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Fujitsu Graphics Display Controllers

Product and Technology Overview



Introduction

The Fujitsu Graphics Display Controllers (GDCs) offer a unique blend of functionality that merges two popular graphics-based technologies into a single device, improving efficiency and performance.

Specifically, the Fujitsu GDCs combine powerful 2D/3D Graphics Processing Units (GPUs) with Fujitsu's advanced Display Controller Unites (DCU) capability. DCUs provide a highly efficient, cost-effective way to generate graphics to display and animate recurring content such as menus, messages, and icons. Offloading this function to the display controller frees up memory and the GPU for rendering-based tasks.

Fujitsu has been developing DCU technology for more than 20 years. Current implementations drive up to four high-resolution displays simultaneously, manage up to four video-capture ports, and blend up to eight layers of graphics and video data.

Although the roots of Fujitsu's DCU and GPU technology are in consumer and desktop-gaming applications respectively, the current lineup of GDC products is designed for the harsh

automotive environment. All devices meet a minimum temperature range of -40 to $+85$ degree C, and many are rated for -40 to $+105$ degree C. The devices meet AEC-Q100 and ISO/TS-16949 requirements, and the DO-178B avionics certification is available through Fujitsu partner companies. Moreover, all devices must meet the auto industry's requirement that the products be available for 10 years. Of course non-automotive users can take advantage of the long lifecycle.

At the core of the Fujitsu GDCs is a powerful graphics engine capable of rendering realistic 2D and 3D graphics to screen sizes up to 1600×1200 , while consuming only two to three watts of power under normal conditions, and up to four watts in the most extreme scenarios. Fujitsu employs these specific design targets to eliminate the need for secondary cooling aids. Even heat sinks are not required.

Add to the mix the many special features – such as direct and palletized color, video capture and scaling, multiple display layers, and a variety of alpha options – and it's clear the Fujitsu GDCs have no equal in the embedded market.

Layers

Fujitsu GDCs feature a layered display structure providing six to eight separate frame buffer layers. Each layer is capable of managing unique content that can be rendered, captured from one or more video sources, blitted from a bitmap library, or a combination of these options. These functions are carried out in the display controller block where the processing has little or no impact on the GPU, which might be simultaneously processing the rendering. At least four of the layers have separate color palettes, which are set up to draw using 8-bit pallet registers. Each layer is independent, so some layers can be configured for palletized color while others can be set for 16-bit-per-pixel direct-color mode. Layers can have a uniform transparency setting with a range of 256 levels. At least one layer will provide pixel-level transparency settings to produce special effects such as a roving spotlight on a navigation map.

In addition to the layer alpha settings, an alpha mask option can be applied to bitmaps and fonts alike. When the mask is applied to a font or bitmap, both are blitted to a layer in one simple step. The effect is one of edge smoothing or anti-aliasing as the edges of the source bitmap or font are blended to the layer or layers below. When the alpha mask is combined with RGB with alpha, layer level and pixel-level alpha, the possibilities for special effects increase significantly.

Video Capture



Example 2D/3D Instrument Cluster

The ITU-656 or RGB-format video-capture port displays the images from perimeter cameras as well as accepts and displays video content. Because the GDC is a graphics processor, the captured content can be handled as a texture and then mapped to polygons for special effects, such as with Fujitsu's 360-degree Wrap-Around Video Image Technology. That technology maps the images captured from four cameras onto a circular polygon mesh to display a virtual, full-surround image.

Unique Features

As described earlier, Fujitsu GDC products are unique in that they incorporate a GPU and an equally powerful display controller that gives users a high degree of flexibility in how graphics are processed and displayed. Fujitsu also incorporates many special features designed specifically for high reliability applications. For example, the Fujitsu Signature Unit (SU) is a special hardware

function designed to add a level of safety to certain applications. Occasionally, incorrect memory reads or writes can result in images being shifted or put in the wrong place. The SU will perform a checksum on specific critical content to ensure the images are displayed in the right place. This eliminates the possibility, for example, that a warning light would be hidden behind other graphics or placed completely out of view.

SOC Versus Standalone GDCs

There are two basic categories of Fujitsu GDCs: stand-alone and System on Chip (SoC). Historically, Fujitsu has first developed a stand-alone GDC and then integrated the core into a SoC. The benefit of the stand-alone architecture relates primarily to memory bandwidth. In SoCs, the internal processor and GDC share the single external memory bus. Stand-alone GDCs have their own dedicated memory and are not limited by other internal bottlenecks characteristic of SoC designs. However, as process geometries shrink and circuit-switching speeds improve, the internal bandwidth limitations of SoC design are being neutralized when compared with multi-chip stand-alone options.

GDC Families

Fujitsu currently has five GDC families, each of which can feature up to three variations.

