VIP CLUB

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The SNERT Chip Development

By Ken Graber, Larry Bolton, and Jeff Parker – merged by Lowell A. Benson

In 1979 and 1980 I [Ken] was providing technical support of North Atlantic Treaty Organization (NATO) Industrial Advisory Group (NIAG) Subgroup 6 meetings [with the U.S. Navy and Sperry Management] for the NATO Standard Low Level Serial Input/Output (LLSI/O) specification. Bob Salter and I had been supporting this interface design and test work for approximately a year and half as the UYK-20 and UYK-7 had implemented the interface. Believing that we were close to a final agreement for the NATO specification, Bob and I finished the final update of the NATO LLSI/O specification for MIL-STD-1397 – Type E, and submitted a draft for PMS 408 approval [Navy Office]. Marc Shoquist was the primary company representative at the NIAG meetings for over two decades – his story and viewpoints are in a separate article, to be posted fall of 2008.

There were three major reasons for developing the LLSI/O:

1. Cable weight, a tri-axial cable was less than a quarter the weight of parallel interface cables.
2. The Type E was a high speed interface at the time. It was a 10-MHz serial interface, which provided 312,500 words per second for the AN/UYK-7 compared to the 250,000 words per second for the Type B parallel interface.
3. Electromagnetic Interference (EMI) was one of the design items that caused the interface to be implemented with a lower voltage level when compared to the Type D interface. Tri-axial cable was also used for the interface in order to reduce susceptibility to noise.

In January 1981 I [Ken] transferred back to Engineering and accepted project responsibility for development of a Low-Level Serial Interface chip set which could be used to integrate the interface into Sperry computers and peripherals. The Serial NATO Encoder/Receiver Transmitter chip was nicknamed SNERT [same as the dog in the comic strip “Hagar the Horrible”], and was planned to be produced using Sperry Semiconductor Division’s Low-Level TTL process in Eagan, MN. The chip set was defined to require two devices: a custom Integrated Circuit (IC) which would provide the Encoder/Decoder Transceiver function, and a 2nd IC Gate Array which would contain the Serial-Parallel conversion registers, and Serial Interface timing and control. Detail development requirements were:

1. SNERT required a 20 Mega-Hz Oscillator [strict specifications] for clock generation in the device, and to supply a synchronizing 10 Mega-Hz clock for the LLSI/O interface logic.
2. A small transformer was required to connect LLSI/O signals from the SNERT to the cable.
3. The SNERT provided compatible TTL interfaces to the LLSI/O logic of the computer or peripheral device.

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4. The 'Output function' of the SNERT was to Receive TTL NRZ data at the 10 Mega-Hz rate, and then to encode and transmit LLSI/O control frames, and data [Manchester Code].
5. The "Input function" was to receive LLSI/O Manchester Code from the cable, decode, then determine whether the code was either a Control Frame or Data signals.
6. This would have required a set of registers for output and input [for control frames - 4 bits, and data - 34 bits] for storage and synchronization.

Based on this function set, I [Ken] estimate that the SNERT device has an equivalent of 300 to 350 gates, plus the required custom transistor circuits, or about 1800-2000 transistors.

The need for the SNERT chip was mandated by the physical constraints within the AN/UYK-44. While it was originally thought that both the UYK-43 and UYK-44 would use the chip set, the UYK-43 team chose a more conservative design approach and implemented the interface using discrete parts because the real estate was available and the operating temperature range was 0-50^{o} C. The UYK-43 later picked up the chip as a cost savings. The physical constraints in the UYK-44 were driven by the Standard Electronic Module (SEM) Format B card size. The SEM family of modules was driven by the NWSC Center at Crane, Indiana. The thought at the time was that the Navy would standardize on electronic card racks and embed the computer with the other electronics of the particular subsystem such as the SQQ-89. The SEM Format B and the wider operating temperature range [-40 to +55 ^{o} C] drove us to leadless chip carriers mounted on ceramic substrates.

A custom design for the SNERT was also required because of strict specifications for signal speeds and symmetry, and required an "active transistor circuit" design to accomplish this. Although the LLSI/O interface had been implemented on printed circuit boards for both the UYK-20 and UYK-7 computers, there was no single chip off-the-shelf part which performed this unique function. The chip set was to replace several separate standard analog and digital circuits which would have occupied much more board surface area.

In 1981 Bob Salter and Ken Graber completed writing the SNERT specification, and the custom IC design was contracted for with I.C.E. of Scottsdale, AZ. The designer there was Bob Hartley. The schematic is on Sperry procurement drawing 7222100.

The design challenge that was unique for the SNERT chip was that it was a custom IC with both analog and digital functions on a single wafer. I don't believe that Sperry had attempted that combination before. As previously mentioned, because of the required high speed and low voltage level, the analog portion of the circuit needed tight tolerances. Combining the digital front end on the same wafer was required for both proximity requirements of the analog and digital circuitry and the overall real estate available on a SEM Format B. This combination of challenges drove the design requirements for the chip. The leadless chip carrier (LCC) package was required by the

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SEM module ceramic substrate. It was provided in a 64-pin shown right package - shown on the next page.

SNERT operates with supply voltages of +5.0 Volts and -5.2 Volts. It has analog comparator inputs. It is capable of operation over a case temperature range of -55° C to +125° C.

