

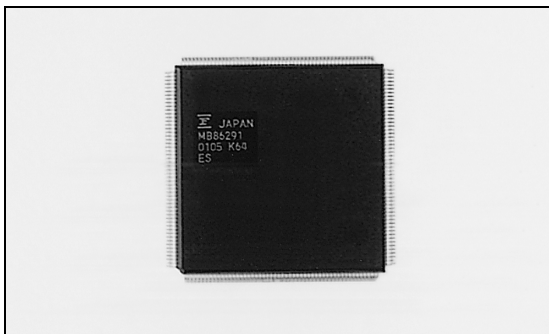
# Graphics Display Controllers: MB86291/MB86292

*MB86291/MB86292 are graphics display controllers that have digital video capture functions and geometry processors. They perform numeric graphical calculations on a graphics LSI instead of a host MPU, greatly enhancing embedded system performance.*

## Features

- **Embedded geometry processor**
- **Digital video input/output function**
- **Embedded SDRAM (MB86291)**
- **Connect to FCRAM (MB86292)**
- **Upwardly compatible to the MB86290A**
- **Device driver for WindowsCE® available**

**Photo 1. MB86291/MB86292 External View**



## Product Overview

In recent years, automotive navigation systems have progressed from simple map displays to information terminals that must process a variety of external information in real time. The resulting load on the host system MPU has increased tremendously.

Now FUJITSU has developed the MB86291 and MB86292 graphics controller LSIs, which relieve the burden on the host MPU by shifting the processing of map data and polar coordinate processing of polygons from the host MPU to the graphics LSI. In addition, the MB86291 and MB86292 provide rendering capability far superior to the MB86290A.

## Product Features

Table 1 (see p. 48) lists the principal specifications, and Figure 1 (see p. 47) shows the block diagram.

The principal features of the MB86291 and MB86292 are as follows:

### *Embedded Geometry Processor*

A geometry processor provides graphical operation, such as model-view projection conversion, clipping operations, etc. This greatly reduces numeric computation for graphics processing that otherwise would be a major load on the CPU of an embedded system.

### *Digital Video Capture Function*

Digital video images from TV or other sources can be captured in graphic memory. This makes it possible to display graphic

**“... display graphic images and video images on the same screen.”**

images and video images on the same screen (Picture in Picture).

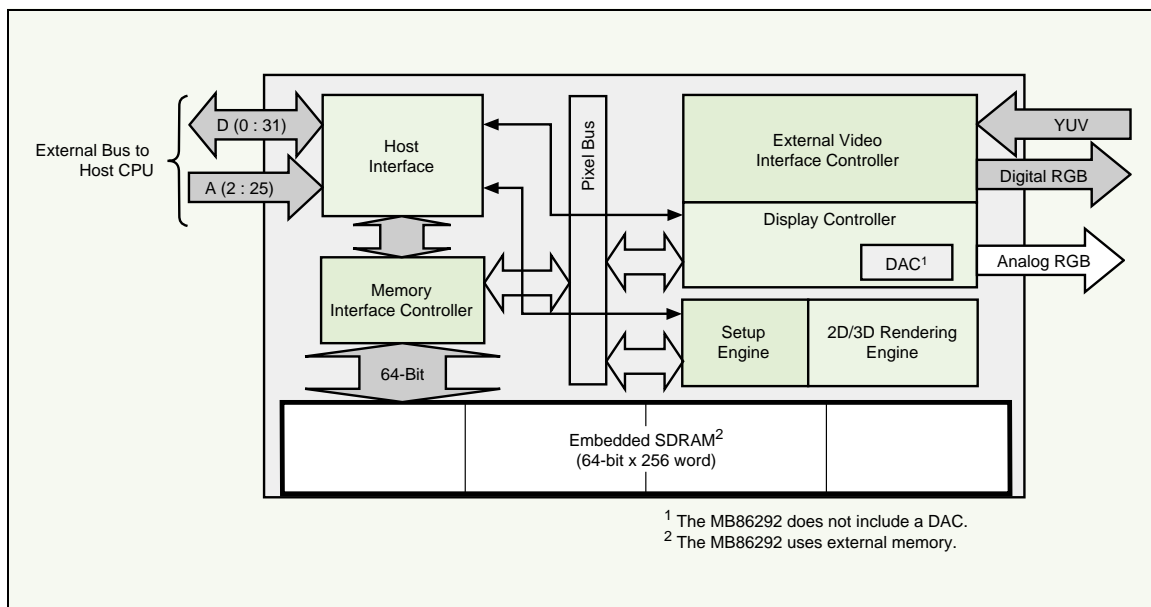
### *Embedded Graphics Memory (MB86291 only) or FCRAM (MB86292 only)*

The MB86291 has 16 M-bit embedded SDRAM to accelerate memory access, normally the bottleneck in graphic drawing. The MB86292 can be connected to an FCRAM with high-speed latency for memory page miss events. Both protect against loss of efficiency in drawing functions due to the shape of graphics and provide high-speed drawing processing.

