AccessionIndex: TCD-SCSS-T.20141212.001
Accession Date: 12-Dec-2014
Accession By: Prof.Neville Harris, Dr.Brian Coghlan
Object name: Sun Pre-production SUN-1 Workstations
Vintage: c.1980
Synopsis: Seminal workstation developed by Stanford University, with first-generation 3Mbps Ethernet.

Description:
The SUN-1 Workstation was a seminal networked workstation developed by Stanford University. The pre-production prototype boards for Sun Microsystems first workstations, comprising a MC68000-based CPU board and a first-generation 3Mbps Ethernet board, were originally designed by Andy Bechtolsheim for his PhD.

trivia: 'SUN' stands for Stanford University Network.

The CPU boards were based on Motorola MC68000 CPUs, with custom logic for two-level demand-paged memory management, allowing them to support Berkeley BSD UNIX. They had 256kB of DRAM, 32kB of EPROM, dual serial ports, a 16-bit parallel input port, a system timing controller and a Multibus interface. These boards were produced by several suppliers, for example see the manuals for those made by VLSI Systems and Forward Technology in the related folder in this catalog.

The SUN-1 pre-production workstations were networked using 3Mbps Ethernet. Ethernet was invented at Xerox PARC in 1973 by Bob Metcalf and others, based on the Hawiian ALOHA radio network, and was patented by Xerox in 1974, then used in Xerox PARC from 1975. The name came from the *luminiferous Ether* that was at one time thought to be the medium through which electromagnetic waves propagate.

Ethernet employed Manchester encoding on a 9.5mm diameter baseband coaxial CATV cable (*thickwire* cable). A hole was punched through the coax cladding and the outer conductor so a connection ('tap') could be made to the inner conductor. The two cable ends (branching was not allowed) were impedance terminated to minimise reflections. For networking hardware see elsewhere in this catalog. Fig.62 shows a photograph of the 3Mbps Ethernet black coaxial cabling as installed around the Dept.Computer Science, TCD.

The 3Mbps Ethernet boards implemented a network controller for the physical and datalink layers, and queues for a 4kB receive FIFO packet buffer and a 4kB transmit packet buffer. The controller was comprised of three 4-bit bitslice CPUs, with 8kB of static RAM, two 8-bit bidirectional I/O ports and a 16-bit Multibus interface. Again, see the manuals in the related folder in this catalog.

A number of pre-production board sets were made available by Stanford to interested third parties, typically universities, in the years prior to the formation of Sun Microsystems. In particular the 3Mbps Ethernet boards are now very rare, as they were only ever available within Xerox PARC and on these pre-production workstations. By the start of production Sun (which was founded 24-Feb-1982) had been able to switch to 10Mbps Ethernet.

On his return from a visit to Stanford University in 1980, Dr.Neville Harris bought three of these early pre-production board sets (sufficiently early not to bear the Sun logo) back to TCD's Dept.Computer Science, where they were assembled and the department was wired with 3Mbps Ethernet coaxial cabling. An early diagram of how their Ethernet connections were wired is shown in Fig.61. Remarkably, three of these three early pre-production board sets survive in this collection, although not in their assembled state.

The board sets were used for research by the department's Distributed Systems Group (DSG). An operating system called *OGHMOS* (after an obscure Celtic deity who was big into fine golden chains) that had been created by three MSc students (Sean Baker, Brendan Tangney and Damien Lyons) was installed, and they soon had 'packets flying all over the place'.

Further board sets were acquired in various 'shipments' from California. Alexis Donnelly recalls meeting Andy Bechtolsheim before leaving Stanford one summer, and bringing back in a rucksack some boards (CPU and/or network), possibly some transceivers and heavy black coaxial cable, probably a second batch.

One of these later pre-production board sets, bearing the Sun logo, survives in this collection nearly intact as assembled, only missing a graphics board. It consists of a CPU board and a 3Mbps Ethernet board in a Multibus cardcage plus a power supply, all on a plywood base, constructed by Brendan Kiernan or Alexis Donnelly and Myles Cagney (???).

Starting in reverse with this nearly intact system:

Accession Index	Object with Identification
TCD-SCSS-T.20141212.001.01	Sun Pre-production SUN-1 Workstation: Multibus Cardcage. S/N: ???
TCD-SCSS-T.20141212.001.02	Sun Pre-production SUN-1 Workstation: CPU Board (1). (Multibus form factor) Includes: (empty) MC68000 microprocessor socket 4 x TCD BIOS EPROMs Am9513DC system timing controller NEC D7201C up/down counter 36 x DRAMs Intel D8218 bus arbiter BIOS EPROMs label: TCDMON Rev.D 101, Rev.E 102, Rev.D 103, Rev.E 104 Marking: SUN Microsystems 270-0001 Rev D Extra inked markings, probably S/N, also "1010".
TCD-SCSS-T.20141212.001.03	Sun Pre-production SUN-1 Workstation: Ethernet Board (1). (Multibus form factor) Includes: 3 x Am2901BPC-8 4-bit CPU bitslices 4 x HM6116P-2 2K×8 static RAMs 2 x Am2951DC 8-bit bidirectional I/O ports

	Marking:
	SUN 3M Ethernet, Copyright 1982, VLSI Systems Inc, Rev.B 820112, Manufactured 5-May-1982, S/N: 1001.
TCD-SCSS-T.20141212.001.04	Sun Pre-production SUN-1 Workstation: Graphics Board (1). (Multibus form factor) *<<< **Missing ???** >>>*
TCD-SCSS-T.20141212.001.05	Sun Pre-production SUN-1 Workstation: Weir Power Supply. S/N: ???

As stated above, three of the three early pre-production board sets survive in this collection. This a puzzle, as the third early board set was presented to the Irish subsidiary of Sun Microsystems when they invested in Iona Ltd, a TCD campus company spun out from the distributed systems research efforts within the Dept.Computer Science. It is not known whether this board set survives at Sun or elsewhere, or whether this third board set was returned to TCD.

One of the early board sets is completely intact, including the graphics board, but not as assembled. The other two early board sets include additional boards: a memory board, and Logica I/O boards (possibly disk interfaces). The board sets are as follows, where the additional boards have been numbered as per their board set:

Accession Index	Object with Identification
TCD-SCSS-T.20141212.001.06	Sun Pre-production SUN-1 Workstation CPU Board (2). Forward Technology Inc Gateway Series FT-68M PCB Multibus form factor, Includes: MC68000L8 'CO18140' microprocessor Forward Technology 2717110 SUNMON BIOS EPROMs S/N 249-101 and 249-103 Am9513DC system timing controller NEC D7201C up/down counter 36 x Motorola MC6605L20 DRAMs Intel D8218 bus arbiter Marking: S/N: ???
TCD-SCSS-T.20141212.001.07	Sun Pre-production SUN-1 Workstation CPU Board (3). Forward Technology Inc, Gateway Series FT-68M PCB Multibus form factor, c.1981. Includes: MC68000L8 'GN78232' microprocessor Forward Technology 7112 SUNMON BIOS EPROMs S/N 287-101 and 287-103 Am9513DC system timing controller NEC D7201C up/down counter 36 x Motorola MC6605L20 DRAMs Intel D8218 bus arbiter Marking: S/N: ???
TCD-SCSS-T.20141212.001.08	Sun Pre-production SUN-1 Workstation CPU Board (4). Forward Technology Inc, Gateway Series FT-68M PCB Multibus form factor, c.1981.

	Includes: 　MC68000L8 'GN78232' microprocessor 　Forward Technology 7112 SUNMON BIOS EPROMs 　　S/N 287-101 and 287-103 　Am9513DC system timing controller 　NEC D7201C up/down counter 　36 x Motorola MC6605L20 DRAMs 　Intel D8218 bus arbiter Marking: S/N: ???
TCD-SCSS-T.20141212.001.09	Sun Pre-production SUN-1 Workstation: Ethernet Board (2). 　(Multibus form factor) Includes: 　3 x Am2901 4-bit CPU bitslices 　4 x Fujitsu MB8128 2K×8 static RAMs 　2 x Am2951 8-bit bidirectional I/O ports Marking: S/N: ???
TCD-SCSS-T.20141212.001.10	Sun Pre-production SUN-1 Workstation: Ethernet Board (3). 　(Multibus form factor) 　*<<< Neville ??? >>>*
TCD-SCSS-T.20141212.001.11	Sun Pre-production SUN-1 Workstation: Ethernet Board (4). 　(Multibus form factor) Includes: 　3 x Am2901 4-bit CPU bitslices 　4 x Fujitsu MB8128 2K×8 static RAMs 　2 x Am2951 8-bit bidirectional I/O ports Marking: S/N: ???
TCD-SCSS-T.20141212.001.12	Sun Pre-production SUN-1 Workstation: Graphics Board (2). 　(Multibus form factor) *<<< Missing ??? >>>*
TCD-SCSS-T.20141212.001.13	Sun Pre-production SUN-1 Workstation: Graphics Board (2). 　(Multibus form factor) *<<< Missing ??? >>>*
TCD-SCSS-T.20141212.001.14	Sun Pre-production SUN-1 Workstation: Graphics Board (4). 　(Multibus form factor) Includes: 　???? Marking: S/N: ???
TCD-SCSS-T.20141212.001.15	Intel PWA460 Multibus Memory Board (2). 　Was installed into a pre-production SUN-1 Workstation. Includes: 　32 x NEC uPD416D 　Intel D3242 　Intel D8126 　Intel B3222 Marking: P/N: 000772, S/N: 05-0632-000-01MC.
TCD-SCSS-T.20141212.001.16	Logica VTS V300-028-50 Multibus I/O Board (2). 　Was installed into a pre-production SUN-1 Workstation 　(possibly disk interface) Marking: S/N: 00115.

