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# Advanced Graphic Controller Enhances Performance of Portable Systems

Low-power chips and systems are what people are targeting these days, especially in portable devices. The Graphic Controller (GC) chip SSD1918 from Solomon Systech is tailored for cost-effective portable systems, with low power consumption in both the IC itself and the system. The on-chip's fully embedded low-power SRAM also allows dual display panel support in portable systems.

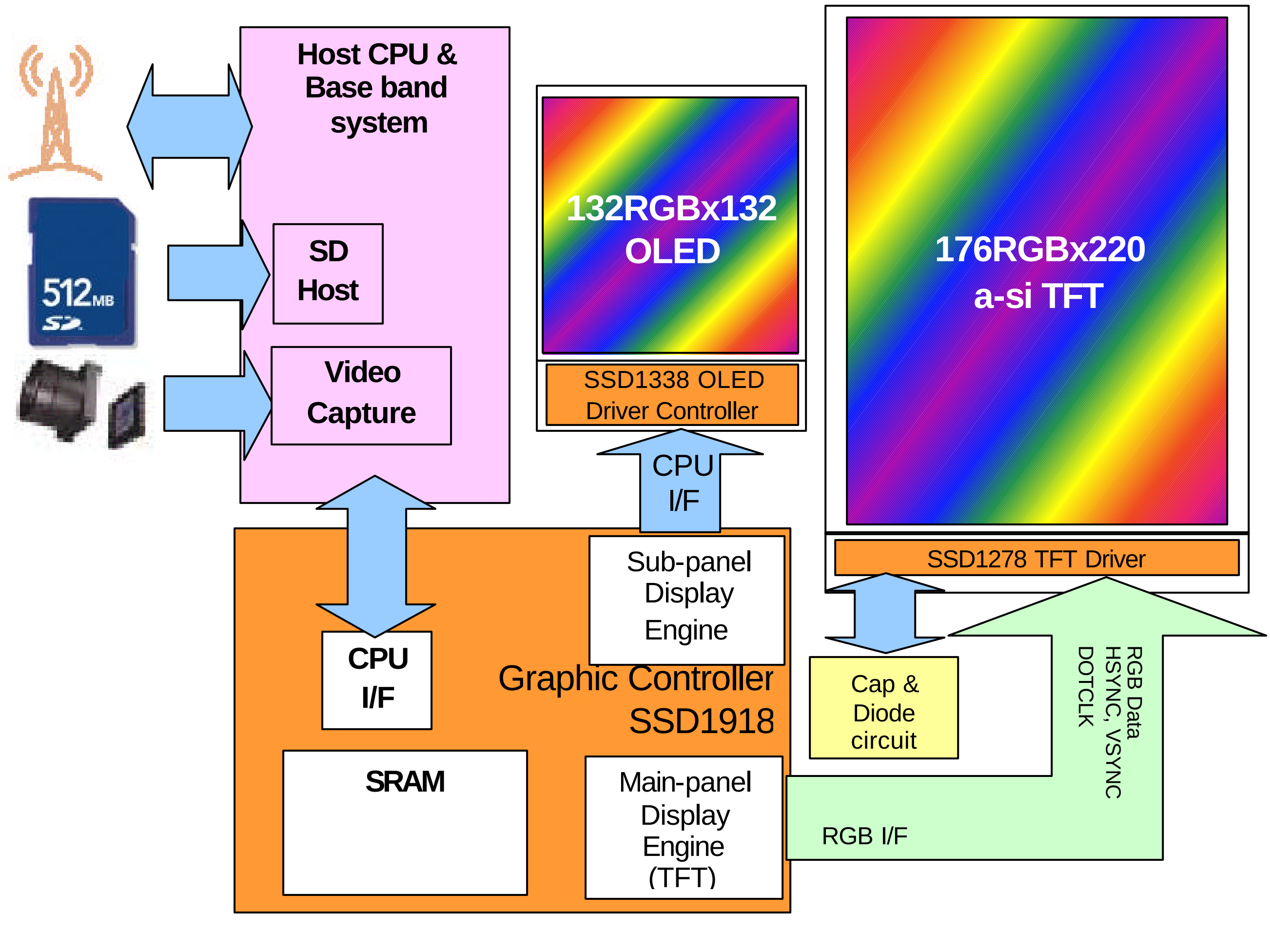


**Fig. 1.** **Typical configuration in mobile phone applications.**

Some highlights of the SSD1918:

