MULTIMEDIA SOLUTIONS

DVB/MPEG-2 & GRAPHIC CONTROLLER PRODUCTS

PRODUCT OVERVIEW
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INTRODUCING
BUSINESS UNIT MULTIMEDIA

Fujitsu Microelectronics Europe’s Business Unit Multimedia, based at the company’s headquarters near Frankfurt, Germany, offers customers advanced multimedia products for digital TV and set-top boxes as well as graphic display controllers for such applications as car navigation, mobile terminals and industrial applications.

In addition to the range of products offered by the Business Unit Multimedia, an experienced support & development team is in place to work closely with customers on their multimedia systems projects.

Fujitsu Microelectronics Europe is a major supplier of semiconductor products to the European and global market. The company’s main business focus is on providing systems solutions to the multimedia, networking/telecommunications, mobile communications, and automotive markets.

Fujitsu offers a broad range of semiconductor devices, including telecommunications ICs, RF devices, MPEG encoders & decoders, microcontrollers, graphic display controllers, microprocessors and FCRAM™. The company is also a leader in colour plasma display panels.
At the heart of Fujitsu’s Business Unit Multimedia is its development centre in Frankfurt, which designs and supports semiconductor multimedia solutions, calling on the skills and expertise located in other Fujitsu design centres in Europe. The MPEG-2 decoder for digital television, SmartMPEG, was designed here, a complete API library was created, reference designs are available and customers are using it successfully in their digital TV products, such as set-top boxes. The SmartMPEG is the third generation MPEG-2 decoder for set-top box applications and is especially designed to reduce system cost of the end-product.

A Fujitsu API software library is available, which enables the customers a fast and easy implementation of the SmartMPEG into their products. The Centre has a set of resources on call, for both hardware and software development. The support group assists customers to design-in multimedia components into their end-products.

The following components are offered from the Business Unit Multimedia:

- Single-package front-end solutions for digital satellite television
- MPEG-2 decoders for set-top box applications
- Single-chip MPEG-2 encoders including audio encoders, video encoders & system multiplexers
- Graphic display controllers for embedded solutions

For complex components, the Business Unit Multimedia can also supply development kits to customers. These kits include an evaluation board, software and documentation.
Fujitsu Microelectronics Europe continues the success story with one of the most advanced, highly integrated single-chip solutions for digital satellite broadcasting, which combines a tuner, a QPSK demodulator and a Forward Error Correction Unit into one 120-pin package.

Many set-top box manufacturers around the world already use the well known MB86A15. It offers a series of benefits over previous-generation discrete QPSK NIMs, including much smaller size, significantly reduced power consumption and lower cost.

The chip integrates a Zero IF Tuner, a QPSK Demodulator and Forward Error Correction (FEC) circuitry, making it ideal for DVB-S and DSS transmissions, without the use of tuning-diodes, expensive capacitance and inductive elements.

This means that the only external components needed to design and build a complete working front-end for a set-top box are the F-connector, a 4MHz crystal, and some resistors and simple capacitors.

In addition, the MB86A15 internally generates the control signal for DiSEqC 1.x, the standard for interfacing between the satellite dish and receiver, which makes it possible to switch between an array of dishes.

The DiSEqC 1.x standard requires a protocol involving very strict timing, and this is supported by the new chip directly in hardware, optimising performance and reducing the amount of software needed.

Much lower power consumption is an attractive feature of the MB86A15, which operates from supply voltages of just 2.5, 3.3 and 5V. This contrasts with previous generation designs in which the tuning diode required a 30V supply. Maximum power dissipation of the new device is 1.5W (at 45Mbaud), and thanks to this it is available in a compact LQFP 120-pin package.
The low power consumption will help to further reduce costs and make design and implementation easier.

**Key Features**

- Multi-Chip-Package (MCP), using Fujitsu’s advanced MCP technology
- For logic module: CMOS 0.25µm technology
- For RF module: BiCMOS technology
- Includes Zero IF Tuner, QPSK Demodulator and Forward Error Correction
- DVB-S (SCPC, MCPC)) and DSS compatible
- No external inductors or variable capacitance diodes required
- Supply voltages: +5, +3.3 and +2.5V, (30V for tuning is not required)
- Input frequency range: 950 to 2150MHz
- Input signal level per channel: typ. -75 to -10dBm
- Symbol rates: 1 to 45Mbaud
- Carrier capture range: ±5MHz
- Automatic IQ detection
- Automatic detection of Viterbi code rates (DVB: 1/2, 2/3, 3/4, 5/6, 7/8)
- I²C® bus interface
- DiSEqC® 1.x compatible
- Built-in carrier frequency offset monitor (via I²C bus interface)
- C/N Monitoring function (via I²C bus interface)
- Total power consumption: less than 1.5W (at 45Mbaud, decreases at lower baud rates)
- Package: 120-pin plastic LQFP (FPT-120P-M21)
- Ambient temperature: 0 to +70°C

**Development Kit available which includes:**

- Evaluation Board with RF input and transport stream output
- Application Programming Interface software (API) in source code will be provided by Fujitsu
- Evaluation board including monitor software for PC is available. This software offers graphical BER display, bar graphs for signal strength/quality and transponder administration including DiSEqC control.

**Key Applications**

- Digital set-top boxes for satellite reception
- Television Set incorporating a digital satellite reception (IDTV)
- Network Interface Module (NIM) for Satellite reception
- PC Cards, which use the DVB-S Standard for Data Broadcasting
- Head-end stations
The third generation MPEG-2 decoder called SmartMPEG (MB86H2x) is ideally suited for medium- and low-end set-top box applications. The SmartMPEG includes nearly all of the required features for these set-top box applications, requiring only a single SDRAM and a FLASH memory for operation.