MB88F332 "Indigo" Series: This sprite-based, non-rendering GDC includes many peripheral-support functions such as backlight control, an advanced sound generator, and six stepper motor controls. The MB88F332 "Indigo" features on-chip memory in the form of 160KB of NOR Flash and 128 KB of SRAM. The MB88F332 "Indigo" device supports up to 512 bitmaps, making it capable of acting as a stand-alone GDC in applications that require only animated bitmaps. The recently released MB88F333 "Indigo-L" device is a lower cost addition to the series. It supports two stepper motors and is packaged in a smaller 176 LQFP package.

The MB88F33x "Indigo" Series can also be configured to work with an advanced controller such as Fujitsu's MB86R02 "Jade-D." This pseudo master/slave configuration is possible owing to the inclusion of APIX®, the high-speed serial interface that supports both bi-directional communications. The two-chip setup enables a broader variety of configurations that can reduce costs.

MB91590 "Sapphire": This SOC device is based on Fujitsu's high-performance FR81S CPU core (which offers the highest performance level in the industry). MB91590 "Sapphire" integrates a version of the MB88F332 "Indigo" sprite core and external video-capture capabilities, including both analog (NTSC/PAL) and digital (RGB and BT656) support. An on-chip video memory makes MB91590 "Sapphire" a fully self-contained, single-chip solution for applications that require robust color display and video-input capabilities. The device is particularly well-suited for use in automotive instrument clusters and center consoles

using color displays to generate flexible and intuitive driver interfaces. MB91590 "Sapphire" supports simple line drawing for more dynamic graphic requirements, and also supports dual LCD displays.

MB86R0x "Jade" Series: This product family is based on the 330MHz ARM®926 core and the Fujitsu MB8629x "Coral" GDC core, which supports 2D and full 3D rendering. The MB86R01 is designed for high-end, high-volume embedded automotive graphics applications such as on-board navigation systems, graphical dashboard systems, head-up display (HUD) units and rear-seat entertainment systems. The three "Jade" variants – MB86R01 "Jade," MB86R02 "Jade-D," and MB86R03 "Jade-L" – support different peripheral sets. All MB86R0x "Jade" devices provide dual-display support, video capture and DDR2 interfaces.

MB86298 "Ruby": This stand-alone GDC functions as a high-performance graphics co-processor when coupled to any PCIe-enabled CPU. The MB86298 "Ruby" supports Open GL 2.0 shader-based operations for 3D. Its highly specialized 2D engine provides the high level of efficiency so important in embedded environments. The co-processor configuration means the GDC has higher performance than comparable SOC-based GDCs. The MB86298 "Ruby" supports four video-capture ports and drives up to four high-resolution displays.

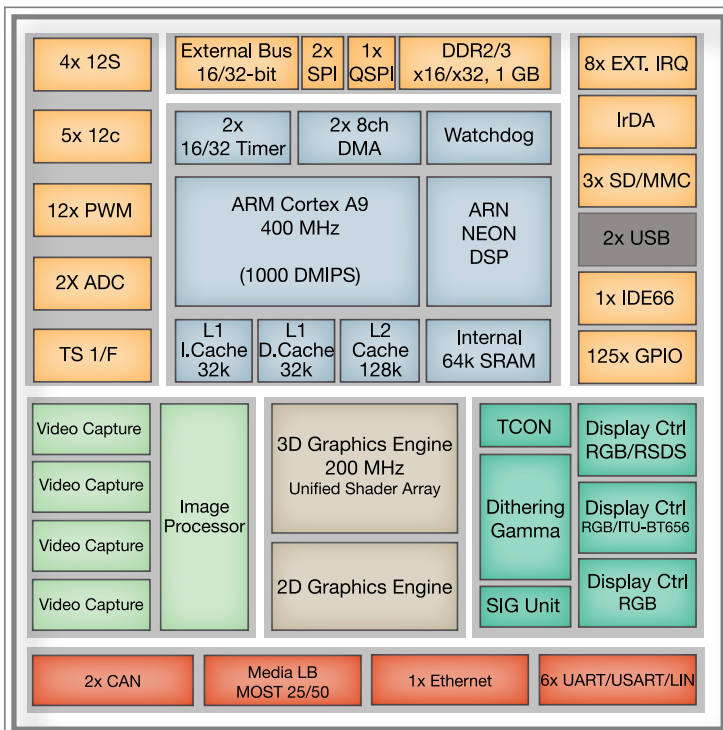
MB86R1x "Emerald" Series: The first device in Fujitsu's current flagship SoC product family is the MB86R11 "Emerald-L" featuring an ARM Cortex A9 processor operating at 400 MHz

(1000 DMIPs) plus an enhanced "Ruby" graphics core. A DDR3 memory controller ensures high throughput and optimal graphics performance. MB86R11 "Emerald-L" features a variety of popular peripherals such as a USB and Flash controller. The SoC supports four video-capture ports and three display controllers. A dithering unit and ARM Neon DSP core help enhance images and manage certain audio-video processing. To enable advanced graphical content, the MB86R11 "Emerald-L" DDR 2/3 controller can access up to 1GB of memory.

