Fast OLED driver IC for video applications in portable devices

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MP3 players and mobile phones are the two most popular and fastest-growing commercial electronic products today. Encoding audio data by compression into MP3 format is changing how people listen to music. By the time the first portable MP3 player appeared in 1998, people were able to enjoy listening to music in MP3 format, wherever and whenever they wanted. Shipments of MP3 players are expected to grow from 27 million units in 2004 to over 100 million units in this year. In addition to the coding, each MP3 player also needs a display panel as the communication interface with users. With the advancements in display technology development, MP3 players are now available with mono, area color, gray scale and full color display panels, and in different resolutions. Besides displaying track numbers and song names, previous OLED driver ICs have enabled still picture display applications with the commercialized OLED technology in MP3 players. Now, users can even view music videos while listening to MP3 players/ Portable Media Players (PMPs).

On the other hand, the mobile phone market is expected to grow continuously in the coming years. Popularization of mobile phone color displays induced a plethora of end-applications: playing and taking videos/photos, playing games, browsing webpages, checking emails and reading e-books, to name a few. It is anticipated that in the year 2006 half the mobile phones will be accompanied with a camera application and that in the year 2009 over 900 million camera mobile phone units will ship. Furthermore, with the transformation from 2G to 2.75G/3G phones, applications like video conferencing, multimedia, video-on-demand and DVB-Handheld (Digital Video Broadcasting for digital mobile TV applications) are being inaugurated. As a result, the demand for video applications on mobile phone grows and grows.

Figure 1: End product using Solomon Systech Single Chip OLED ICs

Video Display trend

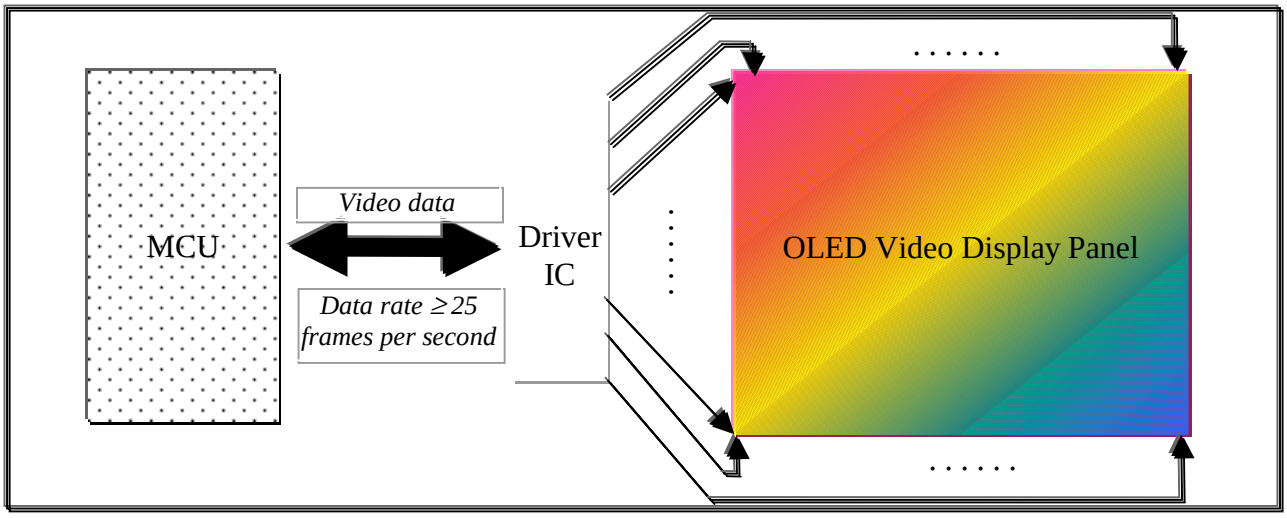
From song names to lyrics, caller numbers to caller photos, still photos to real-time videos, people today expect more content for both of the MP3 player and the mobile phone display. Common video data formats in PMP like MPEG4 and H.263 require high frame rate: 25 frames per second or above to ensure a smooth transition of video image frames. Also, video capable response, using display panels with high resolution, true color and sunlight-readable, is also vital in mobile device video applications. To overcome these challenges in display technology, OLED is expected to be a timely solution for MP3 and even PMP and mobile phone displays due to its invincible advantages: less than one millisecond video response time, self-emissive and hence high brightness, almost 180^{o} viewing angle, good contrast for high level of clarity to the eye, and low power consumption favorable for portable electronic devices.

