



## 1980s

### **Expansion of color graphics display market**

#### **~ Integrated Circuit ~**

The display that outputs computer information has changed from one used for dedicated tube such as Nixie tube to the other used for cathode ray tube (CRT), and evolved from the random-scan type, in which electron beams are directly scanned to draw characters and graphics to the raster-scan type, which operates from corner to corner like TV. The display of the raster scan type CRT has changed from monochrome (single color) display of black and white only to color and multi-gradation display. The display method has evolved from displaying characters only through a character generator to displaying preset semi-graphics patterns, and then to full graphics where buffer memory was used for one frame which is composed of pixel units. In the 1980s, 2D graphics display on raster scan CRTs became commonplace.

In 1981, NEC announced LSI (GDC:  $\mu$ PD7220) with a built-in graphics mechanism<sup>1)</sup>. This revolutionary LSI had ability to draw straight lines, arcs, and other graphics. After that, in 1984, Hitachi announced the advanced CRT controller (ACRTC: HD63484)<sup>3),4)</sup>, which was the successor to the CRT display controller (CRTC: HD46505, HD6845)<sup>2)</sup>. The chip photograph was shown Figure 1 below. Around 1980 was the transition period from 8-bit to 16-bit. Many companies developed various peripheral LSIs in order to match the trend toward 16-bit CPUs. As part of this effort, Hitachi developed the above ACRTC and floppy disk controller (FDC).

ACRTC is characterized by the mechanism that directly controls color graphics (packed pixel method)<sup>5)</sup>. The method which is a plurality of pixel data expressing color data is packed and stored in one word of memory. Figure 1 shows the difference between the conventional plain type and the packed pixel method. The plain type arranges multiple monochrome memory planes, and the configuration is simple, but the processing becomes slower as the number of bits required for color display ( $n$  bits for colors of  $n$ th power of 2) increases. On the other hand, the packed pixel method is superior to color display type because the processing time does not change even if the number of color bits increases. About two years after ACRTC, TI (TMS34010) and the other companies introduced their graphics controller LSIs, and all of them chose the same method as ACRTC's. ACRTC's packed pixel method was superior in technology.

The application of ACRTC in the early stage was graphics accelerator boards installed as an add-on for PCs. Because of that expensive full-color graphics with a lot of memory for standard equipment in PCs, they were mainly used as products for enthusiasts. Meantime, electronic technology was beginning to advance in automobiles, and the development of car navigation systems started in the

1980s. The world's first car navigation system was said to be the 1981 Honda Electro Gyrolocator. There was no digital map yet, and the CRT displayed only the point at the current position, and a transparent map sheet was layered on top of it. In 1987, the Toyota Crown car navigation system was released, and ACRTC was used to display the digitized map made by Denso on the screen. Car navigation systems at that time were based on autonomous navigation using gyro sensors. Since the 1990s, GPS has become available and car navigation systems have entered a period of widespread use. ACRTC and its successors have been applied to many systems and occupied dominant position in this market. Although its application in PCs was limited, ACRTC was used in many embedded applications such as car navigation systems, and widely used also in systems related to social infrastructure. ACRTC became one of the long-run products over 20 years, which was rare case as semiconductor products.

The packed pixel method<sup>6)</sup> has become an indispensable basic technology for digitally displaying color graphics in PCs, car navigation systems, game consoles, etc., and is used in many systems.

