Breadboard Design History

I designed a lot of LSIs in NEC Japan, Chips and Technologies USA, ASCII of America USA, Auctor Corporation USA, and SanDisk USA.

Most of the LSI design needed a breadboard to verify the LSI function real time working under actual system as well as for demonstration before the LSI becomes available. However, designing, making and debugging the breadboard are not easy. Dense expertise spreading over various technical fields (both hardware and software,,,) is indispensable. If you have not engaged in as well as not completed the breadboard related design work, you should not introduce yourself as an LSI logic designer. Have sane common sense.

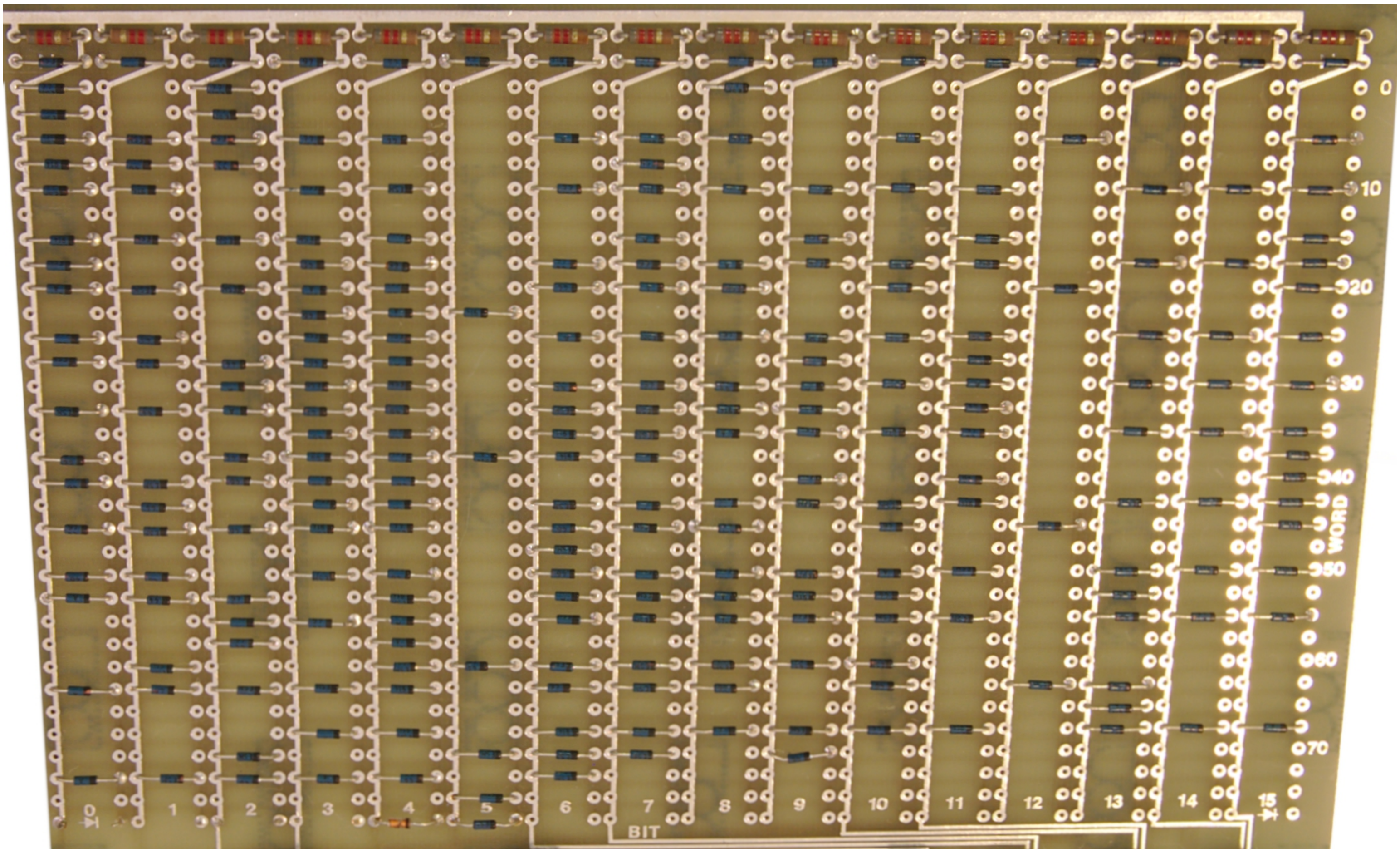
LSI Product	Year	Random Logic	ROM Emulation	System Controller
NEC μPD281/282 chipset	1972	MOS SSIs	Soldering/desoldering diodes directly on board	None (Unnecessary)
NEC μPD940	1974		UVEPROM → Diode short pin matrix board	
NEC μPD1201	1975		Wire memory (Nonvolatile)	NEAC M4 mini computer
NEC μPD1205	1976		Slow speed paper tape reader and puncher installed on Teletype Model 33 to dump ROM code for computer simulation and for preparing photo mask data base	