The SmartMPEG is the first Fujitsu MPEG device to use a shared memory architecture. In this shared architecture, a single SDRAM is used for MPEG decoding, OSD graphic generation and the system processor. Performance of the embedded ARC Tangent-A4 CPU running with 130MHz is very high and after initialisation it is completely available for other tasks like OSD processing or SI data analysis. This high performance increase is achieved through an increased clock frequency, additional instructions, a 2kB data cache, a 4kB instruction cache and a faster memory system.
The specialised SDRAM interface is capable of connecting to both 16- and 32-bit SDRAM devices, allowing selection of the optimal components for each application. A 32-bit device need only be used when extremely high OSD-graphic performance is required.

The on-chip digital PLL (instead of external VXCO), the 7-segment controller and the option to use the video DACs for audio output, allow customers to reduce the cost for low-end applications to an absolute minimum. This high level of integration will enable customers to achieve one of the most efficient solutions for medium- and low-end set-top boxes available on the market today.

There are derivatives available from the SmartMPEG, which include features for special applications. For example, an NDS ICAM, which allows the SmartMPEG to be used in a network, where the NDS scrambling algorithm is used. The SmartMPEG for extended temperature makes it ideally suited for automotive applications. For certain PayTV Networks a Macrovision version is also available.

Fujitsu’s Application Interface software (FAPI) enables customers an easy start for their own development. The FAPI includes many low level driver and middle level examples. The block diagram above shows the FH_LIB (Fujitsu Hardware Library) offering direct access to each register in the device. The FD_LIB (Fujitsu Driver Library) includes the driver set, like I²C, IC-Card and Video Driver. In addition, the middleware and the application are running.

The basic FAPI runs with or without an operating system.

Some interactive APIs are ported to the SmartMPEG. This allows customers to build set-top boxes or IDTVs incorporating OpenTV, MHEG-5 or NDS Middleware.

**Key Features**

- CMOS 0.18µm technology
- MPEG2 video ISO/IEC 13818-2 (MP@ML...SP@ML)
- MPEG audio layer 1/2
- 32-bit RISC CPU (ARC Tangent A4 @ 130MHz) with extensions
- 4k L-cache / 2k D-cache
- Three timers / watchdog / power-down mode
- Shared memory interface (SDRAM, 16/32-bit data), 64Mbit...1Gbit
- Universal processor interface (IDE, NAND/NOR FLASH, Common Interface)
- Two transport stream decoders (decoding/recording) including DVB descrambler
- Flexible MPEG video resizing (factor 1/16 to 2)
- Display controller with up to four true-colour graphic or CLUT layers
- Teletext / WSS / CC / VVID insertion
- PAL/NTSC/SECAM digital encoder
- RGB De-matrix (RGB or YCrCb output)
MPEG-2 DECODER FOR DIGITAL TELEVISION

Typical configuration using the MPEG-2 decoder SmartMPEG – digital video recorder using two front-ends and a hard disk drive.

- Control of brightness, contrast and colour saturation of RGB and YCrCb output
- 5 video DACs @ 10 bit
- ITU-R 656 video input/output
- S/P DIF output for PCM/AC3/MPEG
- UART/2 x Smart Card IF/I2C/GPIO
- 7-segment LED controller for 5 digits
- Infra Red receiver/transmitter
- PWM Output
- On-chip DPLL, requiring only 27MHz crystal
- Typical power consumption: typ. 700mW (1.8V device with 3.3V I/O)
- Typical power consumption in Standby mode: typ. 100mW (1.8V device with 3.3V I/O)
- Low Profile QFP208 Package or BGA256 Package

- Ambient Temperature Range: 0 to +70°C (-40 to +85°C for MB86H22)

**Derivatives of SmartMPEG**

- MB86H20 – SmartMPEG Standard Version in QFP208 Package
- MB86H22 – SmartMPEG for ext. temperature range -40 to +85°C in QFP208 Package
- MB86H23 – SmartMPEG with Macrovision support (Ver 7.1.L1) in BGA256 Package
- MB86H24 – SmartMPEG for Conditional Access Applications (including NDS ICAM in BGA256 Package)
- MB86H25 - SmartMPEG for Free-to-Air Applications in QFP208 Package

**Development Kit available which includes:**

- Evaluation Board with transport stream input and analogue video output, single 12V supply, USB for debug
- Application programming interface software (FAPI) will be provided by Fujitsu
- Software example in Flash

**Key Applications**

- Digital set-top boxes for satellite, cable and terrestrial reception
- Free-to-Air and PayTV applications
- Television Set incorporating a digital reception unit (IDTV)
- Personal / digital video recorder applications
- Automotive/mobile/handheld applications
- Head-end stations
The MB86391 is a full MP@ML compliant MPEG-2 encoder that integrates video, audio and system encoders on a single chip. The MPEG-2 encoder takes advantage of the high-performance MPEG-2 compression algorithm developed by Fujitsu. This device is a combination of hardware and software processed by an internal SPARClite CPU. It is expected to be a key component for realising higher performance and more compact digital audio-visual equipment, such as disk recorders, camcorders, video communication, etc.

