

## **Early 1970s**

### **Evolution of CMOS LSI circuits for watches**

**~ Integrated Circuit ~**

In December 1969, Seiko released the world's first quartz oscillation watch SEIKO Quartz Astron 35SQ (equipped with a hybrid IC). At the same time, Suwa Seiko-sha (now Seiko Epson) started development of its own CMOS IC. In 1971, it succeeded in developing the CMOS IC (R-38A) that operated at a low voltage of 1.5 V, and it was put into practical use for the SEIKO Analog Quartz 38SQW in the same year. The development and commercialization of CMOS ICs that enabled this low voltage operation was a breakthrough in the Japanese semiconductor industry at the time.

After that, in 1972, it succeeded in developing the world's first liquid crystal display watch CMOS LSI (R-57). Together with its own developed liquid crystal display, it was released as the world's first 6-digit liquid crystal display type watch, the SEIKO Digital Quartz 06LC in 1973.

In the midst of rapid progress of quartz application since then, in-house manufactured CMOS ICs were adopted for all quartz watch products of Seiko Epson (chronograph / calculator / world time etc.).

Here, the creation period of the CMOS LSIs for watches in the early 1970s is introduced.

#### **【Development period】**

The development target of the watch IC which started in 1969 was a CMOS IC operating at 1.5 V. For this purpose, they focused on (1) optimization of the surface concentration to form P and N type components on a single silicon substrate, and (2) extremely clean oxide film formation which is stable in long time operation. It was extremely difficult to satisfy these requirements under the circumstances of semiconductor manufacturing equipment and facilities at the time. Despite the start from scratch for equipment and technical skills, they achieved these targets in two years.

#### **【Practical application period】**

The first watch CMOS IC (38SQW Fig. 2) based on the developed technology was a 15-stage frequency divider circuit (with separate oscillator circuit and drive circuit) operating at 1.57 V. It completed the prototype in April 1971 and confirmed the achievement of target values such as various characteristics and reliability. The mass-produced products were shipped in November of the same year, and SEIKO Quartz 38SQW (Fig. 1) was released in December. Subsequently, in analog CMOS ICs for analog quartz watch, oscillation circuit, stepping motor drive circuit etc. were integrated on one chip.

In September 1972, CMOS LSI (Fig. 5) was developed for digital quartz watches, and in conjunction with the liquid crystal display that was developed in-house, the world's first 6-digit liquid crystal display type SEIKO Digital Quartz (06LC Figure 4) was released in October 1973. The FE method liquid crystal display element was used for display and it was six-digit-display of hour/minute/second. The average power consumption was about 1.5  $\mu$ W, the display voltage is 3 to 6 V, which were significantly improved compared to the light emitting diode, achieving a battery life of 2 years.

Semiconductor technology such as CMOS integrated circuit, manufacturing process, circuit

implementation, etc. realized these portable devices including watches, and it became the driving force for the development of the semiconductor industry.



Fig.1: SEIKO Quartz 38SQW (World’s first quartz oscillation watch with Calendar)  
(By courtesy of Seiko Epson)

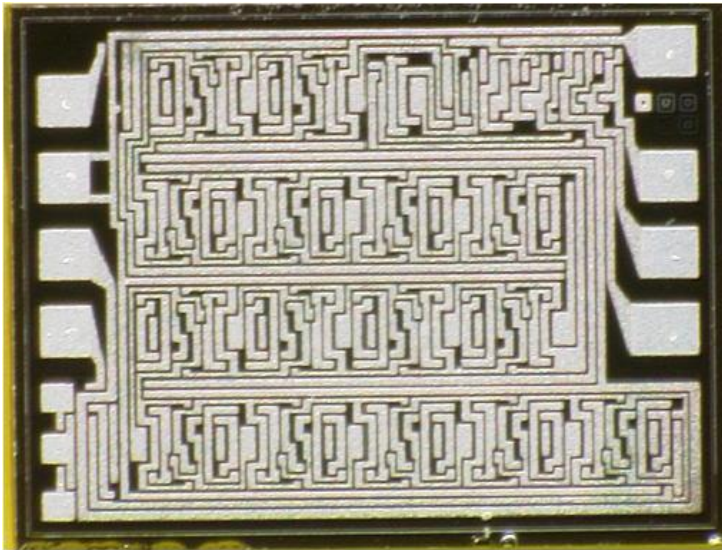


Fig. 2: CMOS IC for Analog Quartz 38SQW  
(By courtesy of Seiko Epson)

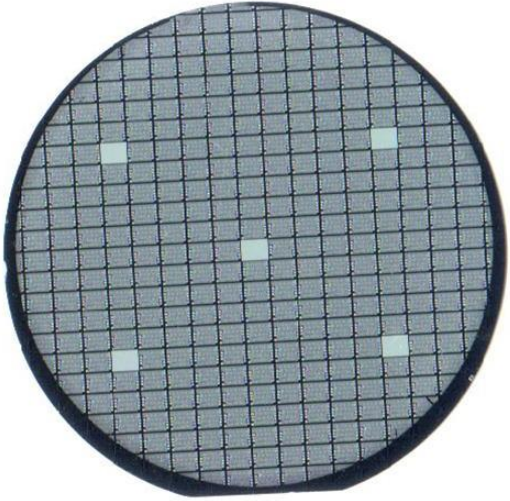


Fig. 3: CMOS wafer (1.5 inch) for 38SQW  
(By courtesy of Seiko Epson)