ABSTRACT

With the rapid deployment of liquid crystal display (LCD) screens in automobiles, car makers are challenged to control costs while providing a useful and stimulating visual experience for drivers and passengers. Not since the introduction of the car radio has a technology offered so much buyer appeal, but these graphics-based systems come at a high cost both in terms of bill of materials (BOM) and developmental expenditures. Re-use of hardware and software is critical to control costs. But with multiple platforms offering different levels of user experience, automakers face the challenge of cost-effectively leveraging a limited number of designs over multiple models. One solution is to deploy smarter architectures that decouple key pieces of the system, so that some components can be used in multiple instances, while others are unique to one or two platforms.

Fujitsu Semiconductor worked with BMW and Inova Semiconductors to integrate the Automotive Pixel Link (APIX®), a bi-directional serial link, with the Fujitsu graphics display controllers (GDCs). This collaboration has enabled BMW to reduce behind-the-dash space requirements, develop more modular architectures, and save money.

BMW was involved from the outset to ensure stability in the development process and to make sure that the company's concerns were addressed. Those concerns included the weight associated with the wiring, and interoperability with other bus standards.

APIX features a primary channel speed of 1Gbit/s, which will scale to 3Gb/s soon. APIX is differentiated from other high-speed serial links, such as LVDS, in that it provides a full-duplex, bi-directional back channel to support command and control. This is a critical feature in the deployment of smart display systems.

Graphics display controllers are the core drivers of display systems, and the Fujitsu graphics controllers offer many features including video input, 2D and 3D rendering functions, a flexible layer capability, support for screen resolutions up to XGA (1024×768), and other features in the area of navigation, such as alpha blending and anti-aliasing.

INTRODUCTION

With the rapid deployment of liquid crystal display (LCD) screens in automobiles, car makers are challenged to control costs while providing a useful and stimulating visual experience for drivers and passengers. Not since the introduction of the car radio has a technology offered so much buyer appeal, but these graphics-based systems come at a high cost both in terms of bill of materials (BOM) and developmental expenditures. Reuse of hardware and software is critical to control costs. But with multiple platforms offering different levels of user experience, automakers face the challenge of cost effectively leveraging a limited number of designs over multiple models. One solution is to deploy smarter architectures that decouple key pieces of the system, so that some components can be used in multiple instances, while others are unique to one or two platforms.

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Collaboration Between Automakers and Semiconductor Suppliers Is Key to Delivering Innovative In-Vehicle TFT Technology

Today's emerging graphics applications require thin film transistor (TFT) LCD panels mounted throughout the car, in everything from the center console and instrument cluster to the heads-up display (HUD) and rear-seat entertainment systems.

To produce these high-performance graphics, graphics display controllers are increasing proportionally in size, power consumption, and implementation complexity.

The problem with this increased electronics content is that larger system-on-chip-based graphics display controllers and their supporting peripherals do not always lend themselves to being located on a printed circuit board (PCB) on the back side of the LCD. In fact, designers are continually “space-constrained” and search for ways to reduce the number of circuits and subsystems behind the dashboard.

Traditional approaches, such as using more highly integrated controller chips, are being offset by the push to integrate more and larger displays, and to add more “infotainment” functionality, in the dashboard space. The added functionality introduces a dramatic number of variables that increases costs as automakers try to provide multiple options for every vehicle.

All this is occurring at a time when automakers are trying to reduce costs, cut down the number of cables, and modularize designs so they can get maximum value from their development expenses.

Leveraging the APIX technology as a starting point, BMW, Inova Semiconductors and Fujitsu Semiconductor met these challenges and jointly developed a highly integrated system architecture that paved the way for the design of flexible display platforms that can be used across all carlines.

The Fujitsu chipset with integrated APIX technology gives tier-one suppliers and automakers flexible options for high-quality, cost-effective and modular displays, and is now an emerging standard that will appear in BMW model cars beginning in 2010.

A New Standard

By integrating the APIX IP onto the Fujitsu graphics display controller, the two companies (Fujitsu and Inova) introduced a new standard for peer-to-peer real-time transmissions of video and peripheral data in the car.

Graphics controllers are the core drivers of display systems and Fujitsu was the first semiconductor company to integrate APIX onto its graphics controller. The Fujitsu graphics controllers offer many features including video input, 2D and 3D rendering functions, a flexible layer capability, support for screen resolutions up to XGA (1024×768), and other features in the area of navigation, such as alpha blending and antialiasing.

Inova Semiconductors developed APIX to transfer video, graphics and other data from a central host to a peripheral display unit. APIX also can be used to directly couple CCD/CMOS video cameras to a microprocessor board.

BMW was involved in the development of this new systems solution. The company's requirements included:

- A stable development process
- Well-integrated component systems (radio reception issues)
- Reduced cables to minimize weight, and
- Integration and interoperability with such standards as CAN and MOST.

The BMW, Fujitsu and Inova collaboration is an example of a growing trend, namely, that semiconductor suppliers are playing a partnership role in automobile development. Companies like Fujitsu and Inova are working as team players with automakers and tier-suppliers, providing not just semiconductors, but system solutions. This helps reduce redesigns, improve performance, stabilize the development process, and control costs. This kind of involvement also makes it easier for automakers and tier-one suppliers to develop modular and system solutions.