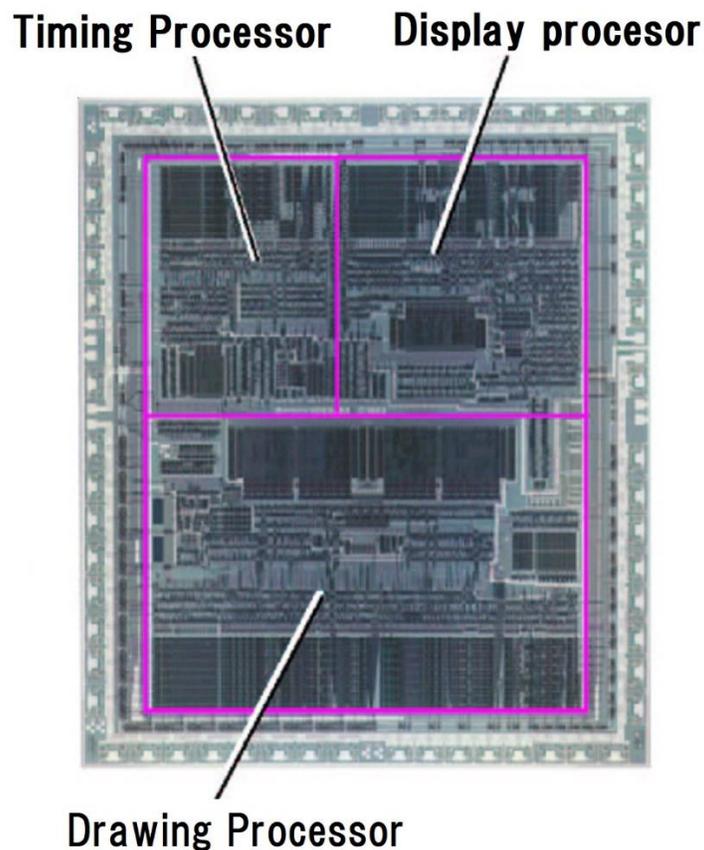


Figure 1 Chip photograph of ACRTC

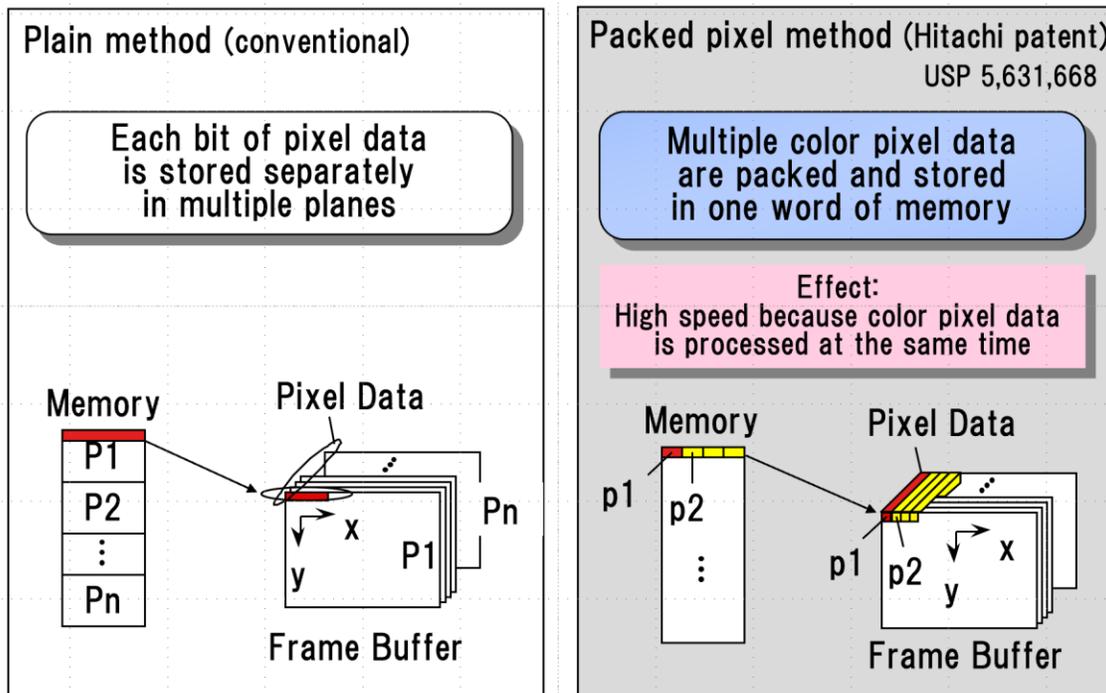


Figure 2 Packed pixel method

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