**Key Features**

- Single chip encoder
- Video encoder
  - MPEG-1 (ISO/IEC11172-2)
  - MPEG-2 MP@ML encoding function (ISO/IEC13818-2)
  - NTSC and PAL video formats
  - Maximum bit-rate is 15Mbps
  - Video input interface: ITU-R 656
- Audio encoder
  - MPEG-1 Audio layer-1/2 encoding function (ISO/IEC11172-3)
  - Maximum bit-rate is 448kbps
  - Audio Input Interface: I'S
- System multiplex
  - Output format is selection of PS, TS and MPEG-1 System
- Constant or variable bit-rate (CBR / VBR)
- Maximum bit-rate is 20Mbps
  - External memory: SDRAM: 4x(1Mx16 bit) or 2x(2M x 32 bit)
  - Time base corrector (TBC)
  - Internal 32-bit RISC processor
  - Simple control of encoding parameters via serial port
  - Power consumption: typ. 550mW
  - Package: HQFP-208
  - Operating temperature: -20 to +85°C

**Key Applications**

- Video distribution systems
- Car entertainment systems
- Video conference systems
- Digital video recorder
- D-VHS recorder
- D-STB, Personal Video Recorder (PVR)
- Video disk recorder
- MPEG-2 PC encoder card
- Surveillance systems
- Head-end stations
INTRODUCTION TO GRAPHIC DISPLAY CONTROLLERS

Fujitsu’s new family of graphic display controllers will optimise solutions for embedded graphic applications such as car navigation and mobile information terminals. The products in this family have numerous functions that are state-of-the-art to graphic controllers today, but have been specially optimised for the area of embedded systems. This means that, in addition to many 2D and 3D rendering functions, there is a flexible layer concept, support for screen resolution of up to UXGA (1600 x 1024) and further features which are of particular interest in the area of navigation, such as alpha-blending and anti-aliasing. All derivatives have a CPU interface to enable direct connection of embedded CPUs and MCUs. Fujitsu offers a range of graphic display controllers with different levels of integration for various applications.

In-car navigation is a key target application for Fujitsu’s graphic display controllers.
MB86290A ‘CREMSON’

MB86290A ‘Cremson’ is a 2D/3D graphics controller, optimised for applications in car navigation systems and mobile information processing terminals. Adopting various sophisticated functions, such as flat or Gouraud shading, bi-linear texture mapping, and Z-buffering, ‘Cremson’ offers a high-speed, superior-performance 3D graphics functionality. Moreover, anti-aliasing, concaved polygon rendering and fast line draw features are also included, allowing smooth and sophisticated-quality rendering. As a result, ‘Cremson’ performs high-quality rendering operations, with similar quality to leading-edge PC graphics, but with lower power consumption. ‘Cremson’ supports a 64 bit-wide external memory interface. This interface is driven at the same 100MHz frequency as its internal operation, to support the large-memory bus bandwidth that is needed to perform the high-performance graphics operations described above. Also, in order to support various kinds of system configurations, ‘Cremson’ offers a configurable host interface for four types of CPUs (Fujitsu FR30, Hitachi SH3/4, and NEC V832) without external glue logic.

To address the especially complex Window configurations of car navigation systems, ‘Cremson’ offers 4 layers of overlay planes. These layers are (from top to bottom): C (console) layer, W (window) layer, M (middle) layer and B (base) layer. All layers can be rendered in 16 bit/pixel colour (65,536 colours displayed at a time) or rendered in 8-bit indirect colour mode (256 selected out of 262,144 colours). The colour palette can be defined separately to the C layer and B and M layers. A transparent colour option is used to blend the layers directly.
Layer Concept

For screen separation in wide-screen displays, the M and B layers can be split into two separate segments (left and right). This feature is useful when two different reduced map scales are displayed side by side. Of course, all these layers and segments can be scrolled independently. In addition, two hardware cursors are supported.

An ‘alpha-flag’ per pixel is supported for the C-layer. This feature is useful for blending the C layer colour with all the layer contents below, providing a variable transparent colour effect (‘alpha-blending’).

‘Cremson’ consists of 4 block modules: host interface block, external memory interface block, display control block, and 2D/3D rendering block. An internal 64-bit bus called Pixel bus connects these modules. Also, the host interface block is connected to each of the other 3 blocks independently to avoid display and/or rendering operations when the host CPU attempts to access these modules.

Key Features

- CMOS 0.25µm technology
- Display resolutions up to 1024 x 768
- 4 layers of overlay display (bottom 2 layers are both split into separate segments)
- RGB analogue output (high speed DAC)
- Includes various kinds of 2D/3D graphic acceleration functions
- Built-in alpha blending, anti-aliasing and chroma-keying
- Up to 32MB external graphic memory (SDRAM) 64 bit-wide @ 100MHz
- Configurable CPU-interface for embedded CPUs/MCUs
- Supply voltage 3.3V (I/O), 2.5V (internal)
- QFP-240 Package
- Temperature range -40 to +85°C
MB86291A ‘SCARLET’

‘Scarlet’ offers some of the most advanced functionality yet developed for use in automotive navigation and multimedia information terminals.

MB86291A ‘Scarlet’ is an enhanced version of MB86290A ‘Cremson’ which adds 16Mbit embedded SDRAM, video input functions and a geometry processor. The concept of display layers, 2D/3D rendering functions and the display controller features are taken from ‘Cremson’ MB86290A.

Scarlet is optimised for applications in car navigation systems, which require video-input features, consumer information processing systems and arcade game applications.