The Technology

The APIX IP high-speed Serial Link Interface is notable partially because it allows the wiring that supports a remote TFT display to be significantly simplified. The interface can pass command and control data to and from the remote module.

Data returning from the remote LCD travels through the APIX backchannel, which is significantly faster than even the fastest CAN standard. The backchannel function eliminates the need to connect the LCD to an existing CAN or LIN network. The function is also crucial to enabling a modular
subsystem design that allows display systems to be mixed and matched to meet different performance needs.

Fujitsu integrated Inova's APIX high-speed serial interface into its graphics display controllers. Fujitsu currently has three automotive graphics controllers with integrated APIX available:

- The MB86R02 “Jade-D” features an industry-standard ARM926 processor, the Fujitsu MB86296 “Coral-PA,” two APIX channels, a TFT timing controller (TCON), and other automotive peripherals
- The MB88F332 “Indigo” combines an APIX deserializer, APIX Remote Hander (ARH) and APIX Automotive Shell, a sprite engine, a TCON, and other automotive peripherals needed for driving a cluster, HUD or center console.
- The MB91F467S is a 32-bit RISC (FR) controller that does not drive graphics over APIX to the remote node, but otherwise has all the other capabilities of APIX.

With two new controllers under development, Fujitsu is continuously expanding the portfolio of products with integrated APIX technology:

- The “Emerald-P” will have four integrated APIX2 channels, latest generation 2D/3D graphic engine and a powerful ARM A9 core with Neon DSP.
- The “ATLAS”, a Cortex R4F MCU with 2MB of Flash, integrated APIX PHY, APIX Remote Hander (ARH)

Many System Architectures
The integration of the Fujitsu and Inova technologies increases flexibility, allowing for system architectures that were not feasible in the past.

Some of the benefits of this flexible architecture are outlined below:

1. **Does not require a local MCU in the cluster, nor a CAN link to the cluster:** The graphics controller can be placed directly on the instrument cluster PCB. The controlling processor or SoC is located elsewhere and communicates to the graphics controller, which operates as a slave, over the APIX link. All control information is passed to the GDC unit via APIX.

2. **No software in the cluster:** A remote MCU controls the cluster or HUD using the PCB-mounted GDC device through the APIX interface. Modifications or improvements to the cluster subsystem can be done without concern for software requalification costs.

3. **Flexibility and modularity:** Changing to a higher-end cluster variant in the same architecture is relatively easy, requiring only a swap to a larger, higher-resolution LCD panel and a change in the remote module driving the cluster.

4. **More displays featuring different content:** The more APIX channels the GDC supports the more independent displays, featuring different content can be added.

5. **The GDC can display basic splash-screen information at start-up before the operating system loads:** In a distributed system, the ability to display information reassures the driver that the display system is functioning. The display also serves an important diagnostic function. Often, when there is a problem in the ECU or with the cabling system between the ECU and the display, the technician has no way to isolate the problem. The typical course of action is to replace everything, including the expensive display subsystem. However, the Indigo device located on the display system will display a diagnostic message such as “No pixel data received from ECU.” The technician would not then replace the display. This can save thousands of dollars in unnecessary replacement costs.

6. **Different applications:** Many other variants using APIX are possible. For example, a rear backup camera can be input into the graphics processing module using APIX. The GDC SoC can process the video, removing any fisheye distortion, and send the video to the display in the cluster via APIX. In another use, the remote graphics processing module can drive a center stack information display instead of a HUD.

![APIX Video and bidirectional Data link](image)
while still driving the graphics to the cluster. In a different architecture, the GDC SoC can be located on the cluster PCB and drive a remote HUD or center display via APIX.

How the Integrated Technology Benefits the Automaker and Semiconductor Suppliers

The combination of the Fujitsu devices with APIX provides many benefits, which help automakers and semiconductor suppliers meet the space, cost and performance challenges of sophisticated graphics. The integrated technology lowers costs and space requirements by reducing the number of connectors and wiring harnesses needed to connect to remote displays. Integrating the programmable TCON into the graphics display controller means the TCON unit can be removed from the LCD, saving money. And the Fujitsu / APIX solution provides many other flexible system architectures.

Emerging from this collaboration between Fujitsu, Inova and BMW could be a new standard for peer-to-peer real-time transmissions of data. In fact, another large US automaker is considering the technology and Inova, interested in establishing a standard, licenses the technology to other chip vendors. There are other competing solutions but the clear trend is to separate the control units from the cluster display, allowing for more space and flexibility within the dash.

The collaboration between semiconductor suppliers and automakers is a global trend, becoming increasingly common in the U.S., Japan and Europe. The most innovative automakers are moving in this direction, to get the comprehensive understanding and involvement in key digital vehicle systems and sub-systems needed to add value, create brand image, control costs and attain market leadership.

The result is that automakers and semiconductor suppliers can provide the rich graphics experience today's car buyers expect. At the same time, automakers benefit from a more stable development, dramatically reduced costs, and increased flexibility—all desirable in today's challenging automotive environment.

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