- Optimised on-Chip low-power **display RAM** of 174,240 bytes
- Dual panel support for most industrial-standard **main panels** and **sub-panels**
- **Main panel**
  - True 18-bit 262K colour support
  - Digital RGB interface with optional SPI, RAMless driver interface
  - Supports 240x320 panel (single-frame buffer), e.g. SSD1279 TFT Driver
  - Supports 176x220 (double-frame buffer to avoid tearing effect), e.g. SSD1278 TFT Driver
- **Sub-panel**
  - Supports 6800/8080 8/9 bit PPI or 3/4 wire SPI, i.e. can support almost ALL driver controllers with frame-buffers embedded
- **Host interface**
  - Very high-speed 6800/8080 8/9/16/18-bit parallel interface OR ¾-wire serial interface
  - Additional WAIT/IRQ to enhance system performance
  - Availability of WSYNC handshaking signal to allow better synchronisation of frame buffer with much less impact on display quality
- **Ultra low-power** 1.8V internal core that hardly any MCU GC can compete with
- Separate signal **voltage levels** for different interfaces or panels
- PCB space-saving **Gold Bump Die** and **LGA** packages available

## Performance Enhancement for MCUs with Embedded GCs

Some people like an MCU that can drive an LCD panel directly using its embedded GC. This does save some PCB board space, but at a cost to the system as a whole. For all applications with a GC function embedded in the MCU, a RAM buffer is required for the display. This buffer is seldom included in the MCU or, if it is included, it is normally not big enough to support a QVGA (320x240) full-colour display. This is because an on-chip RAM buffer decreases an MCU's production yield and hence increases the cost of an MCU chip. Therefore, in most cases, an external SDRAM, which is normally shared with program memory, is used as the frame buffer for the display. The configuration is shown in Fig. 2.:

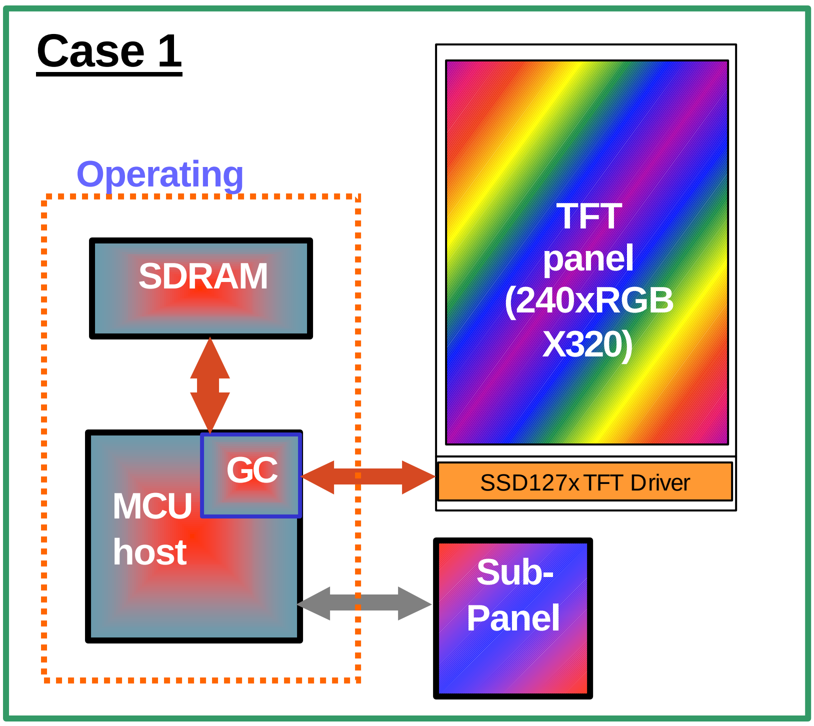


**Fig. 2. GC embedded in MCU.**

If external GC – SSD1918 is used, the system configuration becomes:

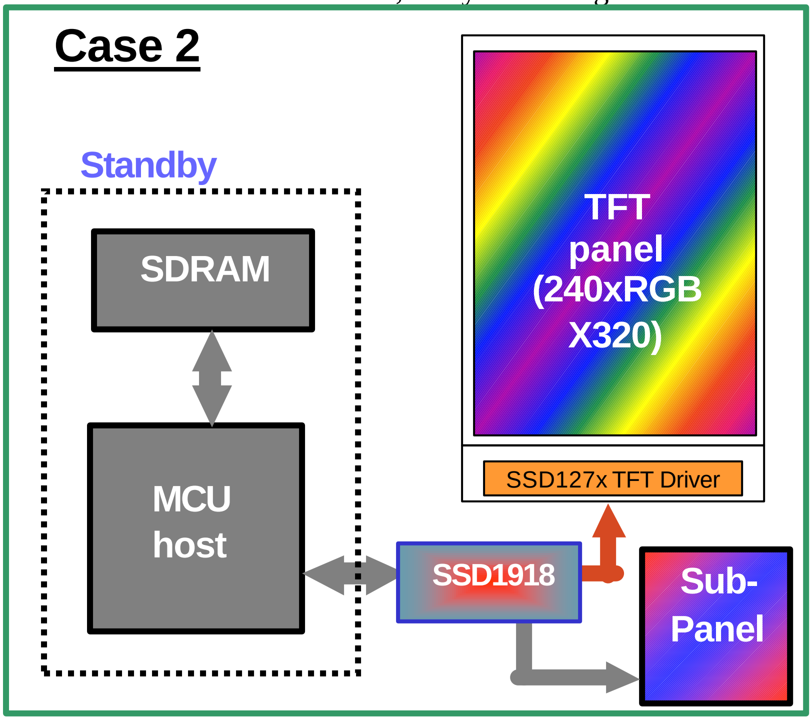


**Fig. 3. Separated GC using SSD1918.**

The configuration of an MCU-embedded GC in Case 1 has **disadvantages** over the external GC solution using the SSD1918. We discuss the details below:

1. High standby power
   The display output of the GC continuously refreshes itself from the content of this SDRAM, i.e. if the application requires a display to be shown, the SDRAM and the MCU's GC can never enter standby mode. This increases power consumption for the whole system.

   However, in Case 2, only the SSD1918 is required to power the main panel display, while other system components, such as the SDRAM and the MCU, can enter halt mode. During normal operations waiting for user input, the system can be set to halt mode frequently. In the above example of a QVGA 18bpp panel displaying at 60Hz frame frequency, the SSD1918 consumes less than 2mA. Some typical figures are shown in the table below:

| | Components \ System | MCU w/ embedded LCD controller | SSD1918 as separated LCD controller |
|---|---|---|---|
| 1 | SDRAM (4Mx32) | ~250mW | ~3mW (SDRAM standby) |
| 2 | MCU host | ~80mW | ~1mW (MCU sleep mode) |
| 3 | SSD1918 | N.A. (not using external GC) | ~4mW (display ON without updating) |
| 4 | 2.5" QVGA 18bpp TFT | ~20mW (most MCU only have 16bpp) | ~20mW (real 18bpp) |
| 5 | **Total** | **~350mW **** | **~28mW **** |

** These are typical states of system where the power defines the standby performance. Assuming no backlight is required for the display.

2. Lowering MCU effectiveness

The display should never be turned off in normal display modes. Suppose the main panel is a QVGA (320x240) panel displaying at 16bpp the SDRAM has a data bus width of 16bits and the TFT panel is refreshing at 60Hz. The SDRAM is then using 320x240x(16bpp)/(16bit)x60Hz = 4,608,000 read access cycles per second to update the display alone. This accounts for approximately 1/2 of the MPU time wasted (depending also on the SDRAM's speed and burst access frequency). This wastes a lot of MPU cycles as the MPU can perform NO useful calculations when the bus is updating the display.

These MCU cycles can be useful only if an external GC such as the SSD1918 is separated from the MCU. For example, when the system is operating and the MCU is performing video decompression using the SDRAM as its operating buffer, a lower performance MCU is required for the intensive computational video decompressions. Alternatively, the display frame rate can be improved with an external GC using the same MCU, e.g. if the film is decoding at 30 frames per second (fps), the GC has to be written at 30 whole frames per second. The accessing speed of the SSD1918 host bus is fast and comparable to some high-speed flash memories. This allows the host MCU more cycles to finish other time-consuming calculations or video decoding jobs.

3. Not flexible for TFT timing fine-tuning

Over the considerable time that Solomon Systech has had experience with display driver IC types of products, it has been noted that TFT display panels have optimum panel-operating frame frequencies where horizontal and vertical sync timing specifications vary from manufacturer to manufacturer. Minor changes to these timings can adversely affect the display quality. These variations in frame frequencies can be a tough job for some MCU-embedded GCs, as their system's clock frequency cannot be changed freely because other resources may also use the same clock. Even worse, the higher the frame rate requirement of a TFT panel, the lower the performance of the host MCU. This means more display data has to be transferred per second from the SDRAM buffer to the display, as calculated in point #2 above. For separate GCs, as in Case 2, the SSD1918 contains a high-resolution user-programmable PLL that can be tuned to fine frequencies to suit various TFT displays. Most importantly, variations in TFT display panel frame frequency requirements will not lower the MCU's performance, as they do in some counterparts.

4. Limitations in display panel's connectivity

The signal voltage levels of different LCD modules may vary, which an MCU-embedded GC cannot accommodate. There can occasionally be an error in transmission data when the voltage difference is not so large. However, in other cases where there is a large voltage difference between the MCU's GC signal and the display panel, additional voltage conversion logic must be used. This is the case for both the main display panel and the sub-display panel.