Scarlet has 16Mbit of embedded SDRAM with high bandwidth (100MHz). No external SDRAM devices are required for graphic memory. The external video input can be used to capture video signals according to the standard RBT-ITU656 YUV4:2:2 format.

Picture-in-picture functions are supported to display the video image (the W-layer is dedicated for that purpose). To adjust the dimensions of the video-input format, a flexible video scaler is integrated.

A geometry processor, capable of performing numeric calculations for graphical operations is included.

Supported functions are Affin-conversions, model-view projections, 3D-clipping operations and others. All drawing functions, display list-formats and software functions are compatible to the ‘Cremson’ MB86290A.

An additional RGB digital interface offers flexible display connections.

Key Features

- CMOS 0.25µm technology
- Display resolutions up to 1024 x 768
- 4 layers of overlay display (bottom 2 layers are both split into separate segments)
- Digital video input
- Video scaler
- I²C interface
- Geometry processor
- RGB analogue output (high speed DAC)
- RGB digital output (8 bit x 3)
- Includes various kinds of 2D/3D graphic acceleration functions
- Built-in alpha blending, anti-aliasing and chroma-keying
- Embedded 16Mbit SDRAM graphic memory
- Configurable CPU-interface for embedded CPUs MCUs
- Supply voltage 3.3V (I/O), 2.5V (Internal)
- QFP-208 Package
- Temperature range -30 to +85°C
MB86292 ‘ORCHID’

‘Orchid’ is another version of MB86291 ‘Scarlet’, which has external video memory connection up to 32MB for those applications where the 2MB embedded SDRAM of MB86291 ‘Scarlet’ is not sufficient. All functions of ‘Scarlet’ including video input, scaler and a geometry processor are also available on ‘Orchid’. The concept of display layers, 2D/3D rendering functions and the display controller features are taken from ‘Cremson’ and ‘Scarlet’. ‘Orchid’ is optimised for applications in car navigation systems that require video input features, consumer information processing and arcade game functions. The external memory interface can be connected to Fujitsu FCRAM™ or SDRAM-type memory devices. The external video input can be used to capture video signals according to the standard RBT-ITU656 YUV4:2:2 format. Picture-in-picture functions are supported to display the video image (the W-layer is dedicated for that purpose). To adjust the dimensions of the video input format, a flexible video scaler is integrated. A geometry processor, capable of performing numeric calculations for graphical operations, is included. Supported functions are Affin-conversions, model-view projections, 3D-clipping operations and others. ‘Orchid’ has only RGB digital outputs for display connections. All drawing functions, display list-formats, and software functions are compatible to the ‘Cremson’ MB86290A and ‘Scarlet’ MB86291.

Key Features

- CMOS 0.25µm technology
- Display resolutions up to 1024 x 768
- 4 layers of overlay display (bottom 2 layers are both split into separate segments)
- Digital video input
- Video scaler
- I²C interface
- Geometry processor
- RGB digital output (8 bit x 3)
- Includes various kinds of 2D/3D graphic acceleration functions
- Built-in alpha blending, anti-aliasing and chroma-keying
- External SDRAM or FCRAM™ interface for up to 32MB graphic memory
- Configurable CPU-interface for embedded CPUs/MCUs
- Supply voltage 3.3V (I/O), 2.5V (Internal)
- QFP-256 Package
- Temperature range -40 to +85°C
MB87P2020A ‘JASMINE’

‘Jasmine’ is optimised to work as a companion chip for the Fujitsu 32-bit RISC devices.

MB87P2020A ‘Jasmine’ is a member of Fujitsu’s graphic controller family for low-cost embedded systems with performance requirements for compact automotive or consumer application, user interfaces or control panels where a high integration of functions is required. No external memory devices are required for graphic memory because of the 8Mbit embedded SDRAM.

The MB87P2020A support almost all LCD panel types (digital or analogue interface) and CRTs or other progressive scanned monitors/displays, which can be connected via the analogue RGB output.

The 2D rendering functions are composed out of standard primitives such as lines, polylines, rectangles, etc., as well as some special functions like decompression of RLE-bitmaps and text display. 4 layers of overlay can be displayed simultaneously. A video input interface was developed which allows acceptance of more formats (include YUV and RGB) and which is compatible to a wider range of video decoder chips. A programmable converter matrix (YUV to RGB) allows writing of the YUV formats to layers and to convert back to RGB for scanning.

In addition, a gamma correction table was added to allow adjustment of the picture characteristics according to the connected display requirements and the colour look-up table that can hold up to 512 entries. ‘Jasmine’ is optimised to work as a companion chip for the Fujitsu 32-bit RISC devices.

Key Features

- CMOS 0.25µm technology
- Flexible display controller for almost all standard LCD panels
- 4 layers of overlay display (out of 16 logical layers)
- RGB analogue output (DAC)
- RGB digital output
- Includes 2D graphic acceleration functions
- Gamma correction

The MB87P2020A ‘Jasmine’ is fully compatible with the MB87J2120 ‘Lavender’ and uses the same internal architecture. No external memory devices are required for graphic memory because of the 8Mbit embedded SDRAM.
The new ‘Coral’ device family offers an increased internal operating frequency of 166MHz, a 64 bit memory bus, support for six independent layers, advanced alpha-blending features and enhanced video input facilities. The higher internal frequency of 166MHz (400MHz for display dot clocks) enables the rendering engine of the devices to achieve a factor 10 improvement in texture mapping and drawing image quality compared to the previous graphic controller devices.