Driver IC for video displays

Further enhancements in IC technology allow faster data rate and true color. Therefore, video OLED display in PMPs is getting ready to launch. The next step will be the video OLED display in mobile phones. In order to fully manipulate the various inborn advantages of OLED in PMP and mobile phone video applications, a highly competitive and smart driver IC is needed. Playing or taking video requires a smooth transition between each image frame. OLED is known for its fast response time; however, a fast data communication rate between the MCU and OLED driver IC is also required to supply image data to the OLED panel continuously, as shown in Figure 2. First, the driver IC should have a fast response MCU interface. Second, in order to display realistic video/photo images, sophisticated color depth management through the driver IC is indispensable.

The SSD1339 from Solomon Systech offers a driver IC solution to migrate mobile display end applications from still picture displays to video displays.

Figure 2 : Communication between MCU and driver IC.



The SSD1339 is a single-chip driver IC with controller for the OLED panel. It supports panel resolution up to 132RGBx132. The driver reveals realistic image colors by providing 262K true color. To achieve such high color resolution, the MCU communication data width has been increased to 18-bit, ensuring both fast and smooth video display performance.

High speed MCU interfaces

The SSD1339 supports 9 different MCU bus interfaces with up to an 18-bit data width, over 180 frames per second for fast data communication and video frame update rate. This special design fits the requirements for fast response applications such as displaying video smoothly on PMPs and mobile phones with higher performance yet at the same cost. OLED display response times of 1ms or below are achievable, while TFT LCD is around 10ms. OLED video display quality is much better than that of TFT LCD. The SSD1339's super-fast response time is powered with a special low power consumption OLED driving scheme.

The SSD1339 displays data directly from its internal 132x132x18 bit SRAM display buffer, with each pixel represented by 18-bit data, with each sub-pixel for colors R, G and B having 6 bits. The maximum color depth is 262k with a 256 steps contrast control. True color video display is achievable through this sophisticated color management.

In 262k color depth mode, both 16-bit and 18-bit MCU interface communication modes can be adopted to access the graphic display data RAM in the OLED driver IC. However, the 18-bit mode speed is double that of the 16-bit mode, as explained below:

For the 18-bit interface mode, communication consists of only one session of 18 data bits. MCU transmits all bits to write a single 18-bit pixel data into the OLED driver IC. Figure 3 shows the 18-bit color depth data writing sequence, where A, B and C represent colors R, G and B in any order.

Figure 3 : 262k color depth data writing sequence in 18-bit MCU interface

Bit	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data bits	C_5	C_4	C_3	C_2	C_1	C_0	B_5	B_4	B_3	B_2	B_1	B_0	A_5	A_4	A_3	A_2	A_1	A_0

For the 16-bit mode, communication is divided into two sessions of 16 data bits. MCU transmits two 16-bit words to write one 18-bit pixel data into the OLED driver IC, as illustrated in Figure 4.

Figure 4 : 262k color depth data writing sequence in 16-bit MCU interface (X = don't care)

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1st word	X	X	X	X	X	X	X	X	X	X	C_5	C_4	C_3	C_2	C_1	C_0
2nd word	X	X	B_5	B_4	B_3	B_2	B_1	B_0	X	X	A_5	A_4	A_3	A_2	A_1	A_0

It can be seen that for each pixel, only a single session of data is transmitted for the 18-bit mode, while two sessions of data are needed for 16-bit mode. This means that the time needed to transmit data for each pixel in 18-bit mode is half of that in 16-bit mode. There are about 17K pixels in panel of 132x132 resolution. Hence, halving the pixels' data transmit time in 18-bit mode makes a big difference, proving that the 18-bit data width can achieve a faster bit rate.

Conclusion

Fast response for smooth video playing and brilliant colors is important for the video display function embedded in PMPs and mobile phones. OLED display technology is a good solution for such applications and a compact design IC driver is essential. In addition to a chip-on-glass (COG) package, the SSD1339 from Solomon Systech can also be in a chip-on-film (COF) package to increase the flexibility of mobile application design. shows an example of the SSD1339U3, a COF package.

Figure 5 : Application example for the mobile phone main display - 128x128: SSD1339 in COF package – SSD1339U3