

FEATURING

System-on-Glass 3.8-Type LCD Display with All Peripheral Circuits Integrated on the LCD Itself

LCD with Fully Self-Contained Drive System Developed

- **System display**
- **All circuits required for drive are fabricated at the same time as the LCD itself on the glass substrate**
- **Circuit design technology that can achieve display free from nonuniformity**
- **Color filter fabrication technology that achieves excellent color reproducibility**

The number of consumers who use PDAs and other portable information terminals has been increasing in recent years, and total worldwide shipments of these units is approaching 12 million units per year. The LCD used in a PDA is truly the "face" of the device, and it is not excessive to say that the display quality of the LCD determines the salability of the product. Furthermore, the market now requires LCDs that achieve light weight and thin form factors in addition to providing outstanding picture quality to provide product differentiation in the information terminal market. As compared to amorphous silicon technologies, the low-temperature polycrystalline silicon LCD technology that Sony has adopted to achieve high picture quality can implement transistors with higher performance. By improving this performance even further,

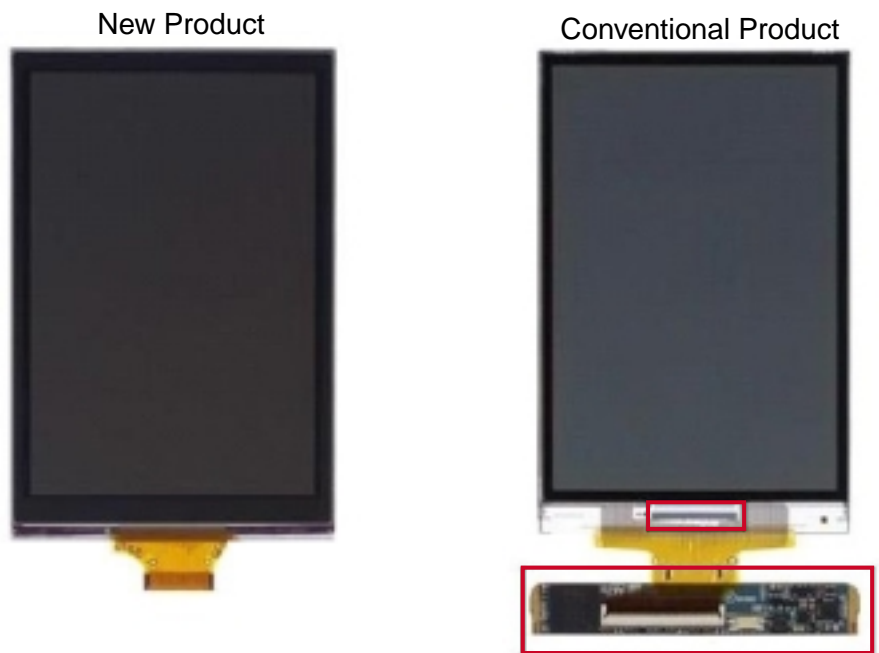
Sony has now succeeded in developing a System-on-Glass LCD display that integrates all drive circuits on the LCD glass substrate thus forming a single unified device. In LCD manufacturing, connection lines with widths on the order of one micron are formed on mother glass substrates about 14 times the area of the 8-inch wafers commonly used in semiconductor LSI manufacturing. Fabrication processes that use these enormous glass substrates are called "giant microelectronics." In the development project described here, Sony created a System-on-Glass product using 2-micron design rule interconnects, lines that are 50 times finer than a human hair.



