

## Episode 6

### **Semiconductor Golden Age Brought by Calculators**

In the evolution of the semiconductor industry, electronic calculators played extremely important roles in some immeasurable ways. The calculator pioneered the era of commercialization of LSI, played a leading role in CMOS technology, and became a trigger for microprocessor development, as we see in the later portion. Let's fly the time machine into 1964 when the Tokyo Olympic Games was held.

The calculator industry in Japan started with the world's first electronic calculator "CS-10A" developed by Sharp (then Hayakawa Electric Industry Co., Ltd.) in 1964. In this model, germanium transistors were used, and it was released at the price of 535,000 yen. In 1965, "CS-20A" model based on silicon transistors was introduced to the market at the price below 500,000 yen, and it became a big hit. In the next year, Sharp commercialized "CS-31A" using bipolar ICs, and further in the following year, in 1967, the "CS-16A" made of MOS ICs was released at the price as low as 230,000 yen. Every year, a new model that utilized new semiconductor technology was introduced to the market.

In this stage, it was Tadashi Sasaki of Sharp who insisted the next direction after MOS IC to be MOS LSI, and he played the central role for promoting this direction. First, he visited executives of domestic semiconductor makers including Hitachi, Mitsubishi, and NEC to inquire about the development and production of MOS LSI for calculators. But the discussions ended in vain because these makers thought it was premature. He then traveled to the United States in May 1968, and visited 11 companies in total, including Fairchild, TI, and AMI, but this did not work well either. Finally, the negotiation settled at the second meeting with North American Rockwell, which he visited as the last company. The transaction was said to be largest ever in LSI business, with 3 million pieces of LSI's and 30 million dollars (unit price 10 dollars). This transaction made a strong impact on both the calculator manufacturers and the semiconductor manufacturers as well.

Inside Hitachi, Kameido Works was responsible for the calculator business at that time, and they put strong efforts to the LSI application, gathering the company wise resources. In October 1968, the target was presented from the Kameido Works to commercialize all-LSI calculator by the end of 1970, and the number of LSI's per unit to be 10 or less. On January 4, 1969, the kickoff meeting was held to start a special R&D project for the development of calculator LSI. It was the companywide project including Calculator Division, Semiconductor Division, Systems Laboratories, and Central Research Laboratories. This type of companywide R&D was called "Tokken" inside the company, as an abbreviation of "Tokubetsu-kenkyu" meaning special R&D project.

The LSI calculator "QT-8D" (Photo 6.1) was announced from Sharp in March of 1969, while this "Tokken" was still in the stage of progress.



Photo 6.1 LSI calculator “QT-8D” announced from Sharp in 1969

Every member of the project took it seriously that, “At last, the era of LSI has come true!”, and the “Tokken” was even more accelerated. With more than expected results, Hitachi made a press release in May 1970, announcing “the completion of the first domestically produced LSI calculator.” Although it was late by over a year to the announcement of Sharp, it was honored for “the first domestic”.

Following this achievement, the semiconductor executives of Hitachi such as Tadayuki Takei, Executive Director of Hitachi, Masami Tomono, GM of Semiconductor Div., and Shotaro Shibata, Deputy GM of Semiconductor Div., visited the top of the calculator makers, appealing “Our company is now able to mass produce LSI’s for calculators. We established a system of custom design, and we can accept your design at any time.”

I was in the position of Product Development Dept. Manager since November of the previous year, and was responsible for dealing with LSI development requirement from many customers.

We dealt with many calculator customers from inside and outside of Japan including Sharp, Casio, Ricoh, Tateishi (now Omron), Sony, Brother, Canon, and Olivetti etc. Each of the development projects of such many custom products had its own stories, and many of them are still in my memory. Here, I would like to introduce two projects that are particularly unforgettable.

The first case was LSI development for Ricoh, which was internally called the “Joni-kuro Project”. “Joni-kuro” is a Japanese word corresponding to “Jonny Walker Black Label”, a brand of Scotch Whisky.