TCD-SCSS-T.20141212.001.17	Logica VTS V300-028-50 Multibus I/O Board (3).
	   Was installed into a pre-production SUN-1 Workstation
	   (possibly disk interface)
	Marking: S/N: 00120.

TCD-SCSS-V.20141212.001	Diagram for pre-production SUN-1 Workstation 3Mbps Ethernet wiring at TCD. See Fig.61 Marking: Handwriting appears to be that of Dr.Neville Harris.

The diagram of the 3Mbps Ethernet wiring is in the Literature category of this catalog.

Accessions:
Later pre-production board set (1): Prof.Neville Harris, 12-Dec-2014.
Early pre-production board sets (2) & (3): Dr.B.A.Coghlan, 9-Sep-2014.

References:

1. Wikipedia: http://www.wikipedia.org/.

2. Bitsavers SUN-1 documents and brochures,
   http://www.textfiles.com/bitsavers/pdf/sun/
   Downloaded 14-May-2015.

3. Sean Baker, M.Sc. Thesis, "The OGHMOS Inter Process Communication
   Facility", Dept.Computer Science, Trinity College Dublin, 1981.

4. Brendan Tangney, M.Sc. Thesis, "OGHMOS Kernel and Process Manager",
   Dept.Computer Science, Trinity College Dublin, 1981.

