality is compatible to the CREMSON (MB86290A). It can draw data using the display lists created for CREMSON (however internal texture RAM is deleted).

  The MB86296 also supports 3D rendering, such as texture mapping with perspective correction and Gouraud shading, alpha blending and anti-aliasing for drawing smooth lines.

- Digital video capture

  The digital video capture function can store digital video data such as TV images in graphics memory; it can display drawn images and video images on the same screen.

- Display controller

  The MB86296 has a display controller that is compatible with ORCHID.

  In addition to the traditional XGA (1024 × 768 pixels) display, 4-layer overlay, left/right split display, wrap-around scrolling, double buffers, and translucent display, 6-layer overlay functionality, 4-siding for palette are expanded.

- Host CPU interface

  The MB86296 has a 32 bit, 33MHz PCI interface fully compliant to PCI version 2.1.

- External memory interface

  SDRAM and FCRAM can be connected.

- Optional function

  Final device can be selected from the combination of geometry high-/low-speed version and video capture function provided/ not provided.

- Others

  CMOS technology 0.18μm

  BGA256 Package

  Supply voltage:1.8 V (internal operation) /3.3 V (I/O)

  Current consumption (TYPICAL)

  1.8 V : 500mA

  3.3 V : 100mA

1.3 Block Diagram

The CORAL-PA general block diagram is shown below:

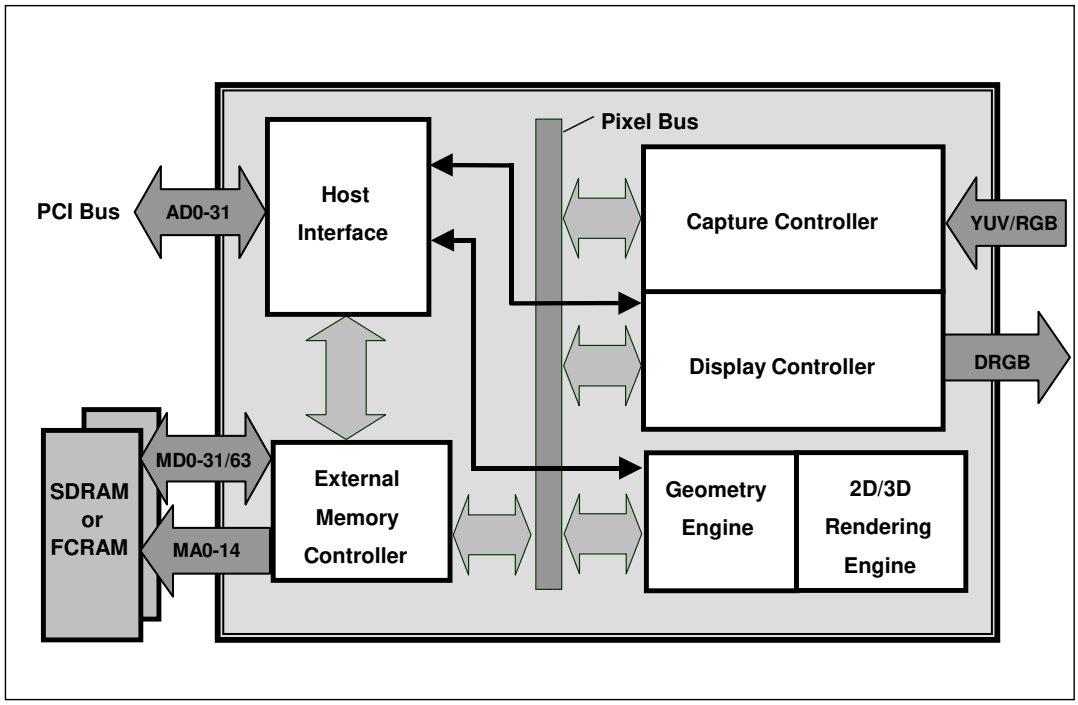


Fig.1.1 CORAL-PA Block Diagram

1.4 Functional Overview

1.4.1 Host CPU interface

Supported CPU

The MB86296 can be connected to any CPU with a 33MHz 32-bit PCI v2.1 host interface.

Configuration

EEPROM configuration supported

Serial interface for external device control through PCI interface

PCI Slave

Supports burst reads/writes of up to 8 double words (32 bytes).

Supports multi-burst transfers with automatic pre-fetch.

PCI Master

Supports transfers of up to 2^{24}-1 double words in bursts of between 1 and 8 double words.

Supports all combinations of transfer (PCI->PCI, PCI->Internal, Internal->PCI)

Host notification on burst complete and/or transfer complete

Optional external burst initiation control

Internal DMA

Supports transfers of up to 2^{24}-1 double words in bursts of between 1 and 8 double words.