### *Embedded Host Interface Functions for Many CPUs*

The MB86291 and MB86292 can connect directly without external circuits to the external bus of a variety of CPUs, including the FUJITSU SPARClite, Hitachi SH3/4, and NEC V832. This conserves mounting area and component parts and simplifies system design.

**Figure 1. MB86291/MB86292 Internal Block Diagram**



**Table 1. MB86291/MB86292 Principal Specifications**

Internal Operating Frequency	100.24 MHz (external input clock frequency 14.32 MHz)
Operating Voltage	2.5 ± 0.2V, I/O 3.3 ± 0.3V
Package	MB86291: 208-Pin Plastic HQFP (lead pitch 0.5 mm) MB86292: 256-Pin Plastic HQFP (lead pitch 0.4 mm)
Technology	CMOS 0.25 µm
Video Output	MB86291: 8-Bit, Digital RGB, Analog RGB MB86292: 5 or 8-Bit, Digital RGB

### *Accelerated Primitive Commands and Special Effects Functions*

The MB86291 and MB86292 have the primitive drawing commands of the MB86290A and upwardly compatible models. Like the MB86290A, the MB86291 and MB86292 provide a variety of built-in special effects functions that produce smooth, realistic drawing of two-dimensional and three-dimensional displays. The drawing capacity of this variety of special effects functions combines with the improved memory access methods and drawing methods to allow rendering at many times the speed of the MB86290A. The following special effects are provided:

- **Anti-aliasing:**  
A technique to make the borders of lines smooth, which blends the line edge color and its neighboring back plane pixel colors and shades over the jagged appearance of the line border.
- **Alpha blending:**  
A transparent effect produced by blending two colors. The MB86291/MB86292 provide two types of built-in alpha blending functions: rendering and overlay.
- **Gouraud shading:**  
A rendering method that produces gradual color shading.
- **Texture mapping with bilinear filtering:**  
A method of texture mapping. At each pixel plot, according to the coordinate of that pixel

position, the four nearest texture points are sampled and their colors are blended to calculate the texture color.

