2-Chip Display Driver Architecture for Tablet Display

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Abstract

Demand for display resolution in Android-based tablets is rapidly increasing from WXGA (800 x 1280) to WQXGA (1600 x 2560). As the market requires a display of 300 PPI (Pixel Per Inch) or more, display is one of the most critical power source with high performance Application Processor (AP).

In this paper, Samsung introduces a 2-chip display driver architecture for A-Si LCD WQXGA resolution display to reduce power consumption in tablet display system. This is because A-Si LCD panel technology is widely used for tablet display and its solution can be applied to Oxide LCD.

The paper shows the cost benefits of 2-chip display driver architecture when compared to conventional Timing Controller (T-CON) + multi column drivers solution in tablet display system.

Introduction

Since smartphones and tablets have been popular, display is one of the key differentiation point to manufactures such as AMOLED display in Samsung Galaxy smartphones.

Users consider panel technology and display PPI, such as AMOLED display or high PPI IPS LCD display, when they decide to buy smartphones and tablets. As a result, smartphone and tablet devices are moving rapidly to high resolution garnering around 24 percent of unit share to be over 300 PPI in 2013 from the display search.

Thanks to high PPI display technology, smartphone and tablet display resolution are similar to or higher than a TV device resolution. Several smartphone manufacturers already launched Full HD (1080 x 1920) resolution with ~6-inch display and tablet makers launched WQXGA resolution product line-up such as Samsung Galaxy Note 10.1 tablet.

High PPI display is an attractive technology to users, however it consumes more power in a limited battery capacity. To solve high power consumption of high PPI display, there are several proposals from high speed serial interface group, such as Video Electronics Standards Association (VESA) and Mobile Industry Processor Interface (MIPI). VESA introduced Panel Self Refresh (PSR) function in eDP™ (version 1.3) interface to save power for still images, while MIPI organization has a similar concept of eDP PSR function in MIPI Display Serial Interface (DSI). This supports DSI command mode to reduce power for still images. Those power saving activities are related to AP and display data transfer interface.
Besides power saving method between AP and display, Samsung wants to find another power saving architecture in display system by paying attention to portrait type tablet device.

Currently, portrait type tablet is introduced by tablet manufactures, such as Samsung introduced 8.0-inch Galaxy Tab 3 8.0 with portrait type WXGA display as illustrated in the figure 3. Tablet with portrait type display can provide similar User eXperience (UX) with smartphone, such as portrait type User Interface (UI) and holding device by one hand.

To provide low power and cost solutions for tablet with a portrait type display, Samsung introduced a 2-chip display driver architecture for WQXGA resolution display.

This white paper introduces the 2-chip display driver architecture. It will also provide a comparison between 2-chip and conventional T-CON + multi column drivers architecture in tablet display system. The paper explains why the architecture, 2-chip display driver, is a much better solution than conventional architecture in terms of power consumption and cost.

### Tablet and Smartphone display system

Tablet is positioned between laptop and smartphone. Therefore, its display size is also in between two product segments as illustrated in the figure 4.

![Figure 4: Laptop, Tablet and Smartphone Display Size](image)

However, the direction of laptop and smartphone application display system development is totally different. Laptop displays adopt T-CON + multi column drives solution, while a smartphone adopts one chip display driver solution. This implements T-CON, memory, power block, and column driver in one chip as illustrated in the figure 5.

![Figure 5: Laptop(left) and Smartphone(right) Display System](image)

Meanwhile, between two display systems, tablet display system has followed laptop display system for a long time with the introduction of tablets. When tablets were introduced in the market, most tablets were introduced as a replacement of netbooks with similar requirements such as watching multimedia content and using internet content. Therefore, landscape type display form factor is adopted in tablets similar to laptop display system as illustrated in the figure 5 T-CON + multi column drivers solution.

Presently, smartphone display adopts one chip display driver solution. However, it is hard to apply in laptop landscape type display because of large bezel size and high temperature problem during display.
With the launch of a portrait type tablet in the market as illustrated in the figure 3, Samsung found a new possibility. It is a lower power consumption tablet display solution, which is a similar concept in smartphone. However, if you apply one chip display driver in WQXGA resolution tablet directly, it results in a large display bezel size and high temperature. Therefore, Samsung introduced 2-chip display driver architecture to reduce display bezel size and high temperature issue instead of one chip display driver solution. Next, this paper will introduce how 2-chip display driver architecture is a suitable solution for tablet display system.

**2-chip tablet display driver architecture**

To explain 2-chip display driver architecture, Samsung checked for the number of output channels required between display driver and display in WQXGA resolution.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Portrait WQXGA</th>
<th>Landscape WQXGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output channel</td>
<td>1,600RGB x 2,560</td>
<td>2,560RGB x 1,600</td>
</tr>
<tr>
<td>(Column channel)</td>
<td>4,800 channel</td>
<td>7,680 channel</td>
</tr>
</tbody>
</table>

Table 1: Number of output channels in landscape and portrait type WQXGA resolution

The basic concept of 2-chip display driver architecture is eliminating T-CON in the display system as illustrated in figure 7. To assemble two identical display drivers in the display system is a similar concept of smartphone display system.