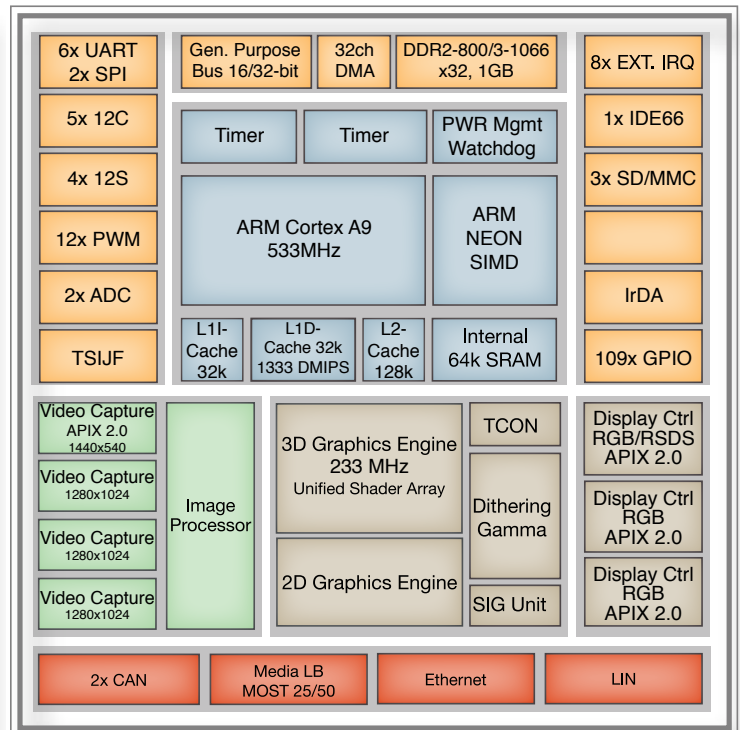
MB86R12 "Emerald-P" is a higher-performance addition to the "Emerald" Series, featuring an ARM Cortex A9 processor operating at 533 MHz (1333 DMIPs) and a 266MHz graphics core. In addition, the MB86R12 "Emerald-P" device includes four high-speed APIX 2.0 ports – three output and one input. (Note: USB was removed from MB86R12 "Emerald-P" to make room for the APIX interfaces.) The device is rated for an -40 to +105 degree C operating range.

The MB86R1x "Emerald" Series integrates support for the new Fujitsu 360-degree Wrap-Around Video Imaging Technology. This revolutionary around-the-car camera system provides a complete view of a vehicle's perimeter, in real time. The new driver-assistance technology adapts to different driving situations, enabling the driver to peripherally view the entire surroundings of a vehicle, from the most appropriate point of view and field of view. The technology improves safety by helping the driver in a variety of situations, such as parking, passing and turning.

MB86R11 Emerald-L



MB86R12 Emerald-P



Conclusion

Fujitsu has been active in the embedded graphics market for more than 10 years and in the graphics space for nearly 20. The company is committed to bringing the most advanced GDCs to market and to making those products available for an extended period of time (many times longer than is required for PC or desktop graphics chips).

Moreover, Fujitsu optimizes its products for embedded applications that require support for multiple, higher resolution display panels. The Fujitsu GDCs strike the right balance between performance and power, and between features and cost.

More information is available on the Fujitsu GDC website at: <http://www.fujitsu.com/us/services/edevices/microelectronics/gdc/index.html>

Product	Description	Embedded Processor
MB88F33x "Indigo" Series	Sprite-based GDC with an APIX interface designed to be used in conjunction with "Jade D" or "MB86R1x" Emerald Series	No
MB86298 "Ruby"	Stand-alone, Open GL-ES 2.0-based GDC that supports both 2D and 3D	No
MB91590 "Sapphire" Series	"Indigo" core plus Fujitsu Automotive MCU (CAN 3ch, SMC 6ch, ADC 32ch, LIN/UART/SIO), on-chip VRAM and Flash (Multiple versions of "Sapphire" are available. They are differentiated by the amount of on-chip memory.)	Fujitsu FR81S
MB86R03 "Jade -L"	2D/ 3D, USB, DDR2, dual display/single capture	ARM926E
MB86R01 "Jade"	"Jade L" features plus USB, Media LB, IDE66	ARM926E
MB86R02 "Jade-D"	"Jade" plus an APIX (USB, IDE removed) dithering unit added to the display controller	ARM926E
MB86R11 "Emerald-L"	"Ruby" GDC core plus new PixBlt engine for enhanced 2D processing. Four video-capture ports, with the ability to drive five displays.	Cortex A9
MB86R12 "Emerald-P"	Faster CPU (533 MHz) and graphics core (266MHz). Four high-speed APIX 2.0 ports – three outputs and one input. Rated for an -40 to +105 degree C operating range	Cortex A9

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 Printed in the U.S.A. GDC-PB-21389-05/2011