Co-author name: Mr. Felix Y.N. Wong
Title: Technical Marketing Manager
Company: Solomon Systech Limited
Website: www.solomon-systech.com

Co-author name: Mr. Alan Richard
Title: Director of Technical Marketing, Display
Company: Kopin Corporation
Website: www.kopin.com

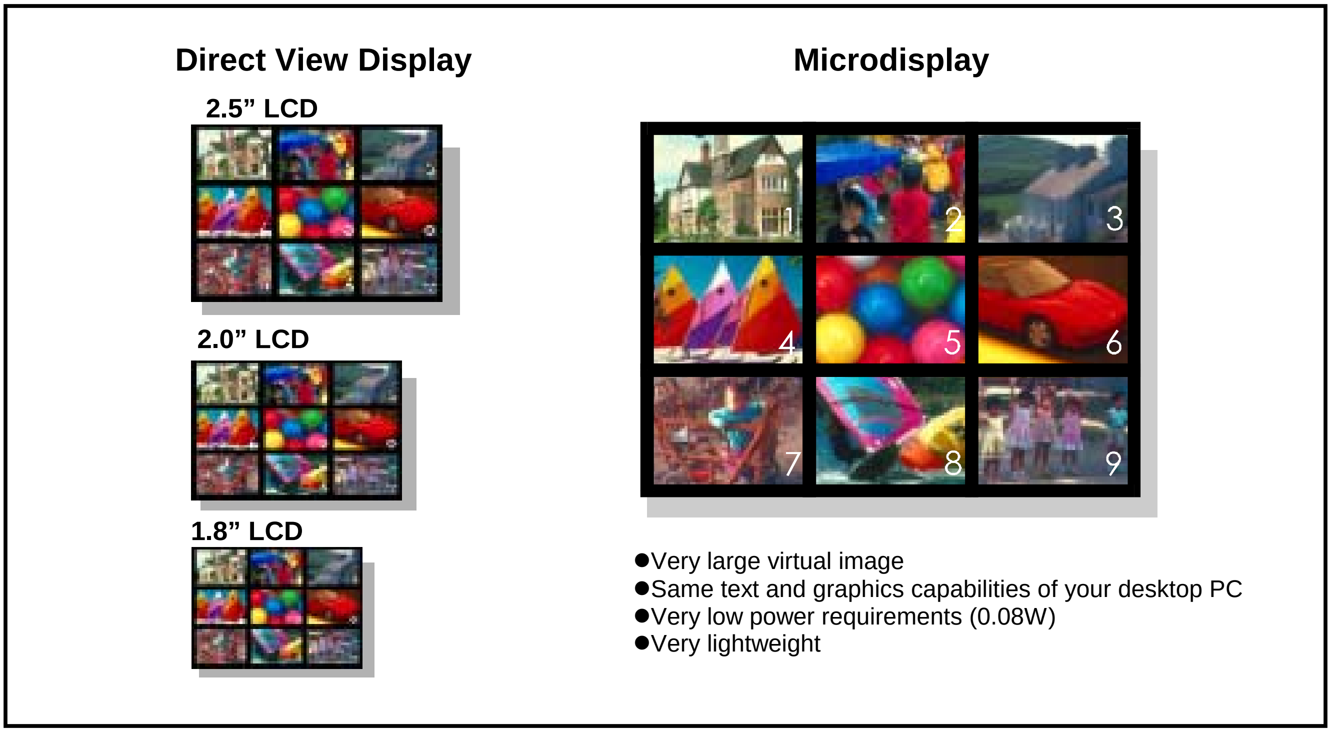
Microdisplay applications for portable systems

Displays for most portable applications must be very small to accommodate device form-factors that can easily slip into a pocket or small handbag. Measured diagonally, older mobile phone monochrome LCDs are only 1” to 1.8”. Current displays use color passive matrix LCDs that vary from 1.5” to 2.2”, Now the trend is toward 2”-2.5” displays in mobile phones, or even 2.8” in some pocket-sized digital cameras.

Higher resolution and more vibrant colors are other growing requirements for portable displays, enabling them to display more information and higher-quality images with the same sized screen. However, due to limitations of the human eye, there comes a point where higher resolution improves the image smoothness only marginally, with few added benefits.