From low power consumption point of view, smartphone display system is more efficient than laptop system because there is only a data transfer path, system interface (MIPI) between AP and display driver as illustrated in the figure 5. Therefore, Samsung developed a 2-chip display driver architecture for portrait type WQXGA display tablet based on smartphone display system architecture.
For 2-chip display driver architecture of portrait type WQXGA resolution, as illustrated in the figure 7, 2-chip is identical. The left half side display driver controls WQXGA panel, which controls from 1 to 800 RGB by 2560 resolution. The right display driver controls the right half side of WQXGA panel that is responsible from 801 to 1600 RGB by 2560 resolution. The 2-chip display driver architecture has similar function with one chip or T-CON + multi column drivers solution and its entire function is divided into 2-chip display driver.

The big difference between 2-chip display driver architecture and conventional T-CON + multi column drivers architecture is whether intra-panel interface is implemented or not in the display system. In T-CON + multi column drivers architecture, intra panel interface should be implemented between T-CON + multi column drivers because column driver ICs do not have any timing controller block. Hence, T-CON should control all kinds of timing related to display panel. However, 2-chip display driver architecture has timing controller in each display driver and it can operate with each other IC through chip-to-chip interface, when it requires to transfer data between two chips.

For a meaningful 2-chip display driver architecture in portrait type tablet display system, display bezel size should be considered when compared to conventional T-CON + multi column drivers solution. Regarding bezel, as mentioned earlier, if one chip display is applied with WQXGA display for portrait type tablet, it increases bottom display bezel. This is due to routing area between display driver and LCD display for 4,800 output channel as illustrated in the figure 8. Routing area is increased proportionally to display size. To achieve one chip display driver with narrow bezel display, one chip display driver x-size should be almost similar with display x-size, but hard to make it. Due to limitations of one chip display driver x-size in a semiconductor equipment, x-size cannot be made over around 3 x mm. Therefore, this paper suggests 2-chip display driver architecture to reduce bottom side bezel as illustrated in the figure 8. You can decrease bottom side bezel by using 2-chip display driver architecture due to routing area between LCD display and each display driver for 2,400 output channel as illustrated in the figure 8. Smaller number of output channel is helpful to reduce routing area. Therefore, this paper suggests 2-chip architecture for narrow bezel display.

Regarding high temperature issue in display system, this paper suggests a 2-chip architecture. This is because high power consumption can be divided by each chip as illustrated in the figure 9. Display power consumption in tablets is higher than that of smartphone display. Therefore, if one chip display driver to tablet display is applied, high temperature problem can result in tablet display system because of power concentration in a chip.
Merits of 2-chip tablet display driver architecture

Merits of 2-chip display driver architecture when compared to T-CON + multi column drivers architecture are described here. Before comparing two architectures, this paper assumes that 1 T-CON + 4 column drivers will be used for portrait type WQXGA display as illustrated in the figure 13. This paper defines the conventional system as 1 T-CON + 4 column drivers solution when compared to 2-chip display driver system.

Regarding interface power consumption, as illustrated in the figure 10, conventional architecture provides an additional interface path as intra panel interface, between T-CON and column drivers.

![Conventional system](image1)![2-chip display driver system](image2)

Figure 10: Comparison of Interface Power Path Diagram

Figure 11 illustrates how 2-chip display driver architecture shrinks the total interface power when compared to conventional system. There is an increase in small interface power consumption due to chip-to-chip interface between 2-chip display driver.

![Power Reduction Concept by Using 2-chip System](image3)

Figure 11: Power Reduction Concept by Using 2-chip System

Figure 12 illustrates WQXGA tablet display interface power comparison between conventional and 2-chip display driver architecture. Based on an estimate, using 2-chip architecture when compared to conventional system shrinks 71 percent of interface power.

![Interface Power Comparison Between Conventional and 2-chip in WQXGA LCD Tablet System](image4)

Figure 12: Interface Power Comparison Between Conventional and 2-chip in WQXGA LCD Tablet System

There can be a deduction in total number of display chips as stated in table 2 and figure 13, which leads to lesser costs.

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>2-chip system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ICs</td>
<td>5 ea</td>
<td>2 ea</td>
</tr>
<tr>
<td></td>
<td>T-CON: 1 ea.</td>
<td>T-CON function embedded in 2-chip</td>
</tr>
<tr>
<td></td>
<td>Column IC: 4 ea</td>
<td></td>
</tr>
<tr>
<td>PCB</td>
<td>Rigid PCB</td>
<td>Flexible PCB</td>
</tr>
<tr>
<td>PMIC</td>
<td>T-CON PMIC</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Comparison of total number of display drivers

As illustrated in the figure 13, T-CON PCB and T-CON Power Management IC (PMIC) have been excluded in 2-chip display driver architecture. FPCB can be used in 2-chip tablet display system similar to smartphones.

![Components Comparison Between Conventional(left) and 2-chip(right) Display Driver System](image5)

Figure 13: Components Comparison Between Conventional(left) and 2-chip(right) Display Driver System
Conclusion

This paper introduces 2-chip display driver architecture for portrait type WQXGA display system, which is used for Samsung System LSI 2-chip display driver system solution for tablets.

In tablets, low power and costs are important for longer battery life as well as lower cost. This paper describes how 2-chip display driver architecture can reduce interface power consumption. This paper also explains on how a 2-chip display driver system has cost benefits.

For future high PPI portrait type tablet display, 2-chip display driver architecture is a kind of tailored approach for low power and costs. It can also spread to other applications such as convertible personal computer and laptops.
References


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