The enhanced bandwidth allows a much greater rate of access for graphics elements, and delivers improved scanning functions at higher display resolutions. The ‘Coral Q’ and ‘Coral B’ devices are compatible with host CPU buses including Fujitsu FR, Hitachi SH3 and SH4 and NEC V83 without external glue logic. All devices are binary compatible with previous generation graphic display controllers, like the ‘Cremson’, ‘Orchid’ and ‘Scarlet’ devices. This helps to speed-up developments and save costs because existing software modules (e.g. map renderer) and drivers can be used without any modifications.

An enhancement to 2D-drawing functions is the integration of a line depth display facility, which clearly defines the correct respective level of intersecting map lines. Enhanced hardware design also provides improvements in pattern line performance.

The ‘Coral’ device address up to 64MB of external SDRAM or FCRAM™ memory @ 133MHz and are capable of adjusting picture sizes to optimise the available memory space. All layers can have a colour depth of 8-, 16- or 24 bits/pixel and can be changed in position, size and priority. The maximum logical layer size has been increased to 4096 x 4096 pixels.

**Key Features**

- CMOS 0.18µm technology
- Display resolutions up to 1280 x 768
- 6 layers of overlay display (Windows)
- Alpha Plane
- Geometry processor
- RGB digital output (8 bit x 3)
- Includes various kinds of 2D/3D graphic acceleration functions
- Built-in alpha blending, anti-aliasing and chroma-keying
- External SDRAM or FCRAM™ interface @ 133MHz for up to 64MB graphic memory
- Configurable CPU-interface for embedded CPUs/MCUs
- Supply voltage 3.3V (I/O), 1.8V (Internal)
- QFP-256 package
- Temperature range -40 to +85°C
MB86294 ‘CORAL B’

‘Coral B’ adds video input to the features of ‘Coral Q’ and is available in a BGA package. The video input is capable of accepting TV tuner, DVD player or camera signals in PAL or NTSC video formats (ITU656 format). Video pictures of diverse resolution and frame frequency rate, in either progressive or interlaced modes, can be grabbed, scaled and displayed picture-in-picture.

The latest automotive and consumer appliance screens are increasing resolution to achieve better readability. They demand improved picture quality to match, for example DVD quality. In order to meet these demands, ‘Coral’ integrates a new video input up-scaling facility, which allows a full-screen mode of multimedia pictures at large resolutions to be displayed. Both up-scaling and down-scaling can be set independently in horizontal and vertical directions in pixel or line resolutions.

Using the Alpha-map features of the ‘Coral’ architecture, a video picture can be blended smoothly together with rendered graphics. The alpha map can be freely assigned to any of the six layers and allows the assignment of 8 bits per pixel, enabling each pixel to be mixed to control transparency to a very high degree of accuracy. In addition, all layers can be blended at a fixed ratio of 256 levels.

To enhance bit BLT (Bit Block Transfers) operations, this feature can now be combined with alpha-mapping. With this function, any bitmap can be copied from any source location (CPU- or Video-memory) and can be copied onto a layer with an independent alpha-map. Software routines that make use of this function can greatly improve image quality (for example anti-aliasing over a moving background).

Key Features

- CMOS 0.18µm technology
- Display resolutions up to 1280 x 768
- 6 layers of overlay display (Windows)
- Alpha Plane
- Digital Video input
- Video Scaler (up/down scaling)
- I²C interface
- Geometry processor
- RGB digital output (8 bit x 3)
- RGB analogue output
- Includes various kinds of 2D/3D graphic acceleration functions
- Built-in alpha blending, anti-aliasing and chroma-keying
- External SDRAM or FCRAM™ interface @ 133MHz for up to 64MB graphic memory
- Configurable CPU-interface for embedded CPUs/MCUs
- Supply voltage 3.3V (I/O), 1.8V (Internal)
- BGA-256 package
- Temperature range -40 to +85°C
'Coral P/PA' is an enhanced version of 'Coral B' with a PCI host interface and a new video input controller. Any CPU with a 32-bit PCI V2.1-compliant host interface can be directly connected to 'Coral P/PA'. The device includes both master and slave functions and an internal DMA controller for multi-burst transfers of large quantities of data between all combinations of PCI data space and 'Coral' internal areas.

Additional functions provided by the host interface are general purpose I/O pins and a serial interface. The external video input of 'Coral P/PA' accepts data conforming to the standards RBT-ITU656, RBT-ITU601, RGB666 and RGB888. This allows video signals of various sources to be displayed together with generated graphics. The video input is capable of accepting TV tuner, DVD player or camera signals in PAL or NTSC video formats. In addition, rendered graphics from any other display controller can be used as video input source.

The video stream is read, modified and written to a video buffer memory completely independent of the display scanning process. Video pictures of diverse resolution and frame frequency rate, in either progressive or interlaced modes, are able to be grabbed, scaled and displayed picture-in-picture. As with 'Coral B', 'Coral P/PA' integrates a new video input up-scaling facility, which now allows a full-screen mode of multimedia pictures at large resolutions to be displayed. Both up-scaling and down-scaling can be set independently in horizontal and vertical directions in pixel or line resolutions.

A set of general I/O pins and a serial interface are also included for simple external resource control.