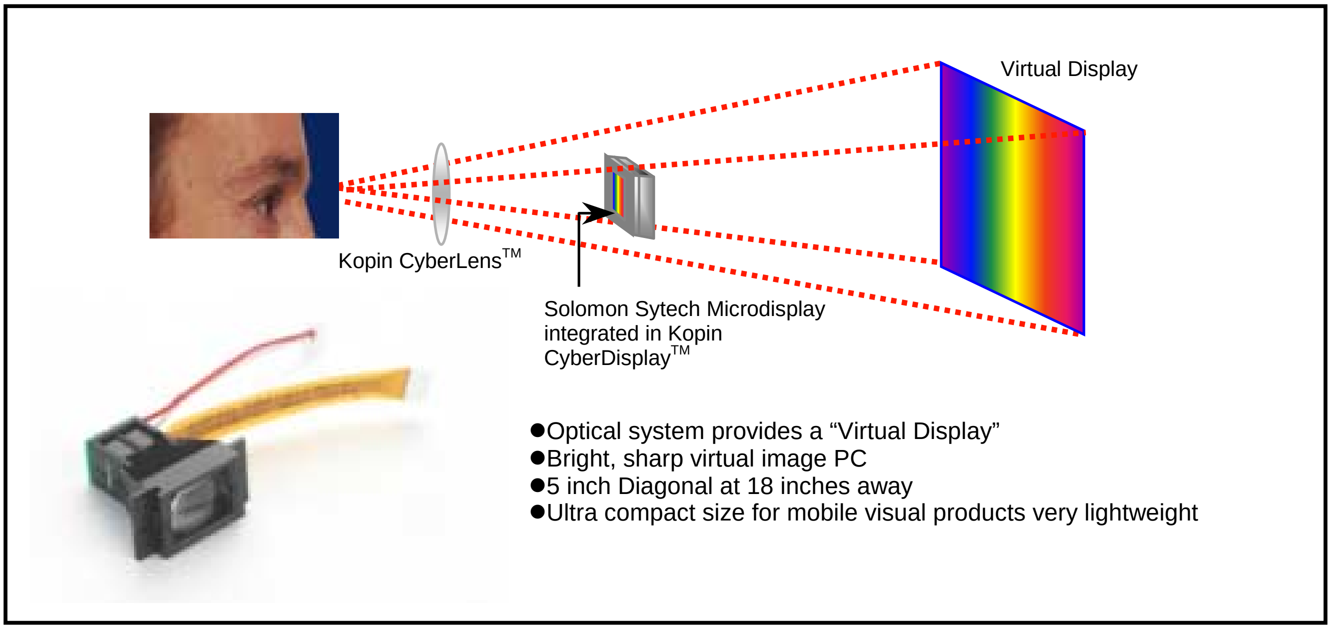
With microdisplays, the panel pixel size can be much smaller than active matrix TFT LCD panels and yet produce images with a much higher resolution, without compromising the applications’ physical size. In sizes ranging from a dime to a grain of rice, microdisplays consume far less battery power than competing offerings. Yet, with an appropriate optic they provide a magnified virtual image size as large and as clear as much bigger displays. A VGA (640xRGBx480) microdisplay is typically within 1/2 inch diagonal.