Interrupt

Vertical (frame) synchronous detection

Field synchronous detection

External synchronous error detection

Register update

Drawing command error

Drawing command execution end

Burst/Transfer complete

1.4.2 External memory interface

SDRAM or FCRAM can be connected.

64 bits or 32 bits can be selected for data bus.

Max. 133 MHz is available for operating frequency.

Connectable memory configuration is as shown below.

External Memory Configuration

Type	Data bus width	Use count	Total capacity
FCRAM 16 Mbits (x16 Bits)	32 Bits	2	4 Mbytes
SDRAM 64 Mbits (x32 Bits)	32 Bits	1	8 Mbytes
SDRAM 64 Mbits (x32 Bits)	64 Bits	2	16 Mbytes
SDRAM 64 Mbits (x16 Bits)	32 Bits	2	16 Mbytes
SDRAM 128 Mbits (x32 Bits)	32 Bits	1	16 Mbytes
SDRAM 128 Mbits (x32 Bits)	64 Bits	2	32 Mbytes
SDRAM 128 Mbits (x16 Bits)	32 Bits	2	32 Mbytes
SDRAM 256 Mbits (x16 Bits)	32 Bits	2	64 Mbytes

1.4.3 Display controller

Video data output

Analog RGB video output is provided as well as 8-bit digital video output is provided. When selecting each 8 bits output, usable external memory bus width is 32 bits only.

Screen resolution

LCD panels with wide range of resolutions are supported by using a programmable timing generator as follows:

Screen Resolutions

Resolutions
1024 × 768
1024 × 600
800 × 600
854 × 480
640 × 480
480 × 234
400 × 234
320 × 234

Hardware cursor

MB86296S supports two hardware cursor functions. Each of these hardware cursors is specified as a 64 × 64-pixel area. Each pixel of these hardware cursors is 8 bits and uses the same look-up table as indirect color mode.

Double buffer method

The double buffer method in which drawing window and display window is switched in units of 1 frame enables the smooth animation.

Flipping (switching of display window area) is performed in synchronization with the vertical blanking period using program.

Scroll method

Independent setting of drawing and display windows and their starting position enables the smooth scrolling.

Display colors

- Supports indirect color mode which uses the look-up table (color palette) in 8 bits/pixels.
- Entry for look-up table (color palette) corresponds to color code for 8 bits, in other words, 256. Color data is each 6 bits of RGB. Consequently, 256 colors can be displayed out of 260,000 colors.
- Supports direct color mode which specifies RGB with 16 bits/pixels.
- Supports direct color mode which specifies RGB with 24 bits/pixels.

Overlay

Compatibility mode

Up to four extra layers (C, W, M and B) can be displayed overlaid.

The overlay position for the hardware cursors is above/below the top layer (C).

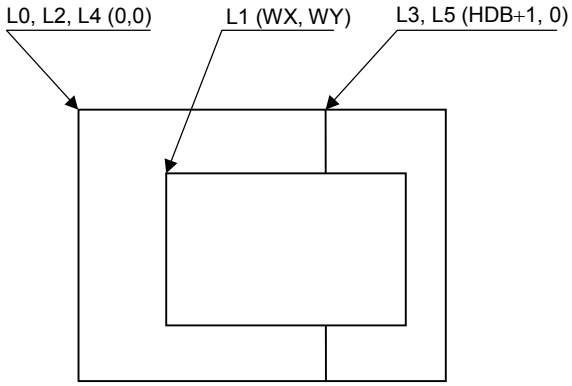
The transparent mode or the blend mode can be selected for overlay.

The M- and B-layers can be split into separate windows.

Window display can be performed for the W-layer.

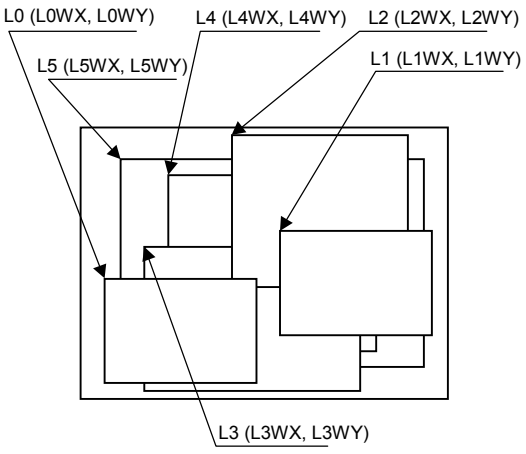
Two palettes are provided: C-layer and M-/B-layer.