5. Damien Lyons, M.Sc. Thesis, "The OGHMOS File System", Dept.Computer
   Science, Trinity College Dublin, 1981.

See the extensive set of documents in the related folder in this catalog.
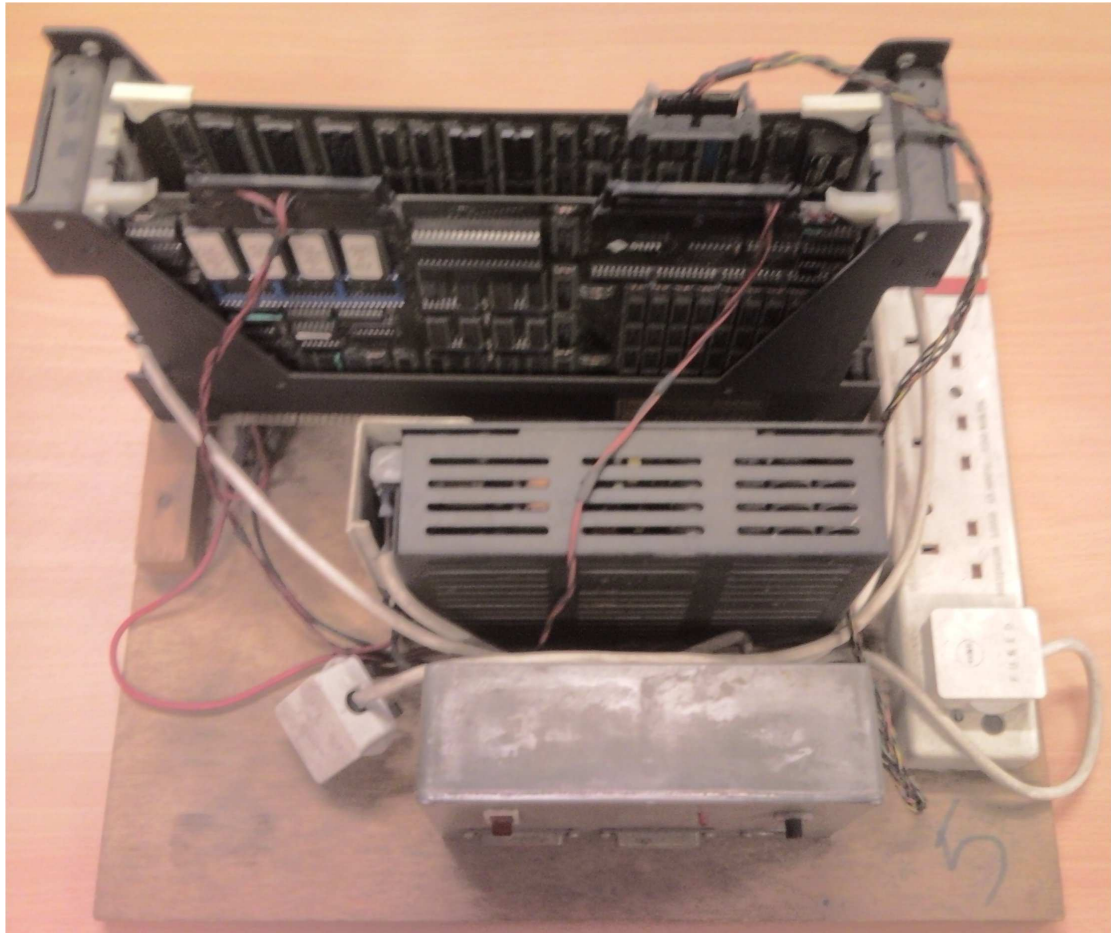
Figure 1: Pre-production SUN-1 Workstation board set 1 front top view