The new MB86296 'Coral PA' is a redesigned and feature-expanded version of 'Coral P'. This chip has the following additional features:

- Direct RGB666 and RGB888 video input without conversion to YUV422
- Dual display feature (independent contents on two connected screens)
- Colour-Space conversion method selectable as programmable option
- Brightness, Contrast, Saturation control for video input
- PCI bandwidth will increase to approximately 70MBytes/s
- New ROM for Geometry Engine (enhanced functions)
- Pixel-clock delay of display output is programmable
- PCI bus clock can be used as clock input
- Video texture mapping (RGB555 mode)
- Simultaneous up- and down-scaling
- Enhanced pixel clock output
- 100% Pin- and Function-compatible to 'Coral P'
The new graphic controller 'Lime' is the perfect choice for 2D-optimised graphic systems based on the 'Coral' family.

'Lime' is a low-end extension to the Fujitsu Graphic Controller Family for 2D applications. This chip is based on the Coral family core functions, and optimised for 2D rendering.

The display controller, rendering engine and video input unit are taken from the successful 'Coral PA' but the floating point co-processor and all 3D-functions have been taken out. Also, the CPU interface is optimised for more CPU connections and the device has some functions to support small footprint graphic applications. 'Lime' is 100% binary-compatible to the ‘Cremson’ and ‘Coral’ families.

**Key Features**

- CMOS 0.18µm technology
- Display resolutions up to 1280 x 768
- 6 layers of overlay display (Windows)
- Alpha Plane
- Digital Video input (various formats)
- Video Scaler (up/down scaling)

**Lime Host IF multiplexing modes**

<table>
<thead>
<tr>
<th>Mode</th>
<th>HST Bit(s)</th>
<th>RGB output</th>
<th>GPIO</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode 1</td>
<td>32-bit</td>
<td>D(31:16)</td>
<td>RGB 8/8/8</td>
<td>N/A</td>
</tr>
<tr>
<td>Mode 2</td>
<td>32-bit</td>
<td>D(31:16)</td>
<td>RGB 8/8/8</td>
<td>GPIO (4)</td>
</tr>
<tr>
<td>Mode 3</td>
<td>16-bit</td>
<td>RGB 8/8/8</td>
<td>RGB 6/6/6</td>
<td>GPIO (3)</td>
</tr>
<tr>
<td>Mode 4</td>
<td>16-bit</td>
<td>RGB 6/6/6</td>
<td>RGB 6/6/6</td>
<td>N/A</td>
</tr>
</tbody>
</table>

- I²C Master/Slave interface
- RGB digital output (8 bit x 3)
- Dual-Display support (2xRGB666 output)
- Includes various kinds of 2D graphic acceleration functions
- Built-in alpha blending, anti-aliasing and chroma-keying
- External SDRAM or FCRAM™ interface @ 133MHz for up to 64MBytes graphic memory
- Standard host interface for embedded CPUs/MCUs (32-bit/16-bit)
- GPIO inputs/outputs
- Serial interface
- Supply voltage 3.3V (I/O), 1.8V (Internal)
- BGA-256 package
- Temperature range -40 to +85°C
'Carmine' is a high-end extension to the Fujitsu Graphic Controller family. This chip will carry a brand new graphics core which will deliver 10x more performance as 'Coral PA'. All relevant blocks inside the chip are redesigned and will be optimised for high-end in-car multimedia applications. 'Carmine' will be 100% compatible to OpenGL ES 1.1. All transforming and lighting functions can be executed in hardware.

As a new feature, 'Carmine' will have two independent display output units. Both can generate individual display timings and resolutions. For each display channel, 8 layers and 4 alpha-planes are available. 'Carmine' also features two independent video input channels - each of them can capture independent YUV and RGB signals.

Key Features

- CMOS 90nm technology
- Internal and memory frequency: 266MHz
- Display resolutions up to 1280 x 1024
- 2 x 8 layers of overlay display (windows)
- 2 x 4 alpha planes and constant alpha value for each layer
- Dual-digital video input (various formats)
- Video scaler (up/down scaling)
- Brightness, Contrast, Saturation control
- Dual-display output
- Rendering engine for 2D/3D graphic acceleration functions
- OpenGL ES 1.1 compatible
- Geometry Processor
- External DDR-SDRAM interface @ 266MHz
- PCI66 host interface
- BGA-543 Package
- Temperature range -40 to +85°C
New enhanced graphics display controllers (GDCs) for various kinds of digital audio/video applications, in which multimedia functions will be integrated together are planned as successive products. In addition, we plan to integrate a CPU core and various I/O functions and define a single-chip solution for car navigation applications. As Fujitsu’s primary GDC product line, the car navigation family will be extended further.
EVALUATION BOARDS

For application development support and functional evaluation, a number of evaluation boards are available from Fujitsu: PCI adaptor cards with all graphics controllers from the ‘Cremson’, ‘Coral’ and ‘Carmine’ families are available, which enable the evaluation of the device features directly from a Windows PC. For this, a Windows 98/NT/Windows 2000 driver and a map driver are bundled with this adaptor card in order to get started, enabling easy programming of the devices from a Windows-based development environment. Also, the source code of various application examples is included. Although the main purpose is software development it can be mounted directly to an embedded system.

‘Cremson’ Starterkit Series

The ‘Cremson’ Starterkit is a modular evaluation board, which provides a stand-alone embedded environment. The kit hardware consists of two parts, a CPU module, which carries a Fujitsu 32-bit RISC MCU MB91F36X and a set of sub-boards for the graphic controllers ‘Cremson’, ‘Scarlet’, ‘Jasmine’ and ‘Lime’. In order to facilitate the appropriate configuration for the application requirements, the system allows easy interchange of the CPU type or the graphic controller.

The interconnection between both module boards is the host-CPU bus interface. All functions of the graphic devices and the CPU are present on pin headers, jumpers or switches, which allow the addition of hardware extensions.