The W-layer is used as the video input layer.



Window mode

- Up to six screens (L0 to 5) can be displayed overlaid.
- The overlay sequence of the L0- to L5-layers can be changed arbitrarily.
- The overlay position for the hardware cursors is above/below the L0-layer.
- The transparent mode or the blend mode can be selected for overlay.
- The L5-layer can be used as the blend coefficient plane (8 bits/pixel).
- Window display can be performed for all layers.
- Four palettes corresponded to L0 to 3 are provided.
- The L1-layer is used as the video input layer.
- Background color display is supported in window display for all layers.



1.4.4 Video capture function

Video input

- The input format is either ITU RBT-656 or RGB666.
- Video data is stored in graphics memory once and then displayed on the screen in synchronization with the display scan.

Scaling

- A scale-up factor 1 to 2 can be used. PAL or NTSC images can be displayed on a wide screen.
- A scale-down factor 1 to 1/32 can be used.
- Picture-in-picture can be used to display drawn images and video images on the same screen.

1.4.5 Geometry processing

The MB86296 has a geometry engine for performing the numerical operations required for graphics processing. The geometry engine uses the floating-point format for highly precise operations. It selects the required geometry processing according to the set drawing mode and primitive type and executes processing to the final drawing.

Primitives

Point, line, line strip, independent triangle, triangle strip, triangle fan, and arbitrary polygon are supported.

MVP Transformation

MVP Transformation

Setting a 4 × 4 transformation matrix enables transformation of a 3D model view projection. Two-dimensional affine transformation is also possible.

Clipping

Clipping stops drawing of figures outside the window (field of view). Polygons (including concave shapes) can also be clipped.

Culling

Backfacing triangles are not drawn.

3D-2D Transformation

This function transforms 3D coordinates (normalization) into 2D coordinates in orthogonal or perspective projections.

View port transformation

This function transforms normalized 2D coordinates into drawing (device) coordinates.

Primitive setup

This function automatically performs a variety of slope computations, etc., based on transforming vertex data into coordinates and prepares for rendering (setup).

Log output of device coordinates

The view port conversion results are output to the local memory.

1.4.6 2D Drawing

2D Primitives

MB86296S can perform 2D drawing for graphics memory (drawing plane) in direct color mode or indirect color mode.

Wide bold lines and broken lines can be drawn. Smooth diagonal lines can also be drawn using anti-aliasing.

A triangle can be tiled in a single color or 2D pattern (tiling) or mapped with a texture pattern by specifying coordinates of the 2D pattern at each vertex (texture mapping). With texture mapping, drawing/non-drawing can be set in pixel units. Moreover, transparent processing can be performed using alpha blending. When drawing in single color or tiling without Gouraud shading or texture mapping, high-speed 2DLine and high-speed 2DTriangle functions can be used. Only vertex coordinates are set for these primitives. High-speed 2DTriangle is also used to draw polygons.

2D Primitives

Primitive type	Description
Point	Plots point
Line	Draws line
Bold line strip (provisional name)	Draws continuous bold line This primitive is used when interpolating the bold line joint.
Triangle	Draws triangle
High-speed 2DLine	Draws lines Compared to line, this reduces the host CPU processing load.
Arbitrary polygon	Draws arbitrary closed polygon containing concave shapes consisting of vertices

Arbitrary polygon drawing

Using this function, arbitrary closed polygons containing concave shapes consisting of vertices can be drawn (there is no restriction on the count of vertices, however, polygons with crossing sides are not supported.) In this case, a polygon drawing flag buffer is used on the graphics memory, as a work area for drawing. When drawing polygons, draw the triangles for the polygon drawing flag buffer using high-speed 2DTriangle. Decide on any vertex as a starting point to draw the triangle along the edge. You can draw the final polygon form in a single color or with tiling or with texture mapping in a drawing frame.

BLT/Rectangle drawing

This function draws a rectangle using logic operations. It is used to draw pattern and copy the image pattern within the drawing frame. It is also used for clearing drawing frame and Z buffer.

BLT Attributes

Attribute	Description
Raster operation	Selects two source logical operation mode
Transparent processing	Performs BLT without drawing pixel consistent with the transparent color.
Alpha blending	The alpha map and source in the memory is subjected to alpha blending and then copied to the destination.

Pattern (Text) drawing

This function draws a binary pattern (text) in a specified color.

Pattern (Text) Drawing Attributes

Attribute	Description
Enlarge	Vertically × 2 Horizontally × 2 Vertically and Horizontally × 2
Shrink	Vertically × 1/2 Horizontally 1/2 Vertically and Horizontally 1/2

Drawing clipping

This function sets a rectangle frame in drawing frame to prohibit the drawing of the outside the frame.