Figure 1: The Virtual Display Advantage



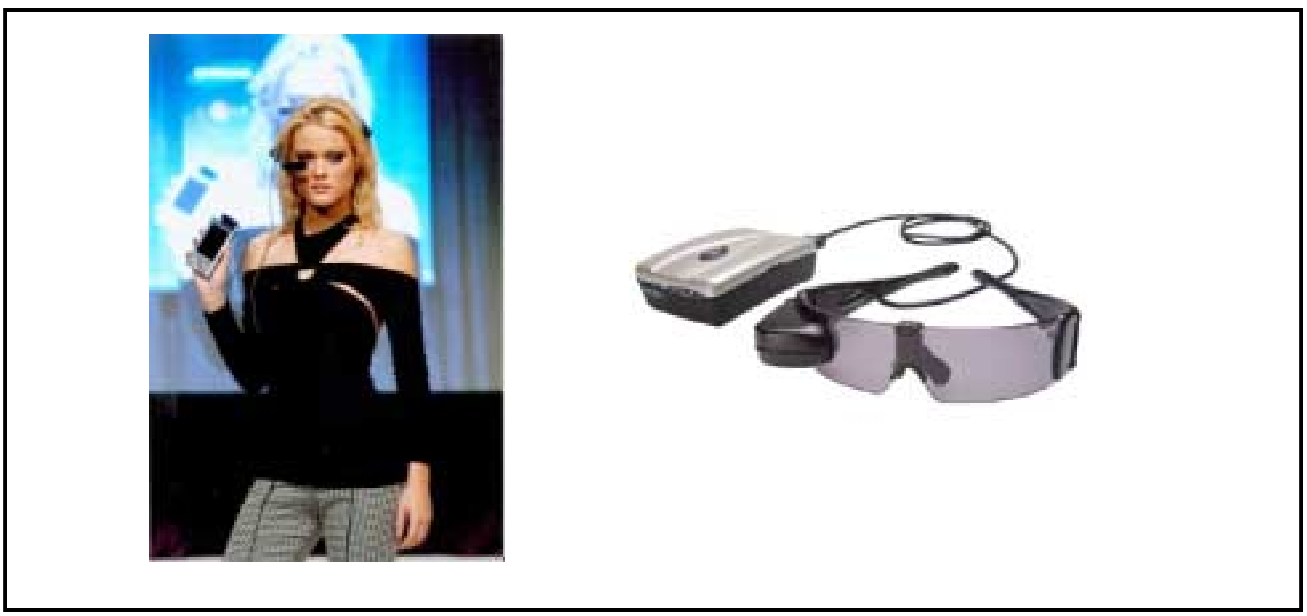
As optical systems advance, using lenses of highly diffractive materials, they are becoming increasingly compact and more suitable for portable displays. The optics solves the microdisplay’s physical size restrictions. For example, many electronic view-finders (EVF) used in popular brand-name cameras or camcorders incorporate Kopin microdisplays. Microdisplay images can also be projected onto a surface. In fact, any portable application using normal display panels can be replaced with a microdisplay.

Figure 2: Viewing a Microdisplay



New applications are also being made possible thanks to microdisplays. When head-mounted in eyewear, microdisplays can provide content to one or both eyes with two microdisplay panels, which is enabling a new technology popularly called micro-theatres for use in mobile video applications. Companies such as Icuiti, Eyeneo and Oriscape offer Kopin microdisplay-enabled eyewear designed for personal DVD viewing.