The new CPU Board, equipped with MB91F369, MB901302, and MB91F467 allows creation and full debugging of applications under Softune Workbench directly! This CPU-module has additionally 2MB debugging RAM on board, which is required for the monitor debugger.
### GRAPHIC CONTROLLER COMPARISON TABLES

**Comparison Table – Devices**

<table>
<thead>
<tr>
<th>Device</th>
<th>Name</th>
<th>Chip Frequency</th>
<th>Max Resolution (typ. @60Hz)</th>
<th>2D Rendering</th>
<th>3D Rendering</th>
<th>Texture Mapping</th>
<th>Number of Layers</th>
<th>Layer Alpha Blending</th>
<th>Drawing Alpha Blending</th>
<th>Dual Display Output</th>
<th>RGB Digital Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB87P2020</td>
<td>Jasmine</td>
<td>64MHz</td>
<td>800 x 600</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>MB86290A</td>
<td>Cremson</td>
<td>100MHz</td>
<td>1024 x 768</td>
<td>x</td>
<td>x</td>
<td>up to 512 x 512</td>
<td>4</td>
<td>4-bit flag blending for top layer</td>
<td>4-bit alpha drawing</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MB86291A</td>
<td>Scarlet</td>
<td>100MHz</td>
<td>1024 x 768</td>
<td>x</td>
<td>x</td>
<td>up to 512 x 512</td>
<td>4</td>
<td>4-bit flag blending for top layer</td>
<td>4-bit alpha drawing</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>MB86292</td>
<td>Orchid</td>
<td>100MHz</td>
<td>1024 x 768</td>
<td>x</td>
<td>x</td>
<td>up to 512 x 512</td>
<td>4</td>
<td>4-bit flag blending for top layer</td>
<td>4-bit alpha drawing</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>MB86293</td>
<td>Coral Q</td>
<td>166MHz</td>
<td>1024 x 768</td>
<td>x</td>
<td>x</td>
<td>up to 4096 x 4096</td>
<td>6</td>
<td>8-bit alpha-plane for 1 layer + 8-bit flag blending for all layers</td>
<td>8-bit alpha drawing + Alpha BLT</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>MB86294</td>
<td>Coral B</td>
<td>166MHz</td>
<td>1024 x 768</td>
<td>x</td>
<td>x</td>
<td>up to 4096 x 4096</td>
<td>6</td>
<td>8-bit alpha-plane for 1 layer + 8-bit flag blending for all layers</td>
<td>8-bit alpha drawing + Alpha BLT</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>MB86295</td>
<td>Coral P</td>
<td>166MHz</td>
<td>1280 x 768</td>
<td>x</td>
<td>x</td>
<td>up to 4096 x 4096</td>
<td>6</td>
<td>8-bit alpha-plane for 1 layer + 8-bit flag blending for all layers</td>
<td>8-bit alpha drawing + Alpha BLT</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>MB86296</td>
<td>Coral PA</td>
<td>166MHz</td>
<td>1280 x 768</td>
<td>x</td>
<td>x</td>
<td>up to 4096 x 4096</td>
<td>6</td>
<td>8-bit alpha-plane for 1 layer + 8-bit flag blending for all layers</td>
<td>8-bit alpha drawing + Alpha BLT</td>
<td>(same res)</td>
<td>x</td>
</tr>
<tr>
<td>MB86276</td>
<td>Lime</td>
<td>133MHz</td>
<td>1280 x 768</td>
<td>x</td>
<td>-</td>
<td>up to 4096 x 4096</td>
<td>6</td>
<td>8-bit alpha-plane for 1 layer + 8-bit flag blending for all layers</td>
<td>8-bit alpha drawing + Alpha BLT</td>
<td>(same res)</td>
<td>2x</td>
</tr>
<tr>
<td>MB86267</td>
<td>Carmine</td>
<td>256MHz</td>
<td>1280 x 1024</td>
<td>x</td>
<td>x</td>
<td>up to 4096 x 4096</td>
<td>8 x 2</td>
<td>4 x 8-bit alpha-plane for 1 layer + 8-bit flag blending for all layers</td>
<td>8-bit alpha drawing + Alpha BLT</td>
<td>x</td>
<td>(indep res)</td>
</tr>
</tbody>
</table>