In the Case 2 system with the SSD1918, each interface can have its own supply voltage for signaling, ranging from 1.6V to 3.6V. This wide voltage range makes the connection to main and sub-panels easy. Furthermore, the MCU-to-SSD1918 interface can range from 1.6V to 2.5V to suit different MCU-interfacing voltages.

Besides signal voltage levels, LCD driving signals slew rate control is also a special feature of SSD1918 that is seldom found in some other embedded LCD controllers in MCU. With this feature, the SSD1918 driving signal to LCD can have the slew rate adjusted without additional external resistors and capacitors.

5. <u>Alternation of display schemes</u>
   Another concern is that the display technologies and algorithms change rapidly, with many tricks such as dithering and FRC available to enhance display quality. The MCU's design cycle is usually longer than that of a GC alone, which makes the embedded-GC design outdated and not adjustable to different display algorithms. The design cycle of a separate GC is much faster than that of an MCU SoC, thereby increasing flexibility as time to market is always critical.

## Easy Host Connectivity, 18-bit Display Colour Depth

New TFT technologies continue to advance at an accelerating pace. Along with an increasing number of panel factories investing in and producing both large and small TFT panels, the technology is at a mature stage that drives the cost further down and therefore allows higher colour-depth displays. In addition, we can see the difference of an 18-bit-per-pixel (bpp) panel over a 16bpp panel with enough contrast. The common GC embedded in an MCU can only support a 16bpp panel with its 16- or 32-bit bus architecture that no longer satisfies market demand. Only a few new high-performance MCUs can support higher colour depth, but at considerable cost and with the disadvantage noted above.

In the current world of rich display colours and contrasts, even in small portable panels, an advanced GC with an 18bpp display option is definitely an advantage over other 16bpp display systems. Host MCU-parallel interfaces have an additional 18-bit data interface to ease the transfer of data from the MCU. The fast interface of the SSD1918 to the host MCU can make the MCU data bus seem as if the SSD1918 is an external SRAM to the MCU. A DMA can also be enabled. With the support of an SSD1918, existing product designs for 16bpp TFT or CSTN panels can now easily migrate into 18bpp TFTs with good colour and contrast for the cost of only a little hardware and software.

## Video Performance Enhancement

Panel screen orientation can be handled easily with an SSD1918 as it offers a selection of display orientations through its register settings. Video or picture content can be shown in different orientations when the main display panel is rotated using some innovative designs.

The size of an embedded SRAM of SSD1918 is full (176x220x18) x 2 bits. This can support two frame buffers of QCIF+ (176x220) resolution at 262K colour depth. The double buffer is a well-known typical way to eliminate the "tearing effect" (where the display has half an updated new bitmap, with the other half showing the previous bitmap). Displaying one page while updating another can solve this problem with ease.

Where the SSD1918 can support (240x320x18) x 1 bits, only one frame can be supported at this QVGA (240x320) resolution. In this case, double buffering is not possible. However, the SSD1918 has an additional hardware signal pin that can help solve the problem. This signal is sent to the host MCU once every display frame. The TFT display update can be imagined as a scan like a CRT, from top-line, left-to-right, and then top-to-bottom for each frame. If the host MCU is programmed smartly, it can update the first line's content as soon as the first line of display has been transferred to the display panel, as it can for the remaining lines. Then, in the next scan, a new image will be shown. This can solve the "tearing effect", although some software assistance is required.

## **Other GC Products from Solomon Systech**

Solomon Systech's LCD graphics controller (GC) family includes the SSD1905, the SSD1906 and the SSD1908, which support grey scale STN, colour STN, and digital or analog TFT panels. They also feature a selection of frame buffer memory sizes for different applications. Solomon Systech GC ICs offer Pb-Free packages that meet the proposed RoHS thresholds. Details can be found on the company's homepage: **www.solomon-systech.com**.

## **About Solomon Systech**

Founded in 1999, Solomon Systech Limited is a leading flat panel display IC company for high-tech products, providing display IC products on an international basis under its own global brand. With a "fabless" business model, the Group specializes in the design, development and sales of proprietary IC products that enable a wide range of display applications for cellular phones, computer monitors, flat panel TVs and other innovative consumer products etc.

Solomon Systech (International) Limited's shares are listed on Main Board of the Stock Exchange of Hong Kong Limited on 8 April 2004 with a stock code: 2878. It is also one of the constituent stocks on the Hang Seng HK SmallCap Index under the Hang Seng Composite Index.

More information about the Group, its products and services may be obtained at:
http://www.solomon-systech.com.