The SNERT development was fraught with difficulties, not the least of which was that ICE underbid the design and test effort. In late 1984, the responsibility for finalization of the SNERT chip development and production was transferred to the UYK-44 program which was dependent on the product for its Ceramic PCA interface card. The original SNERT was supplied to Sperry Defense Systems in accordance with procurement specification P/N 7908767. The original SNERT was fabricated and packaged by Sperry Corporation Semiconductor Operations in Eagan, MN, and had the designation of SL210.

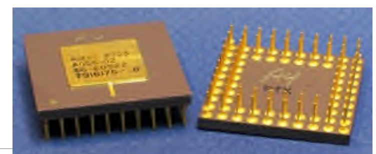
Sperry decided to get out of the semiconductor development and processing business just as the SNERT design was being completed. As a design manager, I [Jeff Parker] got involved with Tom Palkert and Dick Erickson about the time that Sperry Semiconductor Operations (SSO) decided to outsource the fabrication of the SNERT wafer. The Semiconductor Operations was shut down in 1987 after Burroughs acquired Sperry to form UNISYS. We had to find another semiconductor facility with a compatible process which would accept the SNERT as a product. SSO was able to convince AMCC [a San Diego based semiconductor manufacturing facility] to build the part for us with a projection of high volume. The schematics and process for this new version were transferred to AMCC. AMCC originally had significant problems fabricating the wafers and suffered the attendant low die yields. We spent significant time with AMCC in San Diego attempting to understand the low yield problem. AMCC continued to claim the SNERT design from Sperry was flawed and that a redesign would be required. Specifically, we were blowing a transistor within the die. The transistor was Q84, and AMCC claimed the design pulled too much current through Q84. After many days and nights of examining die under a scanning electron microscope, we could not identify the design problem. [Jeff]

Just to elaborate a little and give credit where it is due, both AMCC and an outside lab were unable to determine the problem with the die and why they were blowing a metal path. As a last resort, the Univac failure analysis lab was assigned to look in to the problem. Due to the analysis by Roger Lund, it was determined that the AMCC process produced die that had too much contamination. This led to leakage paths on the device which resulted in blown metal on a transistor. It took a static burn-in to bring out this problem. Armed with our data, a trip was made to AMCC and, confronted with the evidence, they had to agree the problem was theirs. Once they improved their process, the yields improved. [Larry]

The design was OK, but it required a cleaner process than the AMCC norm. It turned out that the original Sperry process met the contamination requirements, so we never saw the problem with Sperry wafers! We got AMCC to specialize the process and we were able to proceed with production. [Jeff Parker]

This is not the only instance where Univac failure analysis did a better job than our suppliers in determining why product was failing in our machines. This lead to improved processes which benefited all component customers. [Larry Bolton]

The SNERT design was later improved and given the designation SNERT II and SNERT III. The improved version was supplied to Sperry per procurement specification 7916175. AMCC made the device under the A004-01 and A005-01 part numbers for the LCC version and A004-02 and A005-02 part numbers for the PGA version, as shown on the right. [Larry]



Unfortunately, the projected volume never materialized. AMCC was obviously disappointed when they realized that we were dealing with lower volumes. When AMCC decided to no longer make the device, fabrication was transferred to VTC in Bloomington, MN. VTC has since made a last time build of the SNERT device. The last VTC wafers were transferred to Austin Semiconductor for die test and packaging. [Larry]

Although it was a long, and sometimes painful, development, the SNERT chip is still used [to our knowledge] on Navy Ships for LLSI/O. [Ken]

Postscript by Jeff:
As an aside, I met Gary Hokenson after work one night in San Diego and described that problem to him in the hotel bar. I took a cocktail napkin and drew out the offending circuit with Q84. Gary told me that we were well on the way to solving the problem. When I asked him where he got his insight, he simply stated that if you can reduce the problem description so that its fits on the back of a cocktail napkin, you understand the problem and will eventually solve it! In the years after that we always threatened to write a book entitled "The cocktail napkin management theory." Unfortunately we never got around to it. Might have been a best seller!

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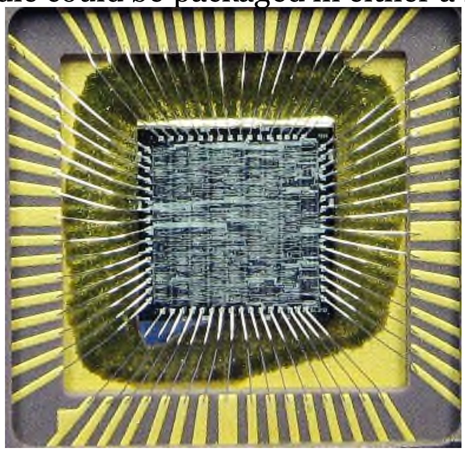
The SNERT die could be packaged in either a PGA or LCC.



Authors

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Larry Bolton graduated from the University of Minnesota with a BEE in 1965. He began at Sperry Rand that summer as a component engineer. He retired from Lockheed Martin in 2007, after 42 years. His mini-bio is on the Legacy web site, http://vipclubmn.org/people1.aspx.

Jeff Parker graduated from the University of Minnesota with a BEE degree in 1970. He also received a BSB degree from the University of Minnesota in 1978. He began at Sperry in 1970 as a test engineer. He continues to work for Lockheed Martin today after 38 years in various engineering and program management positions. His most recent position was Program Director assigned to the Broad Area Maritime Surveillance (BAMS) capture as the Program Manager.

Lowell Benson graduated from the U of MN with a BEE in 1966. He worked at the company from 1960 to 1994 in a wide variety of support, engineering, and management positions. His career highlights summary is also on the Legacy web site, http://vipclubmn.org/people1.aspx.