**Comparison Table – Tools**

<table>
<thead>
<tr>
<th>Evaluation Board</th>
<th>Description</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB86290EB01</td>
<td>PCI board for PCs (WinNT/2000)</td>
<td>MB86290A Cremson</td>
</tr>
<tr>
<td>MB86291EB01</td>
<td>PCI board for PCs (WinNT/2000)</td>
<td>MB86291A Scarlet</td>
</tr>
<tr>
<td>MB86292EB01</td>
<td>PCI board for PCs (WinNT/2000)</td>
<td>MB86292 Orchid</td>
</tr>
<tr>
<td>MB86293EB01*</td>
<td>PCI board combination for PCs (WinNT/2000)*</td>
<td>MB86293 Coral Q</td>
</tr>
<tr>
<td>MB86294EB01*</td>
<td>PCI board combination for PCs (WinNT/2000)*</td>
<td>MB86293 Coral B</td>
</tr>
<tr>
<td>MB86295EB01</td>
<td>PCI board for PCs (WinNT/2000)</td>
<td>MB86295 Coral P</td>
</tr>
<tr>
<td>MB86296EB01</td>
<td>PCI board for PCs (WinNT/2000)</td>
<td>MB86296 Coral PA</td>
</tr>
<tr>
<td>MB86297EB01</td>
<td>PCI board for PCs (WinNT/2000)</td>
<td>MB86297 Carmine</td>
</tr>
<tr>
<td>CREMSON-STARTERKIT-CRM</td>
<td>Subboard for Modular Starterkit</td>
<td>MB86290A Cremson</td>
</tr>
<tr>
<td>CREMSON-STARTERKIT-ROSE</td>
<td>Subboard for Modular Starterkit</td>
<td>MB86291A Scarlet</td>
</tr>
<tr>
<td>CREMSON-STARTERKIT-JAS</td>
<td>Subboard for Modular Starterkit</td>
<td>MB87P2020A Jasmine</td>
</tr>
<tr>
<td>CREMSON-STARTERKIT-LIME</td>
<td>Subboard for Modular Starterkit</td>
<td>MB86276 Lime</td>
</tr>
<tr>
<td>CREMSON-STARTERKIT-CPU</td>
<td>CPU Module for the 'Cremson Modular Starterkit'</td>
<td>MB91F362 as host CPU</td>
</tr>
<tr>
<td>CREMSON-STARTERKIT-CPU369</td>
<td>CPU Module for the 'Cremson Modular Starterkit'</td>
<td>MB91F369 as host CPU + Debug RAM</td>
</tr>
<tr>
<td>STARTERKIT MB91302</td>
<td>CPU Module for the 'Cremson Modular Starterkit'</td>
<td>MB91302 as host CPU + Debug RAM</td>
</tr>
<tr>
<td>SK-91F467D-208PFV</td>
<td>CPU Module for the 'Cremson Modular Starterkit'</td>
<td>MB91F467D as host CPU + Debug RAM</td>
</tr>
</tbody>
</table>

* Combination of motherboard (MB8629XEB01) and daughterboard (MB86293EB01 or MB86294EB01) – both items have to be ordered separately

Order information: Please specify the item according to the 'Evaluation board' or 'Device' columns.
<table>
<thead>
<tr>
<th>RGB Analogue Output</th>
<th>Video Input Formats</th>
<th>Video Input Formats</th>
<th>Video Scale</th>
<th>Other I/F</th>
<th>Video Memory</th>
<th>Geometry Processor</th>
<th>CPU Interface</th>
<th>Temperature Range</th>
<th>Package</th>
<th>Product Status</th>
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<tbody>
<tr>
<td>x</td>
<td>x</td>
<td>YUV/RGB</td>
<td>-</td>
<td>-</td>
<td>embedded (1MByte)</td>
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<td>FR</td>
<td>-40 to +85</td>
<td>QFP208</td>
<td>MP</td>
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<tr>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>external (up to 32MByte)</td>
<td>-</td>
<td>FR, SH3/4, V850</td>
<td>-40 to +85</td>
<td>QFP240</td>
<td>MP</td>
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<td>x</td>
<td>x</td>
<td>YUV</td>
<td>down</td>
<td>-</td>
<td>embedded (2MByte)</td>
<td>Version 1</td>
<td>FR, SH3/4, V850</td>
<td>-30 to +85</td>
<td>QFP208</td>
<td>MP</td>
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<tr>
<td>-</td>
<td>x</td>
<td>YUV</td>
<td>down</td>
<td>-</td>
<td>external (up to 32MByte)</td>
<td>Version 1</td>
<td>FR, SH3/4, V850</td>
<td>-40 to +85</td>
<td>QFP256</td>
<td>MP</td>
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<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>external (up to 64MByte)</td>
<td>Version 2</td>
<td>FR, SH3/4, V850</td>
<td>-40 to +85</td>
<td>QFP256</td>
<td>MP</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>YUV</td>
<td>up + down</td>
<td>-</td>
<td>external (up to 64MByte)</td>
<td>Version 2</td>
<td>FR, SH3/4, V850</td>
<td>-40 to +85</td>
<td>BGA256</td>
<td>MP</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
<td>YUV/RGB (RGB as converted YUV)</td>
<td>up + down scaling</td>
<td>-</td>
<td>external (up to 64MByte)</td>
<td>Version 2</td>
<td>PCI</td>
<td>-40 to +85</td>
<td>BGA256</td>
<td>MP</td>
</tr>
<tr>
<td>-</td>
<td>x</td>
<td>YUV/RGB (RGB full resolution)</td>
<td>up + down scaling</td>
<td>-</td>
<td>external (up to 64MByte)</td>
<td>Version 3</td>
<td>PCI</td>
<td>-40 to +85</td>
<td>BGA256</td>
<td>MP</td>
</tr>
<tr>
<td>-</td>
<td>x</td>
<td>YUV/RGB (RGB full resolution)</td>
<td>up + down scaling</td>
<td>-</td>
<td>external (up to 64MByte)</td>
<td>Version 4</td>
<td>PCI (including Lightning Engine)</td>
<td>-40 to +85</td>
<td>BGA2543</td>
<td>MP (Middle 2006)</td>
</tr>
<tr>
<td>-</td>
<td>2x</td>
<td>YUV/RGB (RGB full resolution)</td>
<td>up + down scaling</td>
<td>-</td>
<td>external DDR (up to 128MByte)</td>
<td>Version 4</td>
<td>PCI (including Lightning Engine)</td>
<td>-40 to +85</td>
<td>BGA2543</td>
<td>MP (Middle 2006)</td>
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</tbody>
</table>
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