Figure 3: Micodisplay end product application

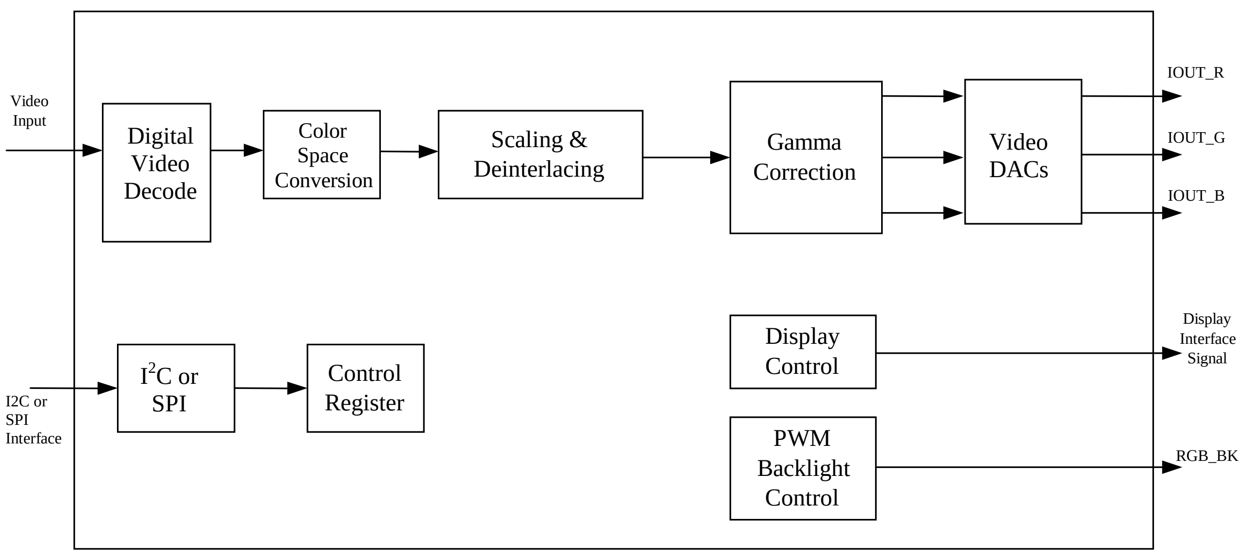


The technology also enables 3D viewing. Imagine two different images projected to the left and right eyes by two cameras at a separation close to that of a pair of human eyes. This enables you to actually see a three-dimensional scene. This kind of 3D impression can hardly be produced using a single flat image. In addition to 3D micro-theatres, 3D gaming and simulation are also well suited for head-mounted displays. Microdisplay products are facilitating new ways to interact with data, such as reading e-mails and browsing the Internet, using digital wireless devices and other portable electronics devices.

Graphic Controller Chip – the mastermind behind microdisplays

Different microdisplays typically need different kinds of signals to control timing and video source inputs. They require programmable timing controllers, scalar, de-interlace for interfacing to a host, and either an MCU or DVD video. In most cases, special FPGAs, timing ASICs or DACs are required. For displays designed for consumer electronics and next-generation mobile video devices, chip integration and costs are key factors. Today, these key elements are included into the microdisplay graphic controller chip to provide a turn-key solution. The system structure and hardware design is simplified for the OEM. Below is a simplified functional block diagram:

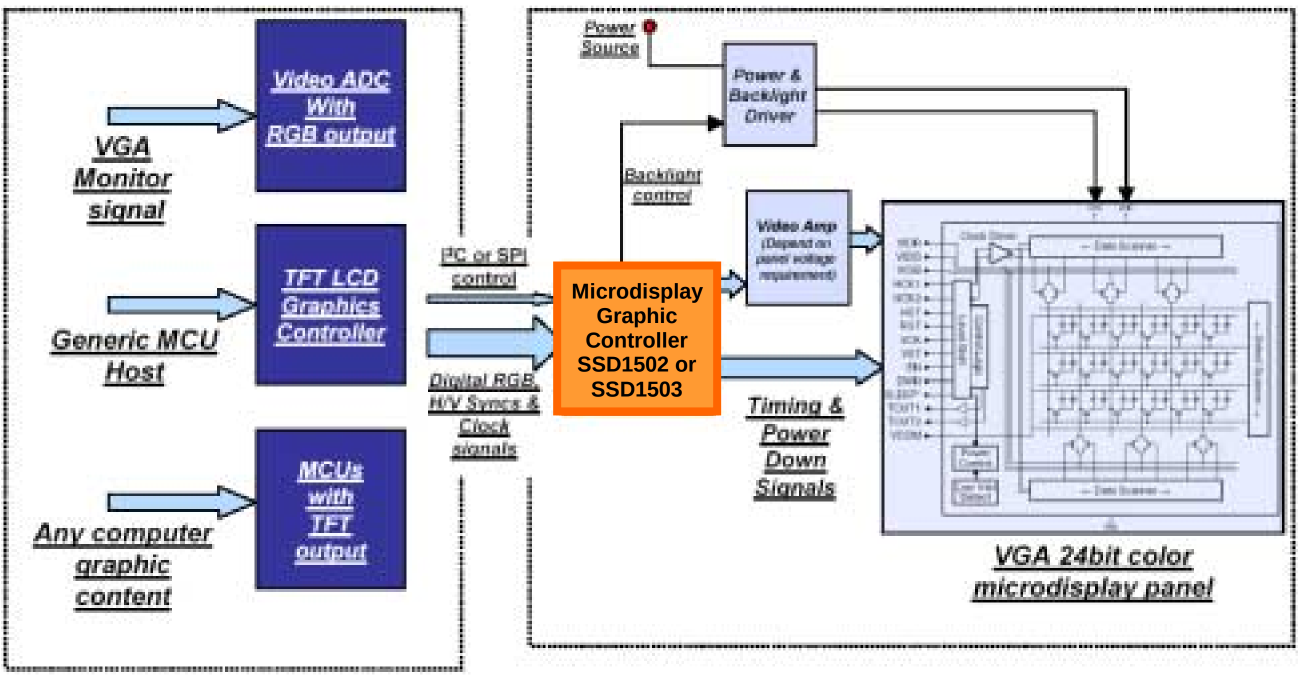
Block diagram #1: Solomon Systech's microdisplay graphic controller SSD1502 or SSD1503