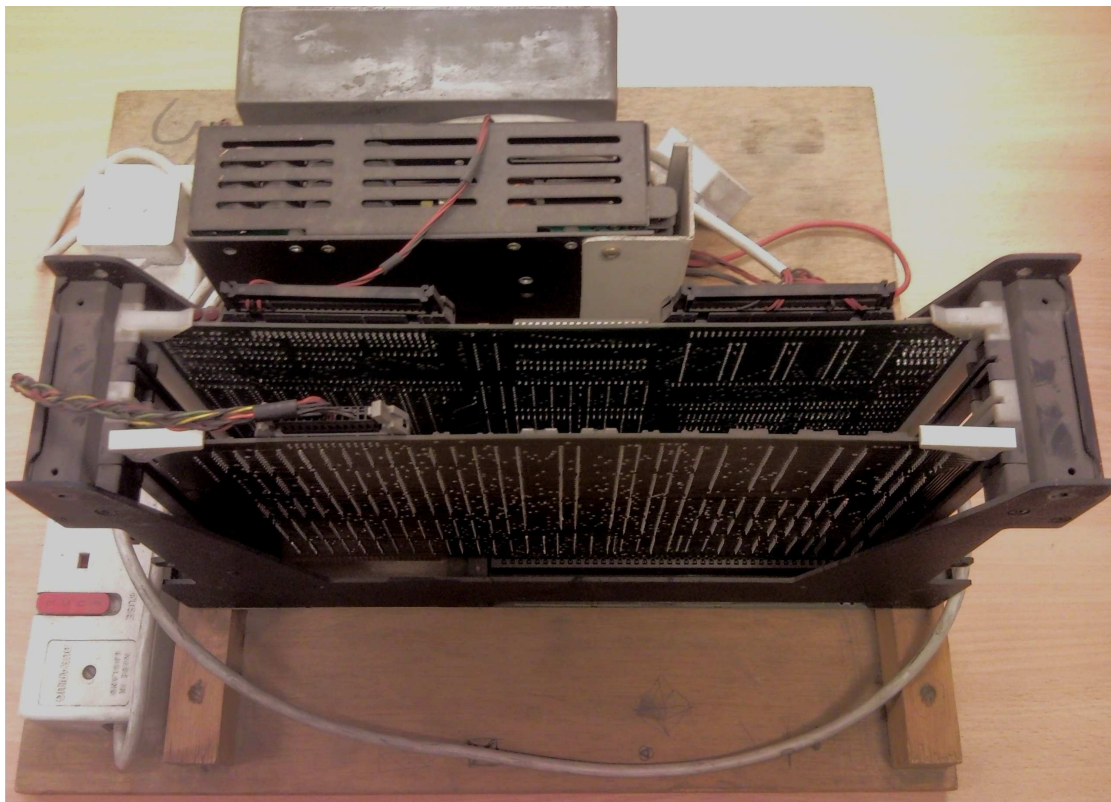
Figure 2: Pre-production SUN-1 Workstation board set 1 rear top view
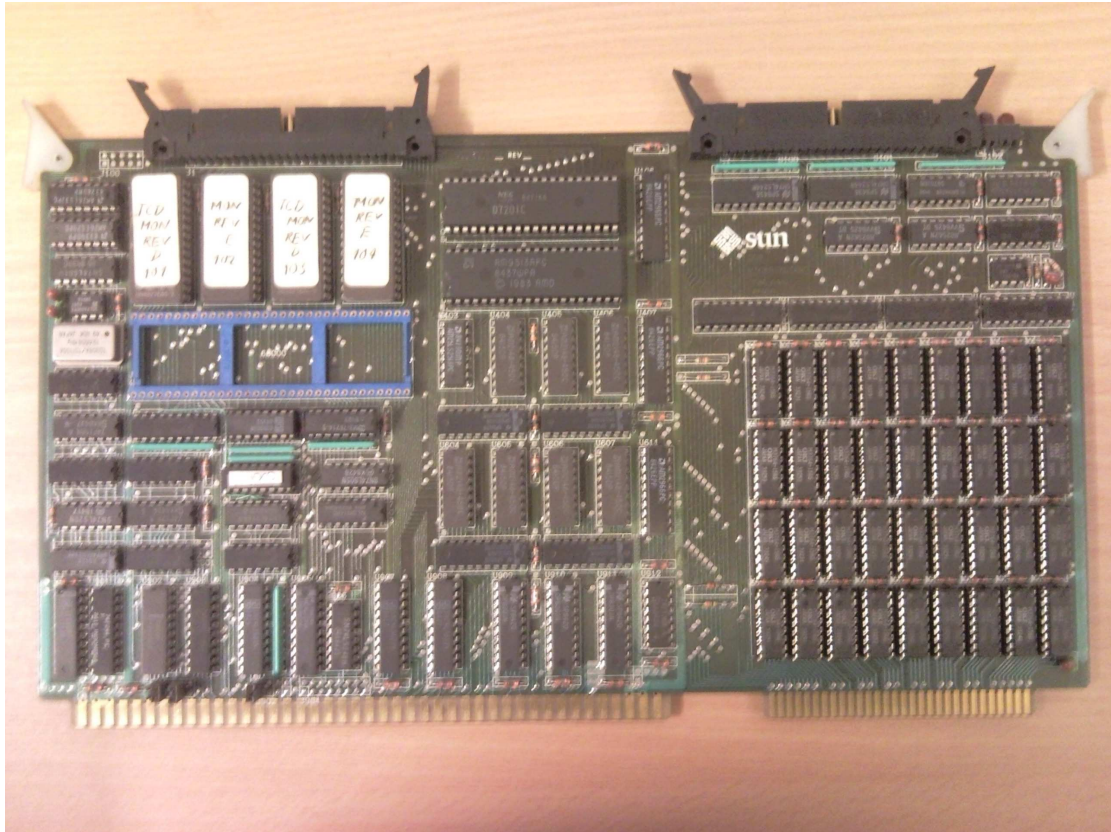
Figure 3: Pre-production SUN-1 Workstation CPU board 1
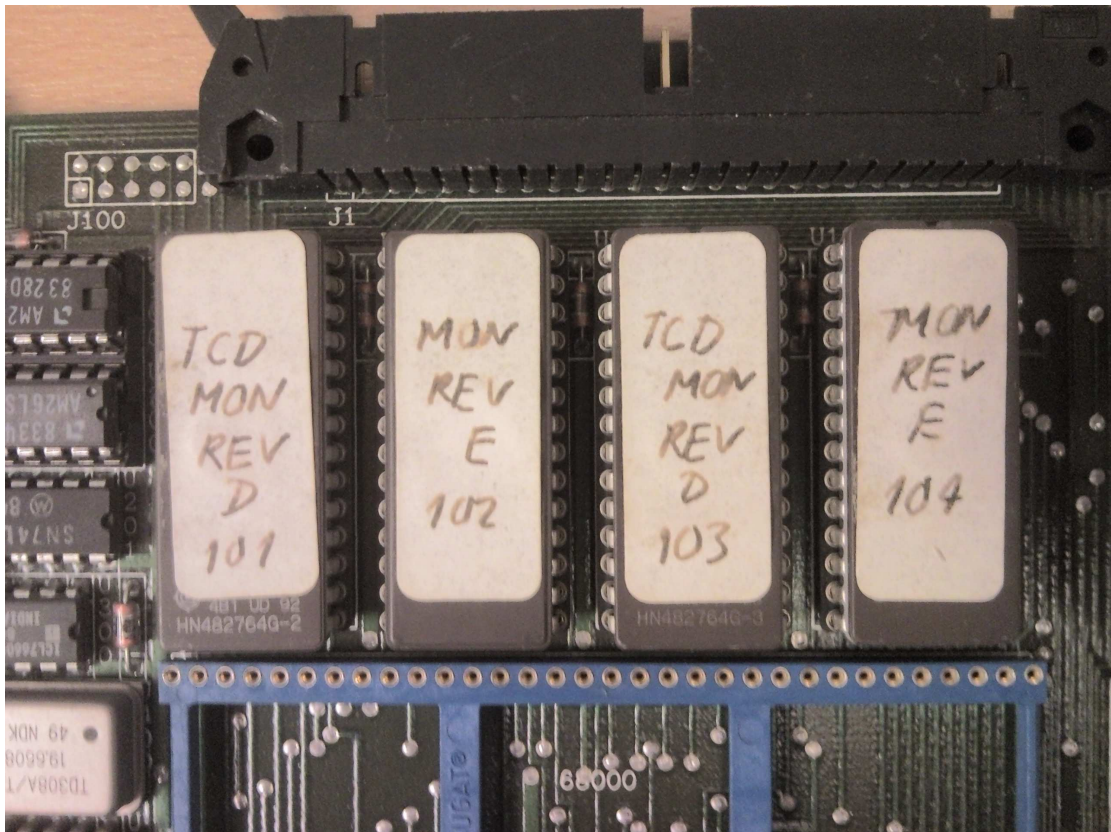
Figure 4: Pre-production SUN-1 Workstation CPU board 1 BIOS EPROM closeup