■ Photograph 1 System-on-Glass LCD Image Display Example

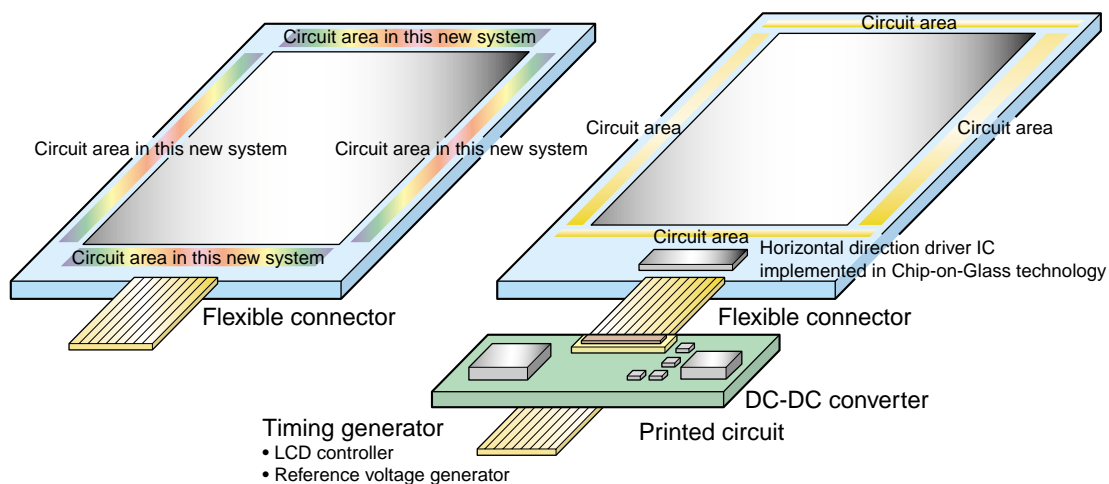
System Display

In this low-temperature polycrystalline silicon process, the silicon film formed on the glass substrate is melted with a laser beam and recrystallized to form an even polycrystalline silicon material. By combining this laser annealing technology with polycrystalline silicon surface control technologies, Sony was able to achieve electron mobilities twice that of conventional polycrystalline silicon. Sony also developed new technologies for forming fine patterns on glass substrates and succeeded in reducing the interconnect rule size by 1/2. Developing these new technologies allowed Sony to reduce the threshold voltage of the transistors on the glass substrate and achieve both stable operation and high performance.



Note: The two sections enclosed in rectangles are peripheral circuits that are formed at the same time as the LCD on the glass substrate in the new product.

■ Photograph 2 System-on-Glass LCD (left) and Sony's Equivalent Conventional Product (right)



■ Figure 1 System-on-Glass Technology Overview

Circuit Design Technology for Display Free from Nonuniformity

As a result of these improvements in TFT performance, it is now possible to implement all of the peripheral circuits required for display drive on the glass substrate itself, forming the whole system as a single device. This is called "System-on-Glass" technology. The following seven main circuits are integrated on this device.

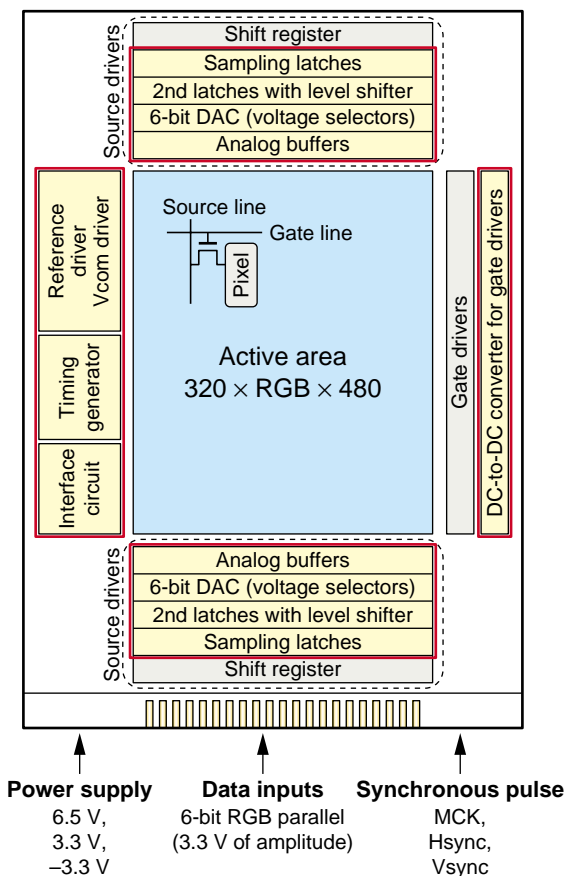
- Gate driver
- High-performance 6-bit source driver that includes offset canceling analog buffers
- 6-bit RGB parallel interface circuit
- Timing generator
- Reference driver
- Vcom driver
- DC-DC converter

The analog buffer circuit adopts the newly-developed double offset canceling technique*1, and achieves voltage variations 1/8 those of conventional methods. This new device incorporates this and other technologies that take full advantage of Sony's high-performance transistors.

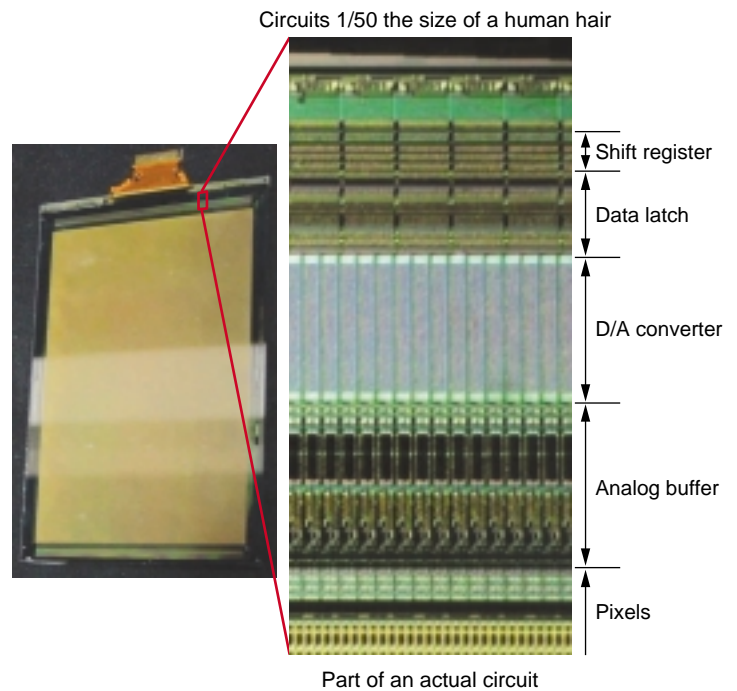
*1: This technology was announced at the Euro Display conference in September 2002.