For common images or video content, the signal interfaces are usually NTSC/PAL digital YUV or digital RGB. Some DSP or MPEG chipsets may support various formats of digital YUV signals of BT-601 or BT-656 formats, whereas general MCU may support only the digital RGB interface that is for generic TFT panels only. With the Solomon Systech microdisplay controller chip, signals from different sources can be interfaced seamlessly to a Kopin microdisplay. The host microcontroller or DSP does not have to bother with special timing and interfacing signals with the microdisplay. Product system designers can simply treat the microdisplay as the conventional display with which a host commonly interfaces and the design can be achieved relatively painless.

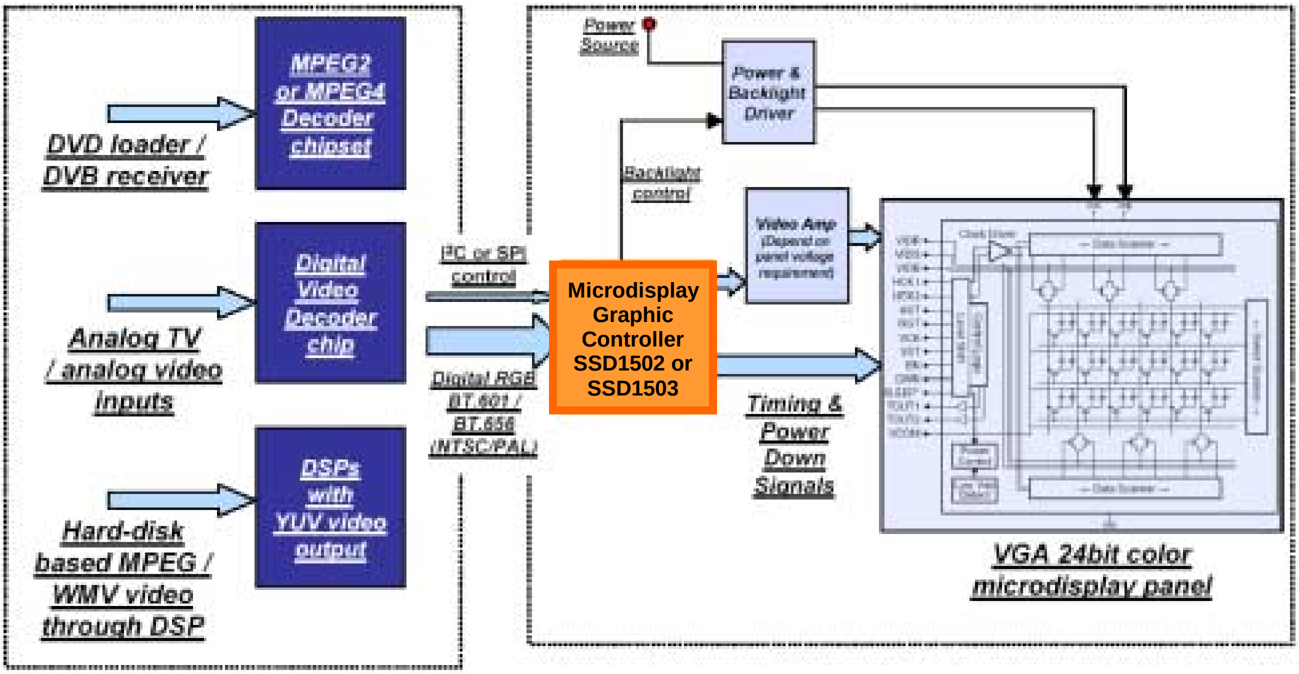
Designers can configure the microdisplay chip using either I^2C or SPI. For common video applications without high-performance MCU or DSP host, I^2C is very common. On the other hand, where the system is connected to a high-speed host, SPI is usually preferred for its higher connection speed. Below are two typical example block diagrams of how Solomon Systech's microdisplay graphic controllers work in a portable system:

Block diagram #2: Interfacing digital video output to microdisplay



This configuration can be applied to many video related applications, like portable DVD players, portable TVs, surveillance systems, camera interfaces, etc. Since the video source can be of a square or rectangular pixel, scaling is required to fit the content onto the display. If the input signal is interlaced PAL or NTSC, the chip can also perform a de-interlace operation. YUV and RGB color space conversion is also included for different input signal formats.

Block diagram #3: Interfacing digital RGB output to microdisplay



For this configuration, generic computer graphic, 2D/3D games, software JPEG or MPEG files can all be displayed from those PDA-type MCUs. This kind of microdisplay application can be found in mobile phones, digital cameras, GPS displays, PDAs or even a PC monitor.

Advanced system with 8-fold battery life extension

In addition to ease of use, low power consumption is a critical issue in most portable applications, especially for driving the display. For normal TFT LCD panels with a VGA 3.8” panel and all related CCFL backlight and panel driving circuits, the power consumption should typically be 800mW (depending on configuration) with most of the power used for backlighting. However, for a VGA microdisplay, the display area is much smaller (<0.5” only), thus the LED backlighting requirements and the lighting area are so small that the power consumption is dramatically reduced. Some members of Kopin’s family of microdisplays consume as little as 25 mW, making them well suited for portable electronic applications where low power consumption is critical for long battery life.

When head-mounted, the microdisplay panel is less affected by ambient light conditions. Consequently, the backlight does not have to be overly bright. The microdisplay graphic controller chip from Solomon Systech can also be set to control the backlight to its optimal brightness. The combined microdisplay and backlighting typically consume just 100mW of total power. During document reading or Internet browsing, most of the usage is spent viewing content; the rest of the system can be on standby mode. The display power consumption relates directly to extended battery life. In summary, battery life can be extended more than eight-fold with such a microdisplay technology.

Superior color accuracy and video quality

The microdisplay graphic controller chip has three built-in high-accuracy 8-bit video DACs to produce color as precise as the input. To match different loading and impedance requirements, the DACs' output currents are adjustable by an external reference resistor.

To make the display color more configurable for different panels, programmable gamma correction has been implemented into the microdisplay graphic controller. This feature gives flexibility when some similar types of microdisplays may have different gamma curves than that of existing designs previously referenced. The panel color can also be used to customize different end-users' preferences.

Another advanced feature is that when the input video is an interlaced NTSC or PAL signal, the chip's built-in deinterlacing algorithm can be activated to make the video smoother to the eye.

3D stereo display

For three-dimensional images, the chip incorporates logic to include stereo 3D content support. With a single video input data stream, a stereo 3D picture or video can be shown with two different microdisplay panels. The product can easily be realized as a 3D goggle, with the small size and light weight of the goggle and minimal components count with the microdisplay graphic controller chip. The chip has built-in circuitry using a single video stream input to produce stereo 3D images on the microdisplay. This minimizes the interconnection signal lines from the host to the 3D goggle. Frame stereo 3D or line stereo 3D can be selected with simple register configuration.

Several PC display cards now support the 3D stereo display utilizing the existing 3D content of generic Microsoft Direct 3D objects. By assuming two parallax points of view to reconstruct the whole 3D scene, the display card software API driver can provide this kind of stereo 3D video output. Existing 3D games, such as car racing, real-time strategy, sports, ball games, city building, etc., can all be implemented using the 3D stereo display with a microdisplay system.

Conclusion

With advances in microdisplay technology, microdisplays are being adopted more and more in the consumer market. Together with the dedicated integrated chip support, microdisplay solutions will be increasingly competitive.