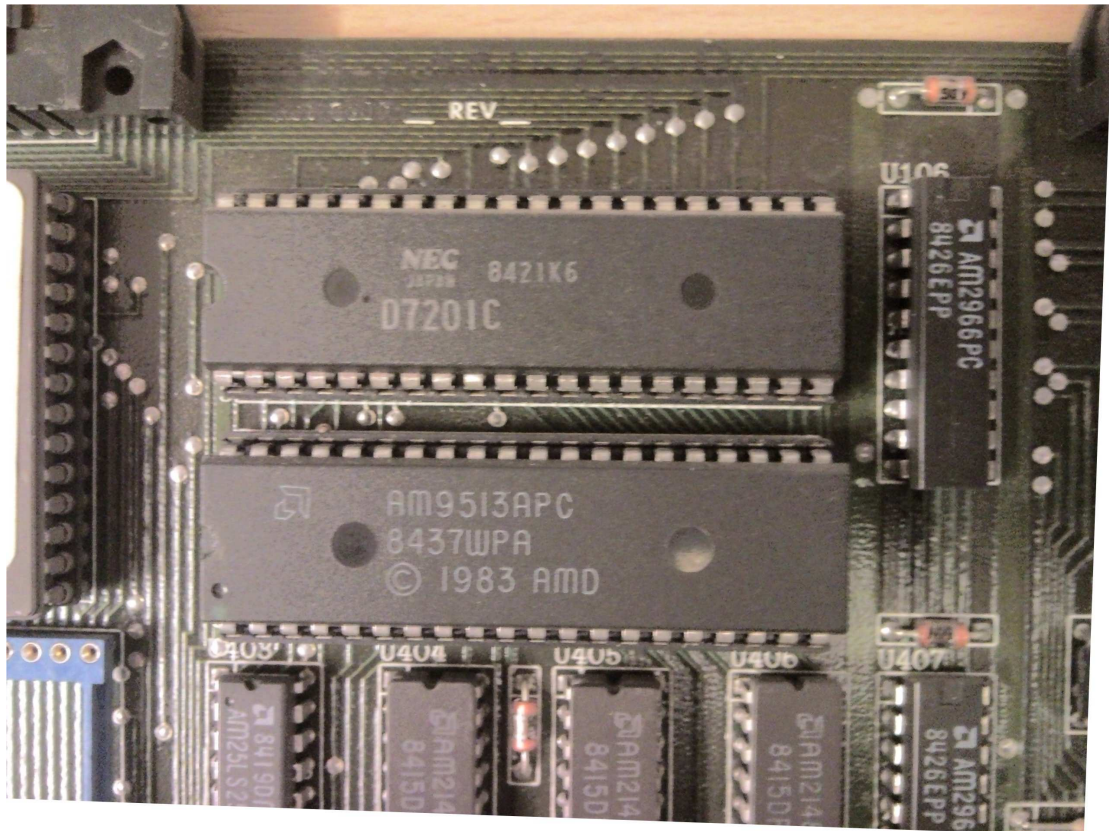
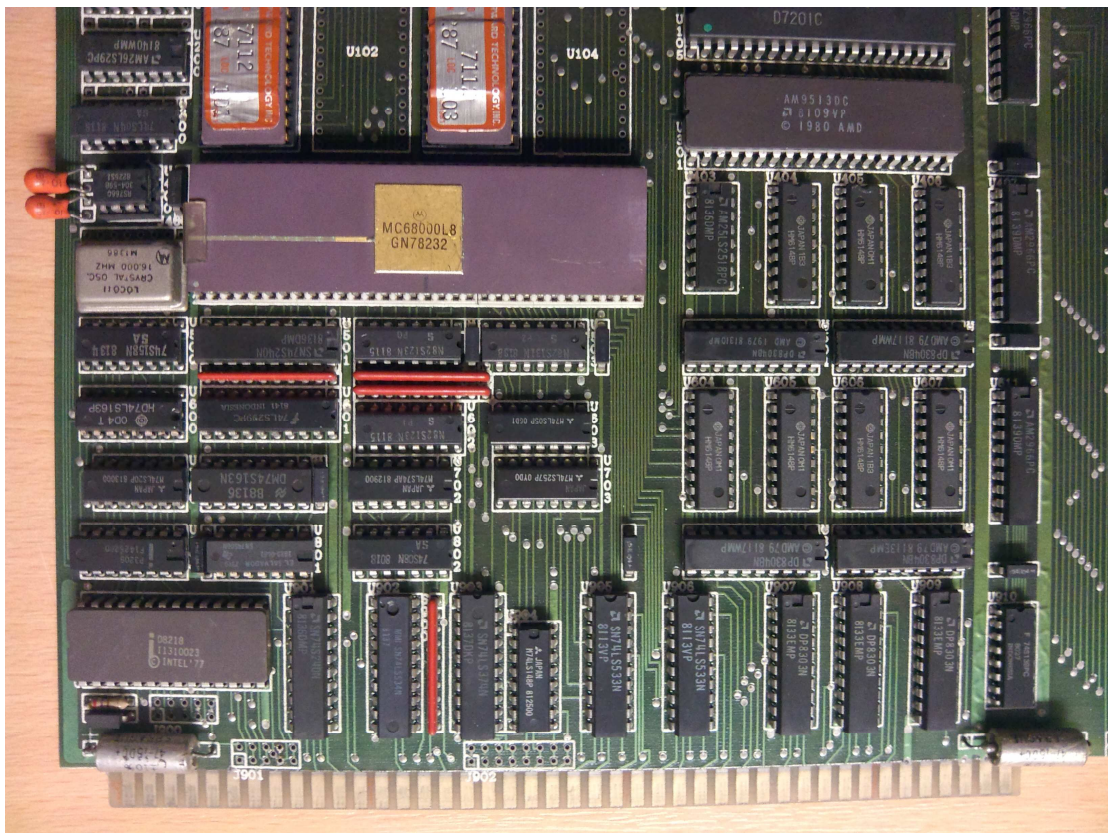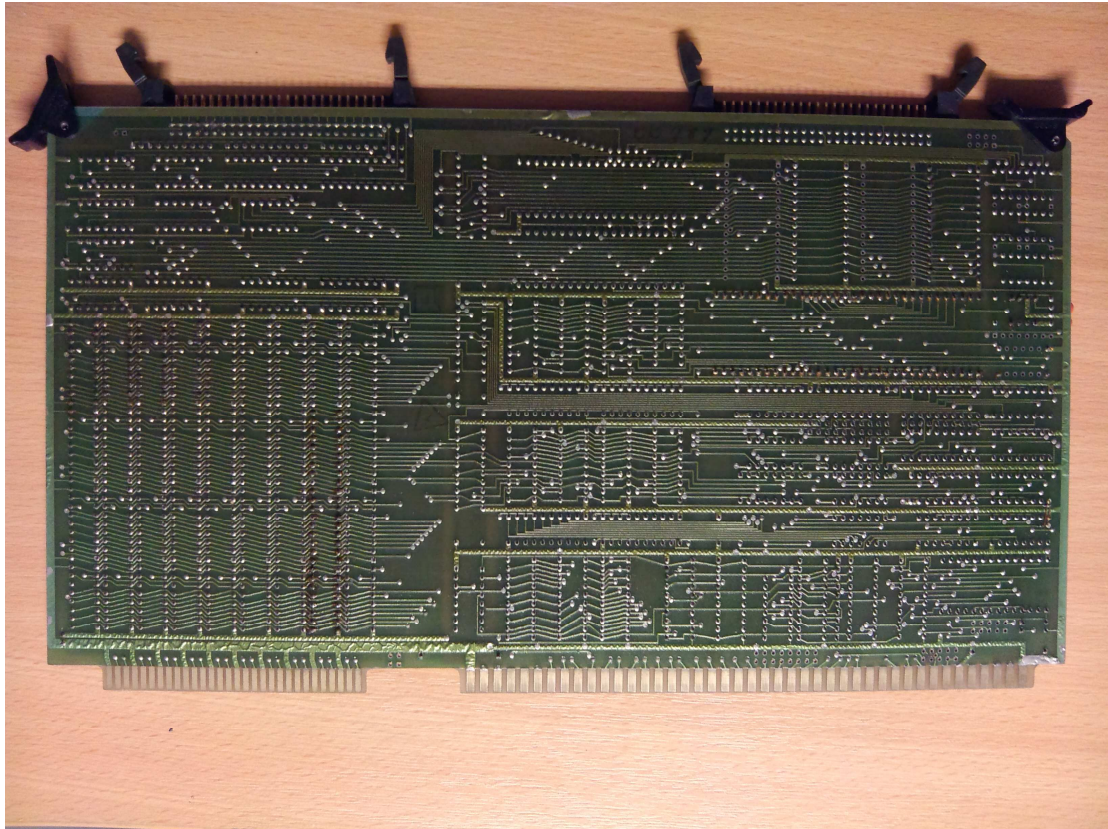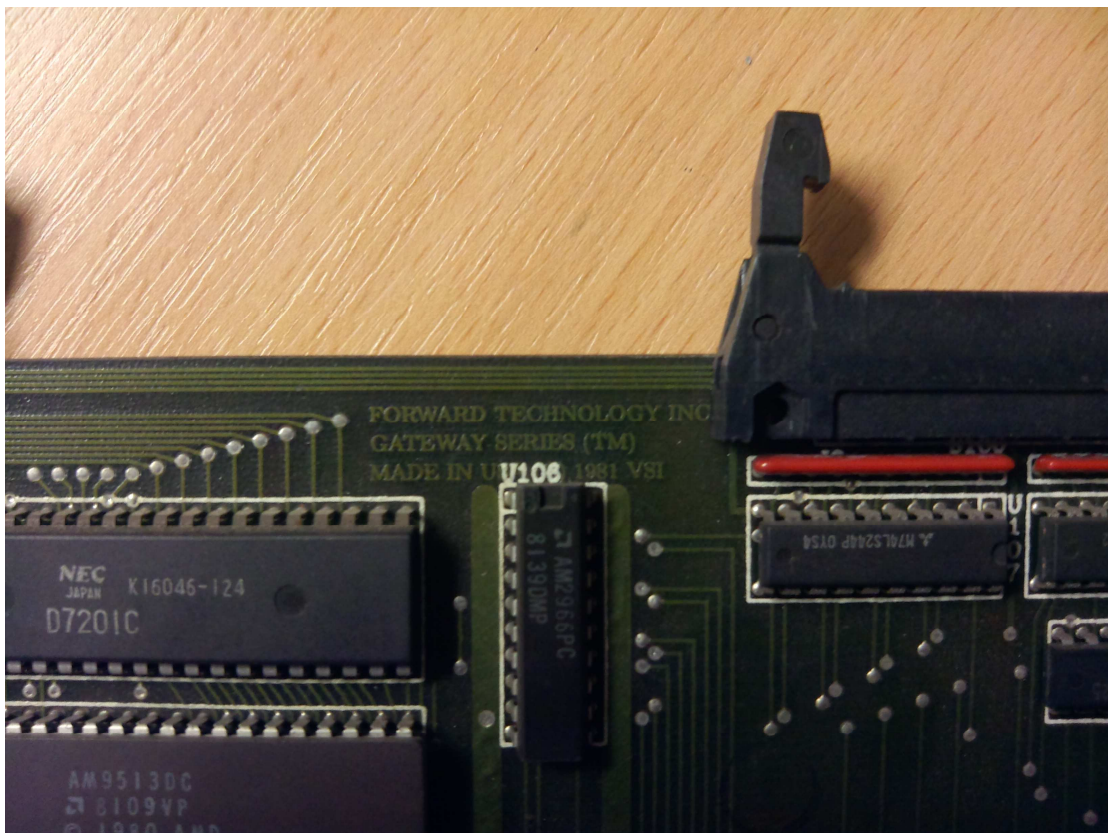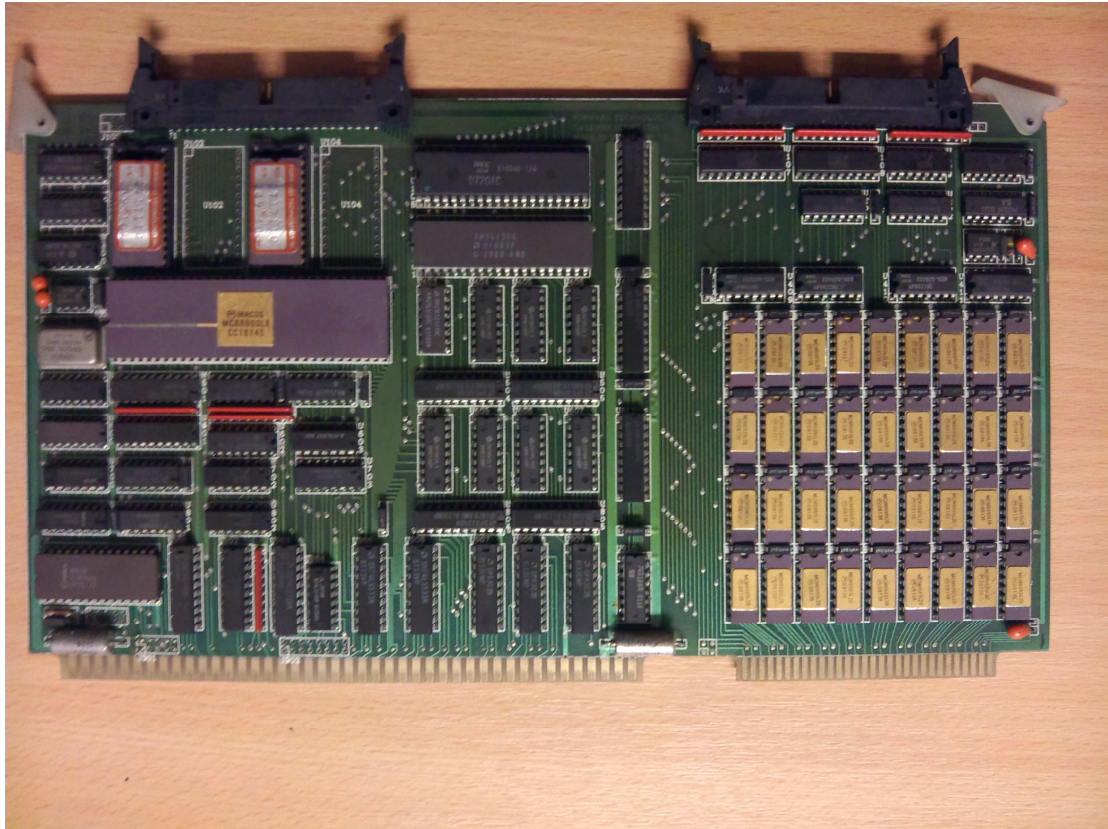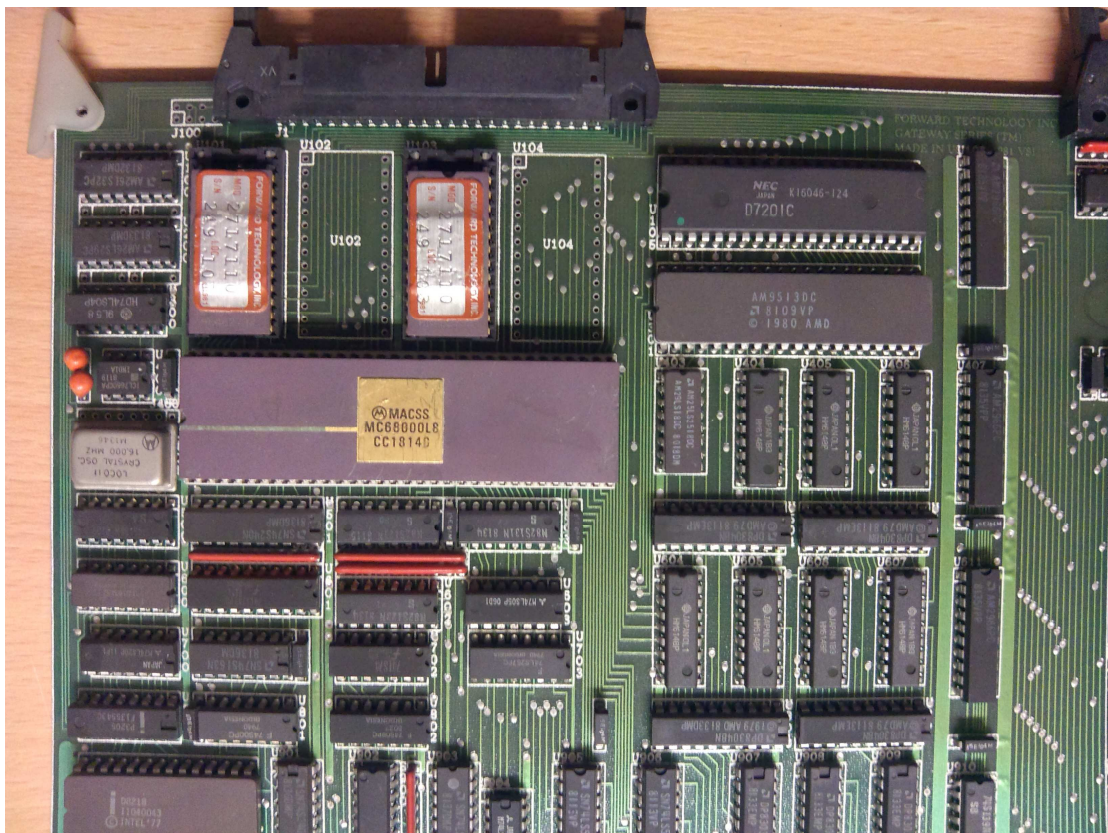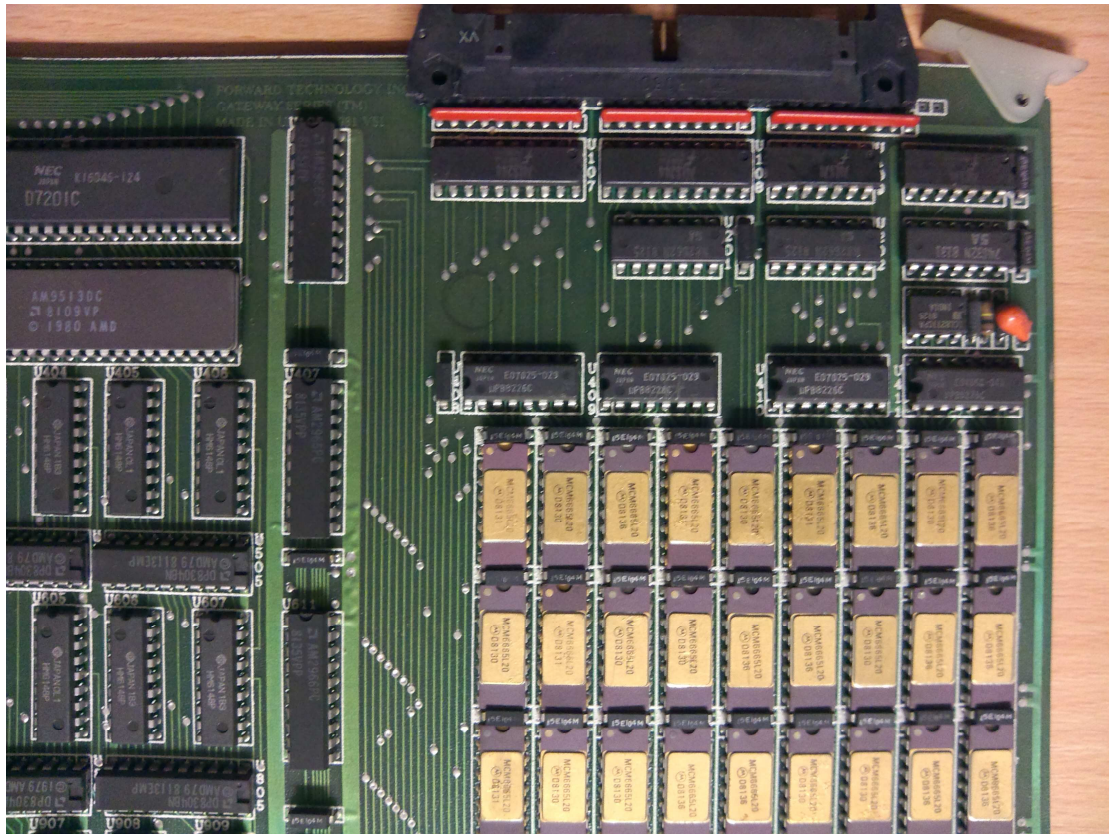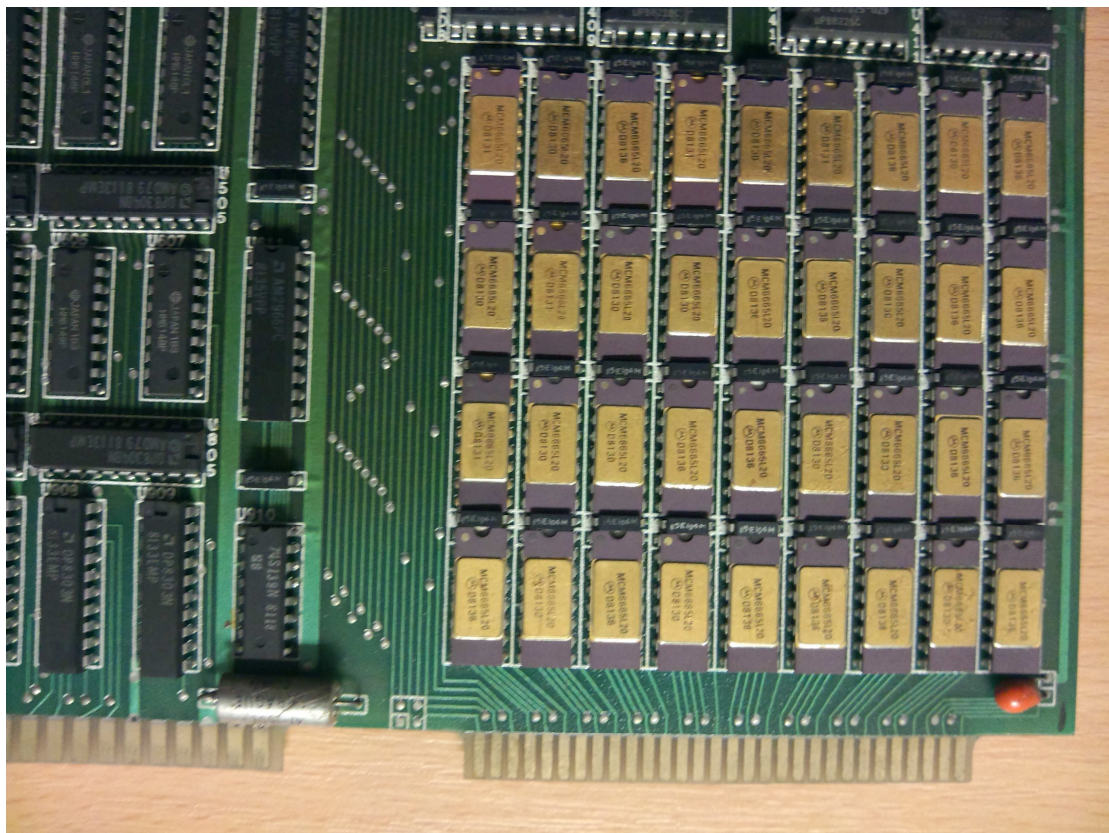