Reduced Parts Count, Lower Power Consumption, and Further Miniaturization

Integrating the peripheral circuits in the display itself makes it possible to reduce the parts count, simplify assembly, and improve reliability in end products. Furthermore, the width of the frame has been reduced by 3.5 mm from that in earlier Sony products, thus increasing design flexibility in mobile equipment and allowing further miniaturization.



■ Figure 2 Newly Integrated Circuit Components



■ Figure 3 Process Technologies that Reduce Frame Widths

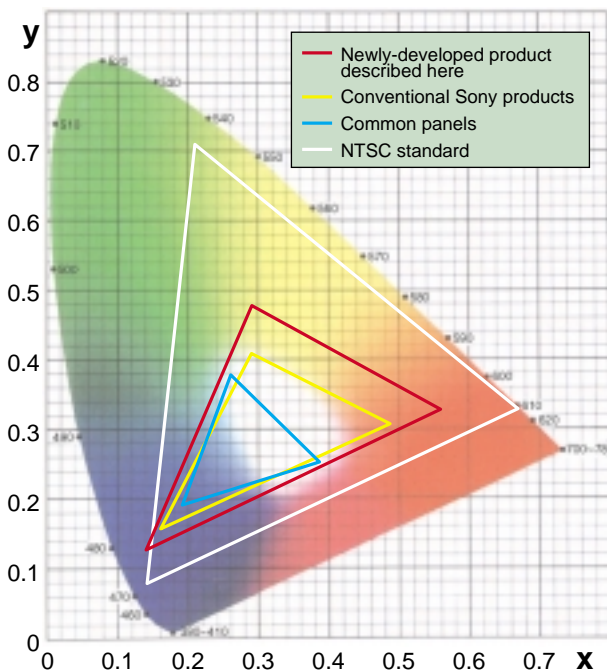
Color Filter Optimization Technologies

High-resolution PDAs are now often used to review images taken with a digital camera. Color reproducibility that can display such images attractively is, of course, strongly desired. This new LCD adopts Sony's LCD monitor technology, which has a proven track record in digital camera monitors, and despite being a 3.8-inch size monitor, achieves equivalent color reproducibility to the monitors used in digital cameras. Since this newly-developed panel is a combined transmissive/reflective display, it can reproduce colors just as accurately as transmissive displays even in bright outdoor light.

Future Developments

While much progress is being made in system-on-silicon devices in the silicon LSI field, many writers have also proposed the approach described here: integrating systems on glass substrates. We feel that only glass substrates can integrate displays and systems as man-machine interfaces while still taking full advantage of the major feature of glass, namely that it is transparent. It will not be long before further improvements in transistor performance and even finer fabrication technologies will allow memory, sensors, CPUs, and other devices to be integrated on LCD glass substrates.

Sony is committed to continuing to develop new display panels that respond to market needs as those needs change and develop. Keep your eye on Sony's System-on-Glass LCD displays for your future display needs.



■ Figure 4 LCD Panel Color Gamut

CIE 1931 Chromaticity Diagram (xy chromaticity diagram)

The xy chromaticity diagram expresses, on a 2-dimensional surface, the chromaticity coordinates determined by the tristimulus values XYZ in the XYZ color space based on the CIE color matching functions $x(\lambda)$, $y(\lambda)$, and $z(\lambda)$ adopted in 1931 by the Commission Internationale de l'Eclairage (CIE). This allows colors to be expressed quantitatively in terms of values on the x and y axes.

■ Table 1 Newly-Developed Product's Specifications

Item	Specification
Display method	Combined transmissive/reflective
Screen size	3.8 type
Display pixels	320 × 480 pixels
Pixel arrangement	RGB stripe
Dot pitch	56 (H) × 168 (V) μm
Color depth	262,144
Number of input pins	39 pins
Drive voltage	+6.5, +3.3, -3.3 V
Power consumption	110 mW (Typ.)