NEC μPD777	1977	Bipolar TTLs	SRAM	NEC TK-80 High speed paper tape reader and puncher to dump ROM code at the end of daily debug work
NEC μPD7220/7220A	1980			TRS80 Z80 1.774MHz 8 bit personal computer (TRSDOS console) 5.25" Floppy Disk Drive to store ROM code at the end of daily debug work
NEC μPD72120	1985			NEC PC-9801XA 8086 8MHz 16 bit personal computer (MSDOS console) 20MB Hard Disk Drive to store ROM code at the end of daily debug work
Chips and Technologies 82C455/456/457	1988	Computer Simulation	None (Unnecessary) Verify by so-called "Full screen simulation" limited to a portion of quarter screen ((160 out of 640) x (120 out of 480) from top-left most screen)	
ASCII of America DA7290/HD814102	1993		None (Unnecessary) Analyze and replay PCM audio sound data output by computer simulation, Encode the sound data and compare to the original MPEG compressed audio data	
Auctor Corporation Flash memory Controller	1995	Altera FPGA	SRAM	IBM PC Pentium 120MHz 64 bit personal computer (MS Windows 95/MSDOS console)
SanDisk USB to Flash memory Bridge	2000			IBM PC Pentium III 550MHz 64 bit personal computer (MS Windows NT/MSDOS console)