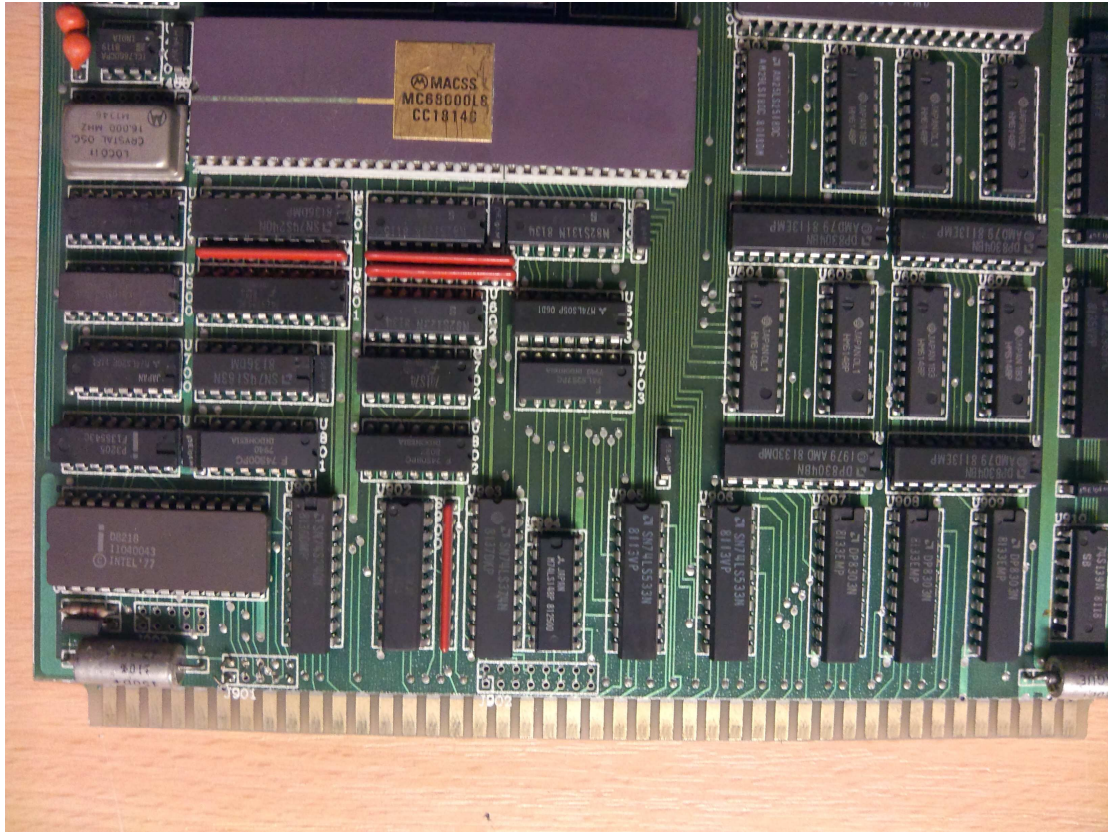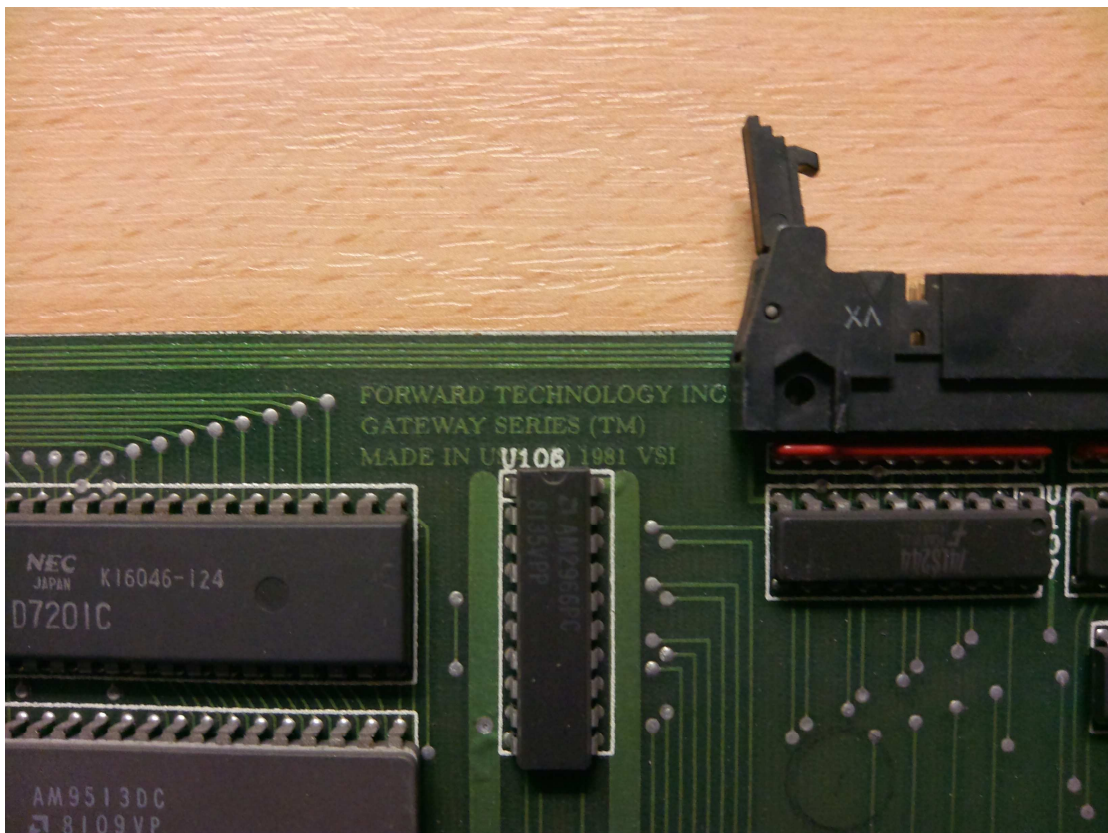*Figure 5: Pre-production SUN-1 Workstation CPU board 1 serial I/O closeup*
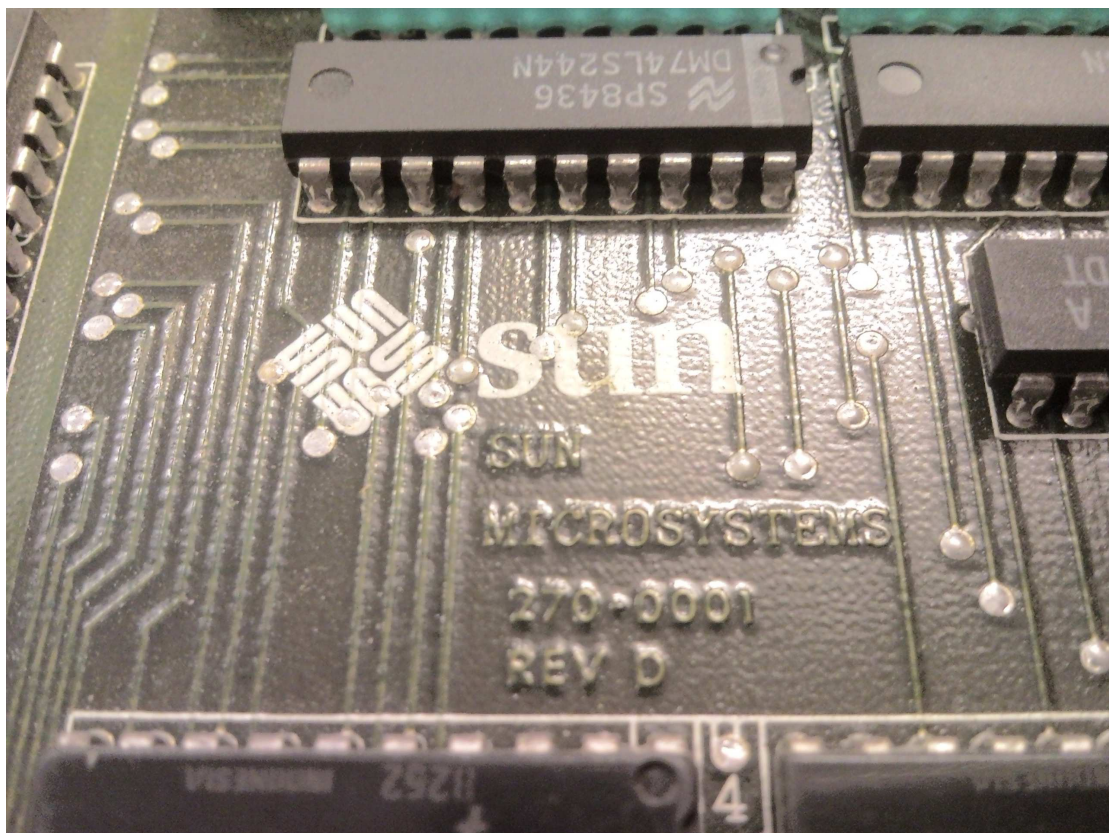
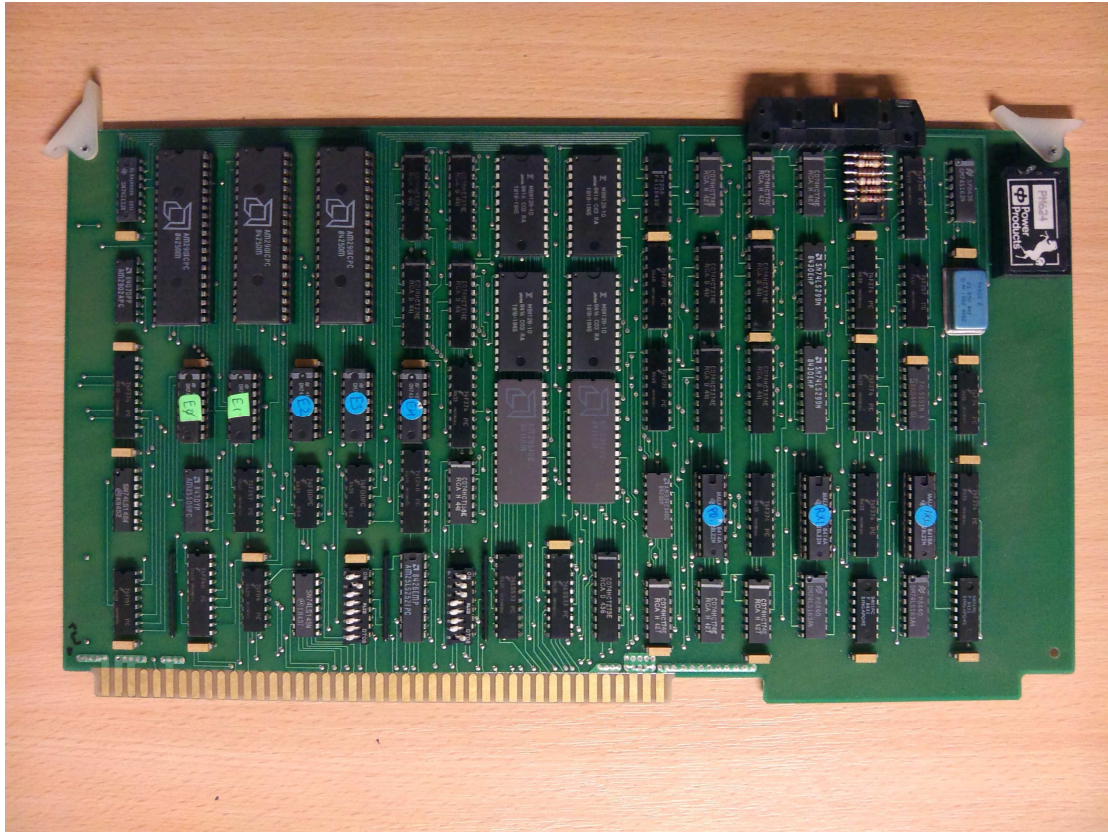*Figure 6: Pre-production SUN-1 Workstation CPU board 1 label*