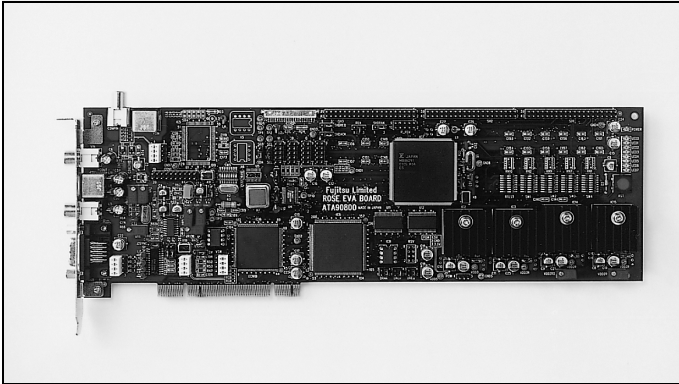
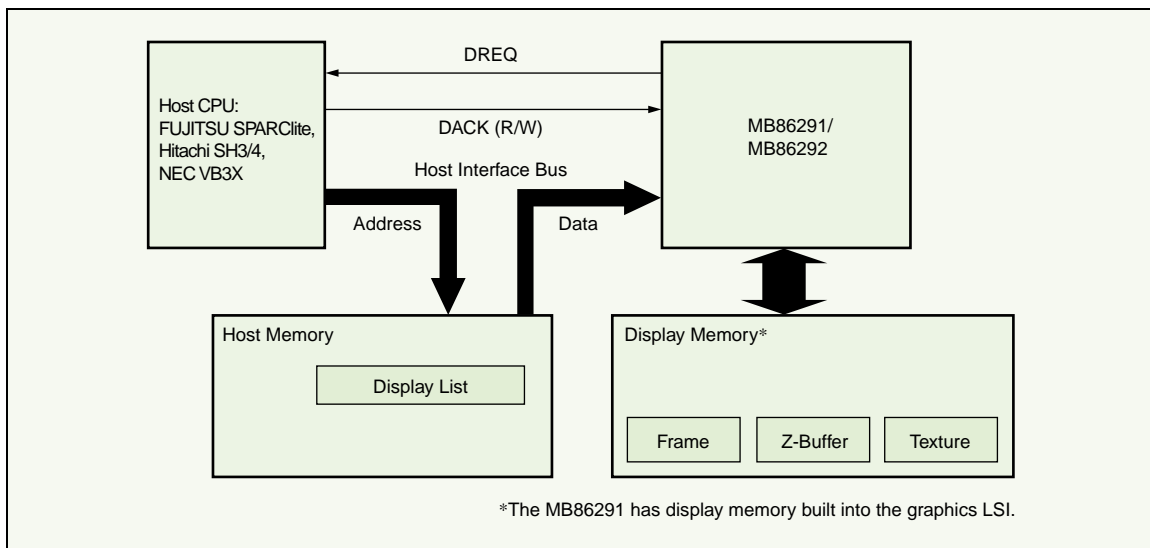
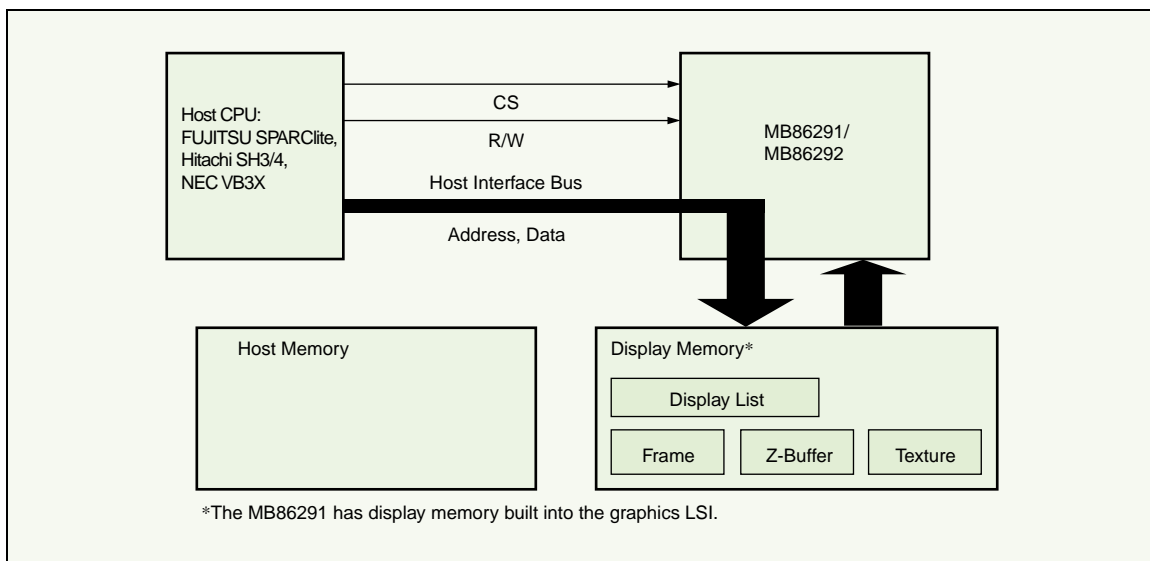
- **Texture mapping with perspective correction:**  
A rendering method of texture mapping that corrects distortions in depth. This enables distortion-free sketching of 3-D objects.
- **Tiling:**  
A rendering method to read color information for certain tile patterns.