1.4.7 3D Drawing

3D Primitives

This function draws 3D objects in drawing memory in the direct color mode.

3D Primitives

Primitive	Description
Point	Plots 3D point
Line	Draws 3D line
Triangle	Draws 3D triangle
Arbitrary polygon	Draws arbitrary closed polygon containing concave shapes consisting of vertexes

3D Drawing attributes

Texture mapping with bi-linear filtering/automatic perspective correction and Gouraud shading provides high-quality realistic 3D drawing. A built-in texture mapping unit performs fast pixel calculations. This unit also delivers color blending between the shading color and texture color.

Hidden plane management

MB86296S supports the Z buffer for hidden plane management.

1.4.8 Special effects

Anti-aliasing

Anti-aliasing manipulates line borders of polygons in sub-pixel units and blend the pre-drawing pixel color with color to make the jaggies be seen smooth. It is used as a functional option for 2D drawing (in direct color mode only).

Bold line and broken line drawing

This function draws lines of a specific width and a broken line.

Line Drawing Attributes

Attribute	Description
Line width	Selectable from 1 to 32 pixels
Broken line	Set by 32 bit or 24 bit of broken line pattern

- Supports the verticality of starting and ending points.
- Supports the verticality of broken line pattern.
- Interpolation of bold line joint supports the following modes:

  (1) Broken line pattern reference address fix mode

  → The same broken line pattern is kept referencing for the period of some pixels starting from the joint and the starting point for the next line.

  (2) No interpolation
- Supports the equalization of the width of bold lines.
- Supports the bold line edging.
- Not support the Anti-aliasing of dashed line patterns.
- For a part overlaid due to connection of bold lines, natural overlay can be represented by providing depth information. (Z value).

Shading

Supports the shading primitive.

Drawing is performed to the body primitive coordinates (X, Y) with an offset as a shade. At this drawing, the Z buffer is used in order to differentiate between the body and shade.

Alpha blending

Alpha blending blends two image colors to provide a transparent effect. CORAL supports two types of blending; blending two different colors at drawing, and blending overlay planes at display. Transparent color is not used for these blending options.

There are two ways of specifying alpha blending for drawing:

(1) Set a transparent coefficient to the register; the transparent coefficient is applied for transparency processing of one plane.

(2) Set a transparent coefficient for each vertex of the plane; as with Gouraud shading, the transparent coefficient is linear-interpolated to perform transparent processing in pixel units.

In addition to the above, the following settings can be performed at texture mapping. When the most significant bit of each texture cell is 1, drawing or transparency can be set. When the most significant bit of each texture cell is 0, non-drawing can be set.

Alpha Blending

Type	Description
Drawing	Transparent ratio set in particular register
	While one primitive (polygon, pattern, etc.), being drawn, registered transparent ratio applied
	A transparent coefficient set for each vertex. A linear-interpolated transparent coefficient applied.
	This is possible only in direct color mode.
Overlay display	Blends top layer pixel color with lower layer pixel color
	Transparent coefficient set in particular register
	Registered transparent coefficient applied during one frame scan

Gouraud Shading

Gouraud shading can be used in the direct color mode to provide 3D object real shading and color gradation.

Gray Scale Gouraud Shading

Gray scale gouraud shading can be used in the in-direct color mode to draw a blend coefficient layer.

Texture mapping

MB86296 supports texture mapping to map a image pattern onto the surface of plane. For 2D pattern texture mapping, MB86296 has a built-in pattern memory for a field of up to 64 × 64 pixels (at 16-bit color), which performs high-speed texture mapping. The texture pattern can also be laid out in the graphics memory. In this case, max. 4096 × 4096 pixels can be used.

Drawing of 8-/16-bit direct color is supported for the texture pattern. For drawing 8-bit direct color, only point sampling can be specified for texture interpolation; only decal can be specified for the blend mode.

Texture Mapping

Function	Description
Filtering	Point sample Bi-linear filter
Coordinates correction	Linear Perspective
Blend	Decal Modulate Stencil
Alpha blend	Normal Stencil Stencil alpha
Wrap	Repeat Cramp Border

1.4.9 Others

Top-left rule non-applicable mode

In addition to the top-left rule applicable mode in which the triangle borders are compatible with CREMSON, the top-left rule non-applicable mode can be used.

Caution: Use perspective correct mode when use texture at the top-left rule non-applicable mode.

Top-left rule non-applicable primitives cannot use Geometry clip function.

Non-top-left-part's pixel quality is less than body. (using approximate calculation)