(1) NEC µPD281/282 chipset

I took charge of µPD282 logic and mask layout design. Arithmetic Logic Unit, shift registers that stores BCD (Binary Coded Decimal) calculation data, timing controller, and so forth were integrated on µPD282. Program ROM was integrated on µPD281.

The ROM code was emulated by diodes soldered directly on ROM board (see example below). This was a primitive and inefficient approach not to be adopted. Every time the program flow is updated, the diodes are desoldered and/or soldered. It was so cumbersome and time consuming work. Actually, I had to work all over night for the desoldering and soldering work.

ROM size of µPD281 was 384 x 13. The size was much bigger than an 16 x 16 example below.



16 x 16 Diode Matrix Board Example

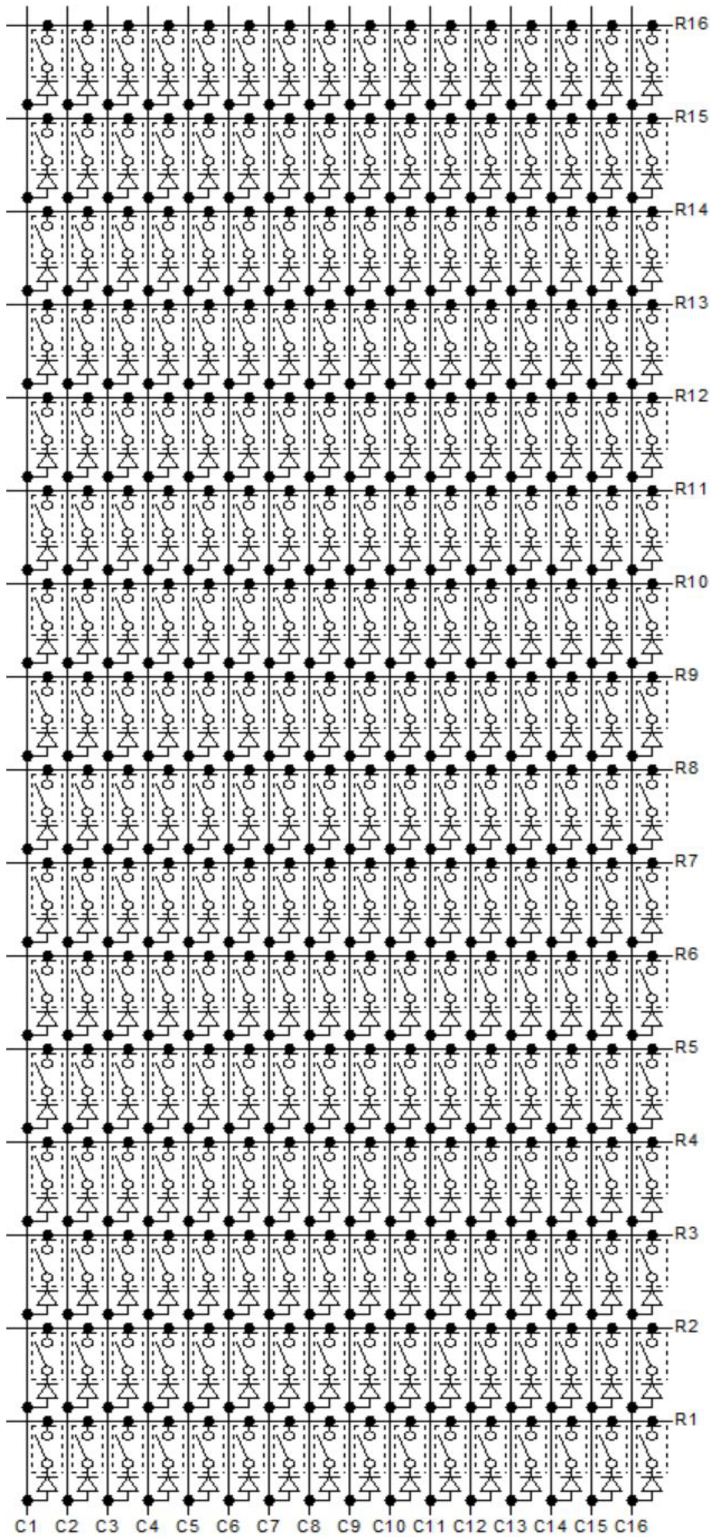
Next day was a day of close friend's marriage. I failed to appear because I had to continue mask layout design work from that morning just after the overnight work. In the evening, I received a call that grand father passed away and attended the wake at Zushi Kanagawa prefecture.

Next morning, Mr. Matsumura, a department manager, came, politely bowed, and said “My condolences to your grand father”. I was so surprised and grateful simultaneously because I was told “Oguchi-kun, although you may be a rookie......” (Refer to “LSI Products”) from him a few month ago. Did he show remorse? Probably, not.

(2) NEC µPD940

At the beginning, I tried to apply UVEPROMs just emerged. However, I recognized that the UVEPROM programming needs handling a small hexadecimal keyboard on EPROM programmer for specifying both address and data one by one as well as handling an ultraviolet light for erasing data slowly. The reliability of UVEPROM itself was not sufficiently high as well.