### *Z-Buffer for Hidden Surface Elimination*

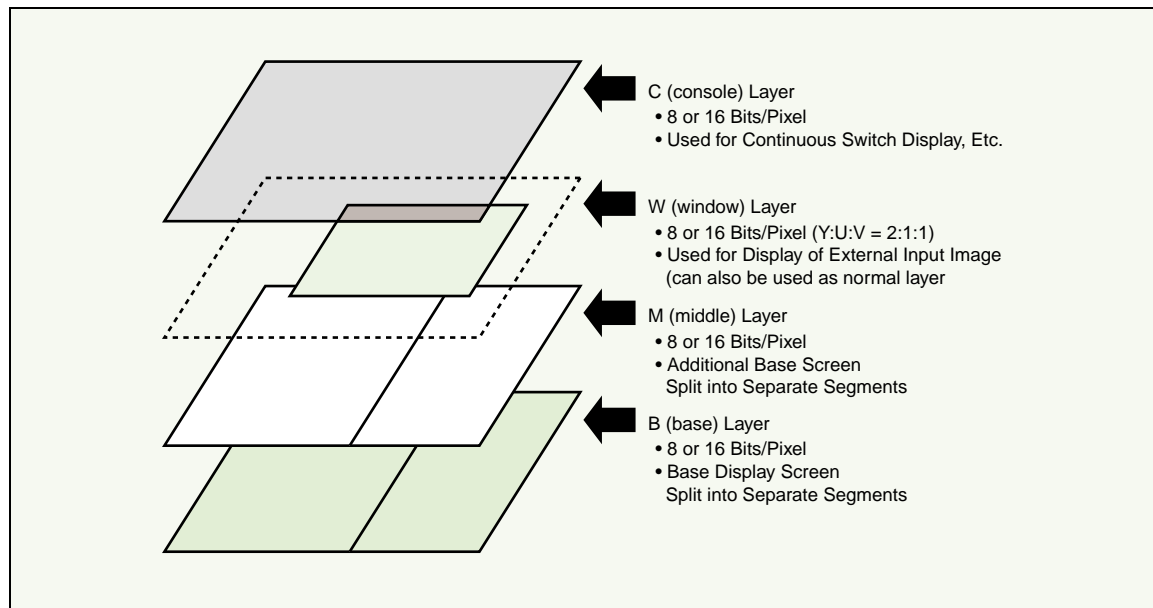
The MB86291/MB86292 support the Z-buffer algorithm for hidden surface elimination. The Z-value of a pixel to be rendered is compared to a Z-value previously written in the Z-buffer, and a draw/not draw judgment is performed. This uses graphics memory as a Z-buffer and requires an area equivalent to a frame of two bytes per pixel.

### *Enables Data Transfer Compatible with a Variety of System Functions*

The MB86291 and MB86292 perform graphics processing using a set of instructions sent from the CPU to built-in FIFO memory with a set of draw command parameters (display list) appended. The display list enables data transfer by read/write access from the CPU program as well as data transfer using the CPU's built-in DMA controller (Figure 2 on p. 49).

**Photo 2. MB86291 Board****Figure 2. Combination with Host CPU (with display list on host memory)****Figure 3. Combination with Host CPU (with display list on MB86291/MB86292)**

**Figure 4. Hierarchical Configuration of Display Screen**



Also, the CPU provides display lists in graphic memory that can be automatically loaded and executed by the MB86291/MB86292 (Figure 3 on p. 49).

This feature enables the CPU bus to be used more efficiently by the system, enhancing overall system performance.

#### *Four-Layer Image Overlay Display*

Figure 4 shows a hierarchical overlay of display images.

The MB86291 and MB86292 enable overlay of four images. In addition, the lower two images can be divided into independent left and right displays. This enables easy configuration of display systems, such as automotive navigation systems that show, for example, a two-dimensional map on the left and a three-dimensional map on the right side of the screen.

#### *Handles Display Resolution up to 1,024 x 768 Pixels*

The display resolution is flexible, with a range of 320 x 200 to 1,024 x 768.

## Evaluation and Development Environment

A development toolkit for evaluation and software development is provided, including graphics driver software and reference board. The board can be connected to various CPU evaluation boards to create a stand-alone built-in system. It also can be connected to a PC with WindowsNT®. The source program of the graphics driver is available for license to allow it to be re-configured for use in a variety of embedded applications.

### Use with WindowsCE for Automotive® Applications

A device driver has been developed to take advantage of the draw accelerator functions of the MB86291/MB86292. It is used with the GDIsub expansion driver of the WindowsCE for Automotive® operating system, which was developed for embedded automotive applications. This enables rapid evaluation and development on a variety of system platforms, without involving the use of a host CPU.

### Facilitates Creation of Full-Scale Graphics Images

Data conversion software and graphics libraries have been developed to allow graphics data created on a PC using commercial three-dimensional modeling software to be placed on a CPU and displayed on an MB86290 Series graphics LSI. This makes it easy to produce embedded systems for full-scale graphics display.

## Future Development

The MB86291 and MB86292 are expected to be succeeded by enhanced versions with even faster drawing capability, as well as rendering functions optimized for various applications. FUJITSU plans to develop graphics system LSIs to meet market requirements for a new generation of multimedia integrated framework systems, not only for automotive information devices, but also digital AV and portable terminal products. These devices will simplify the system by incorporating video/audio decoder and drawing functions into products with low power consumption.

Figure 5 shows a roadmap of FUJITSU graphics display controllers. ◆

### Endnote

WindowsNT and WindowsCE are registered trademarks of Microsoft Corporation in the United States and/or other countries.

**Figure 5. Roadmap of FUJITSU Graphics Display Controllers**