P/N: SUN Microsystems 270-0001 Rev D
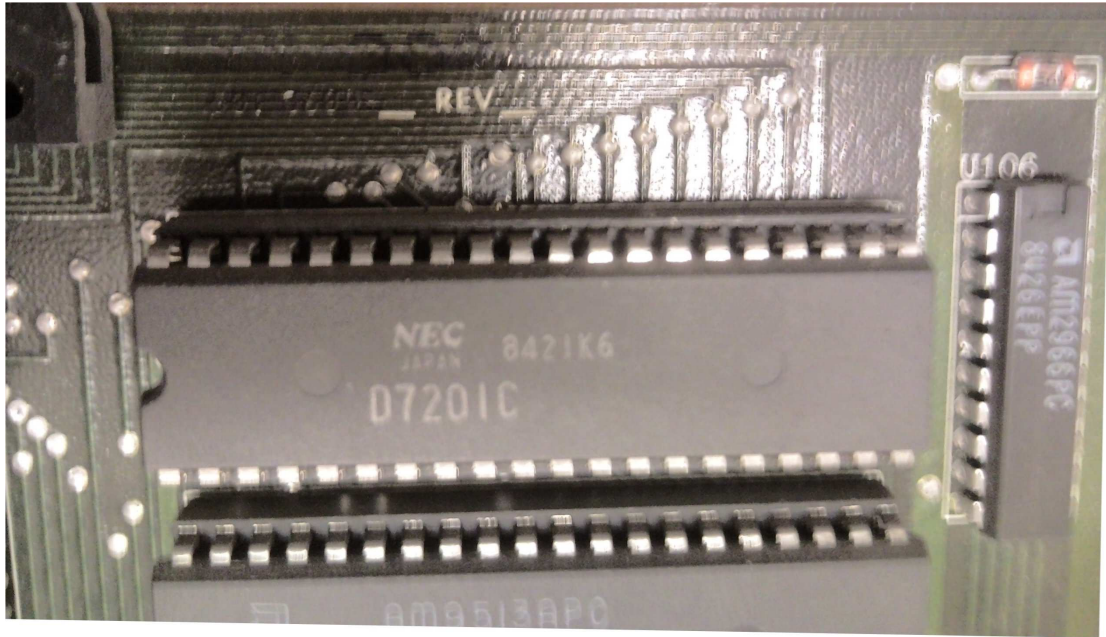
Figure 7: Pre-production SUN-1 Workstation CPU board 1 extra inked markings
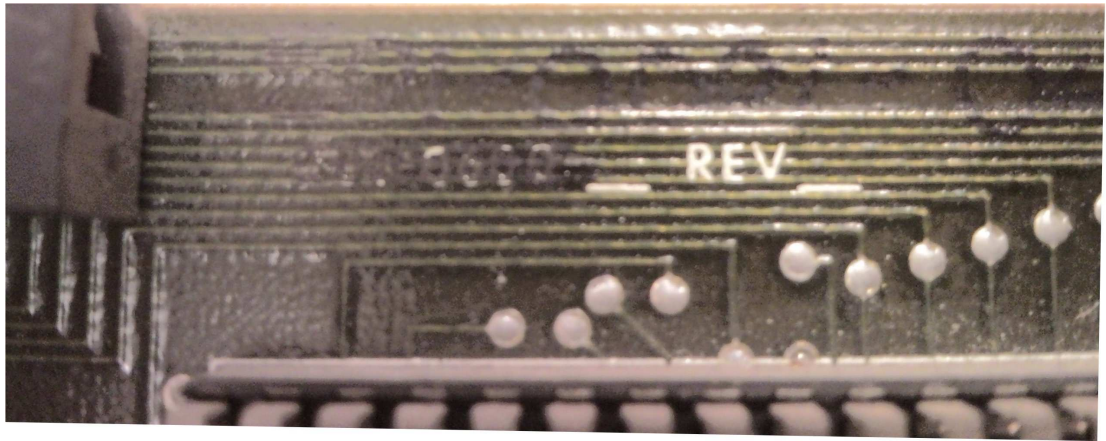
Figure 8: Pre-production SUN-1 Workstation CPU board 1 inked markings closeup, left above D7201C, probably S/N