On November 5, 1971, the executives of Ricoh came to visit us and they inquired about the development of 2 chip LSIs for the next calculator model. As their logic design would be finished by the end of the year, they wanted us to complete the LSI samples by March 1972, so that they could make their product in time for the show to be held in Hanover, Germany from 20<sup>th</sup> of April. They

also requested to start mass production shipment from the end of April. And they added “If you keep this schedule, we will make a present of two bottles of Joni-kuro to you” as a bonus. “Joni-kuro” was regarded as representative luxury whiskey in Japan at that time.

Prior to that, Ricoh’s executives said that they had visited AMI (American Microsystems International in the US) to inquire about the development. AMI was considered the strongest manufacturer of LSI at the time, but they hesitated because the schedule was too tight to execute, and they could not agree on the deal. It was Ricoh’s request to us right after that. This was a task like a touchstone to our LSI development capability, and I decided to take up the “Joni-kuro project” after consulting with Matsukuma and Sakaba who were the persons in charge of practical implementation.

The first step was the layout design, of which double or triple checks were carried out for completeness. The rest of steps starting from mask making, to wafer processing, and to assembly and test were advanced with highest priority. The first prototype worked successfully! And we could keep the promised delivery date for Ricoh. This model was a calculator with a 10-digit printer, and it was released extensively as Ricoh’s strategic model with a nickname of “Ten-Ten-P”. After the project, we had a party to celebrate its success, and we tasted “Joni-kuro” whisky which we received from Ricoh. It is an unforgettable memory.

Up to that time, it was an established perspective that the US was overwhelmingly advanced in LSI, and Japan was clearly lagging. But the success of this project reversed the perspective. The confidence spread in our company, that “We won AMI, the strongest LSI manufacturer in the world!”

The next case is the collaborative development of LSI with Casio for a model that became famous at a later date for its spot commercial “Answer in One Shot: Casio Mini”.

On March 9, 1972, Casio’s executives in charge of calculator business visited us. It was an extremely important development project, and strict observance of the schedule was most important. Their request was to complete the LSI samples in May, followed by the shipment in the quantities of 10,000 pieces in June and 20,000 pieces in July. Moreover, their target of LSI price was less than 1500 yen, very low compared to other cases at that time.

After undertaking this case, development project proceeded through the day and night. Fortunately, the prototype was completed earlier than planned, and it successfully worked in the first trial. Casio executives visited us again in June and they requested for further increase in volume. They showed the quantities of 40,000 in July, 100,000 in August and 230,000 in September, which were almost unprecedented. And in August, Casio made an extensive announcement on the 6-digit calculator “Casio Mini”, shown in Photo 6.2, which was a product with an extremely novel concept.



Photo 6.2 Casio Mini announced in 1972

The calculators at that time had at least 8-digit display, but it was set to 6-digit, and 12-digit display was enabled, if necessary, by pushing the display switch twice. The size was about 1/4 of the conventional model, and it could be put in the pocket. The shocking thing was that the price was only 12,000 yen, or one third of the other models in the market. The spot commercial of “Answer in One Shot: Casio Mini” was repeated on TV, and Casio Mini sold explosively. It is on the company’s website that the lifetime sales reached 10 million units, exceeding 1 million units in the first 10 months after release.

This model had a great influence on the situation of calculator warfare. There were calculator makers as many as 65 in the world at the peak, but many of them began to fall out of intense competition. Meanwhile, Casio established its position as one of leaders of calculator makers.

Hitachi’s LSI was also supplied to a large number of other manufacturers, but Casio Mini’s big hit became an additional boost to our LSI business. The domestic share of Hitachi LSI in the second half of 1972 reached to 65%, and we could establish a position to be called as a sweeping victory.

Our LSI business started with the first shipment to intracompany Division in 1970, and its shipment to global calculator market sharply increased until 1973. As the result, the semiconductor division made a great leap forward resulting in the era of “golden age”. It was not only the case of Hitachi, but most of LSI manufacturers in the world enjoyed the big market created by the calculators. In retrospect, it was one of golden ages in the history of semiconductor industry.

However, good time does not last long. The world economy was severely damaged by the oil crisis that began in the fall of 1973, and the semiconductor market went through the negative growth for the first time in its history. Hitachi’s semiconductor business, too, which had strengths in custom LSIs for calculators, encountered a great ordeal. Stories of sad reality will follow.

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