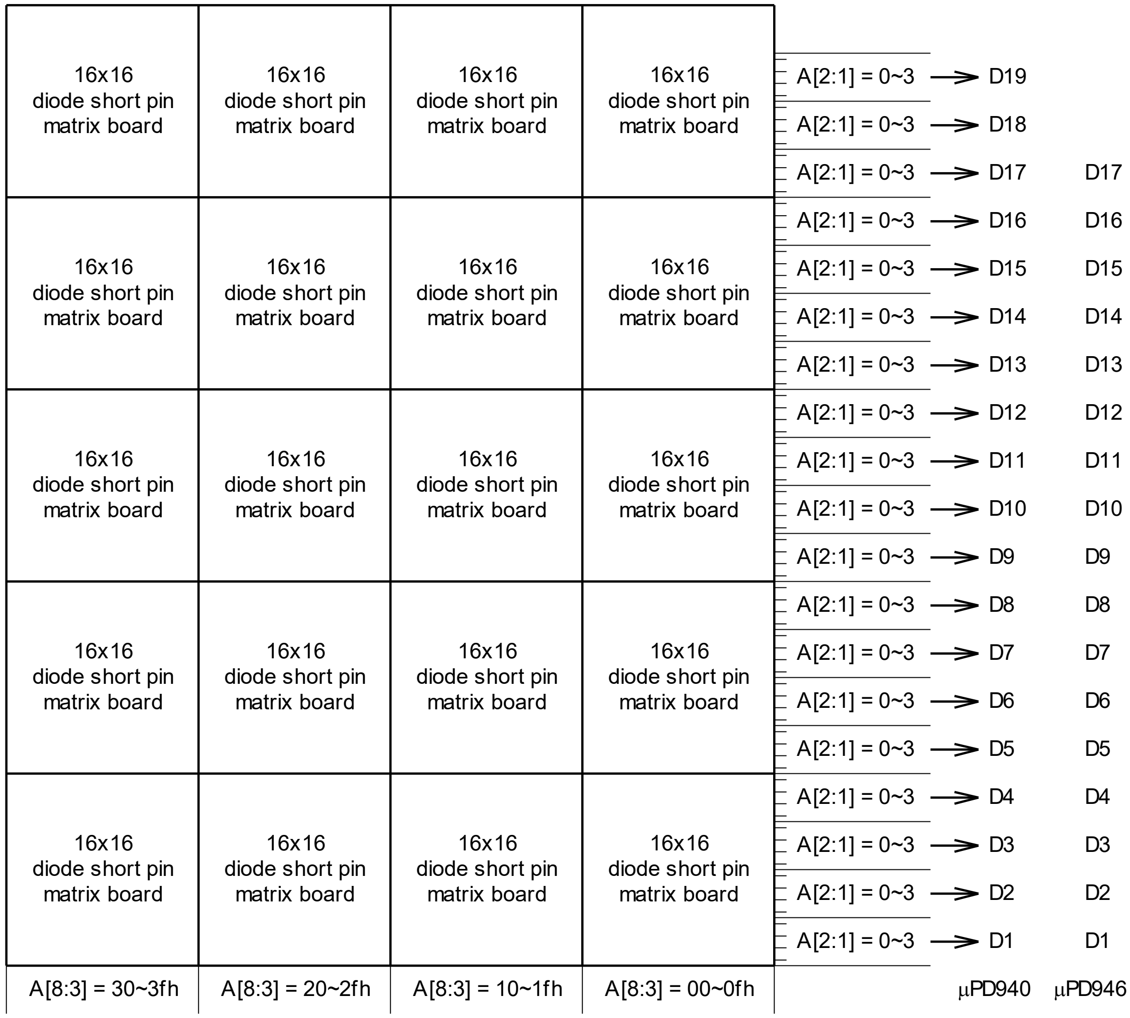
Fortunately, I found a 16 x 16 diode short pin matrix boards at electronic parts market. Because the 16 x 16 matrix size was much smaller than the µPD940 ROM size of 256 x 19, I had to order 20 pieces (The total number of short pin provided and diode assembled was 5,120 (20 x 16 x 16) each). Wow!



16 x 16 Diode Short Pin Matrix Board (Physical size is not so big, 3” x 3” x 1”)

All the diodes have been already assembled in the matrix board. By inserting a short pin into a hole, a correspondent diode is connected.

I did wiring connection between the 20 pieces of the 16 x 16 matrix boards and made a 256 x 19 diode short pin matrix ROM board which operated as a key major electronic component of µPD940 breadboard.



256 x 19 Diode Short Pin Matrix Board (20 pieces of 16 x 16 Diode Short Pin Matrix Board) Assembled

This valuable ROM board I made was inherited to another µPD946 development project which ROM size was 256 x 17 later on. It is clear that µPD946 breadboard debug had to start after the µPD940 breadboard debug had completely finished.

(3) NEC µPD1201 and µPD1205

The ROM size of µPD1201 became 1024 x 14, 4 times bigger than the one of µPD940. As a matter of course, the diode matrix board approach was abandoned.

Instead, an NEAC M4 mini computer along with a Teletype Model 33 detached from an old LSI tester was applied utilizing nonvolatile wire memory equipped inside. I updated ROM codes through keyboard of the teletype writer using NEAC M4 command.

NEC NEAC M4 Mini Computer

Teletype Model 33

Initially wake up NEAC M4;
(1) Type in short machine language codes of paper tape reader program through push buttons on front panel.
(2) Read a paper tape contains a boot strap loader through paper tape reader equipped in the teletype writer.