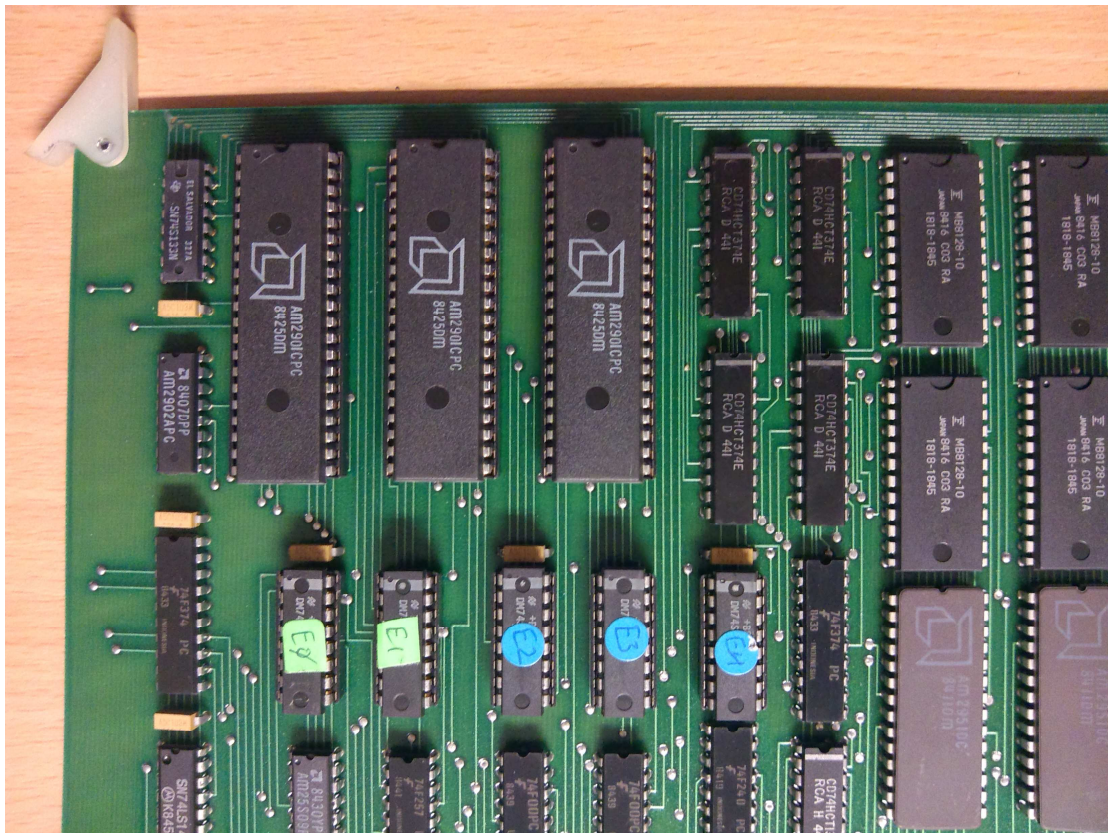*Figure 9: Pre-production SUN-1 Workstation CPU board 1 inked markings closeup, right above D7201C, "1010"*
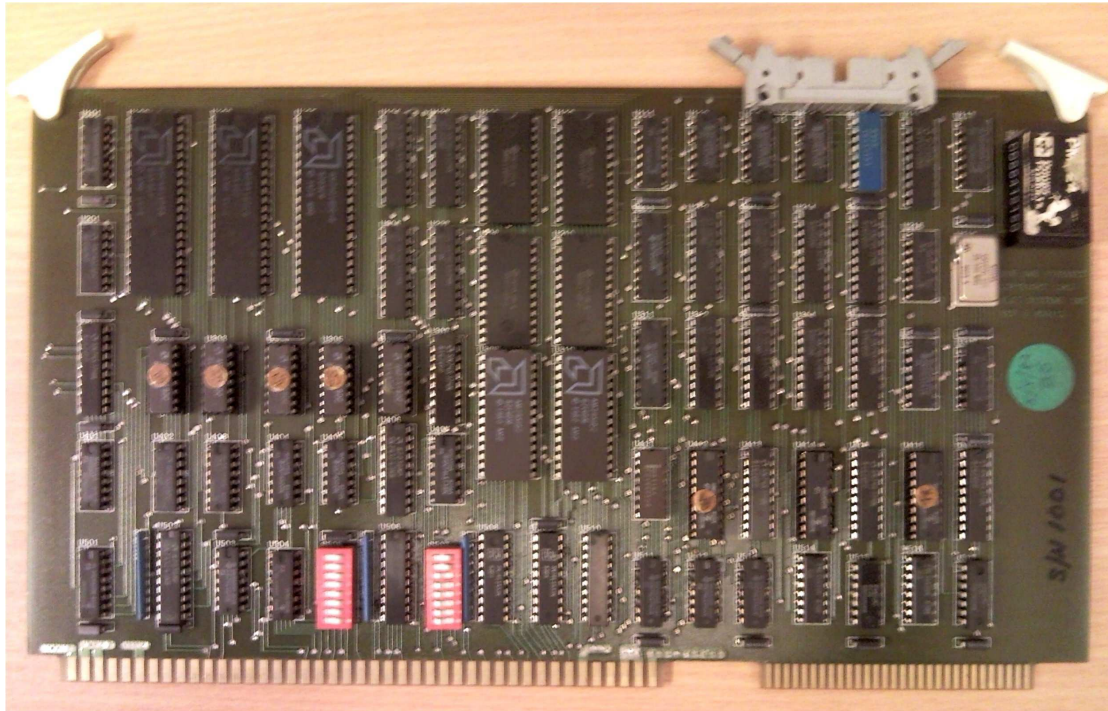
Figure 10: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1
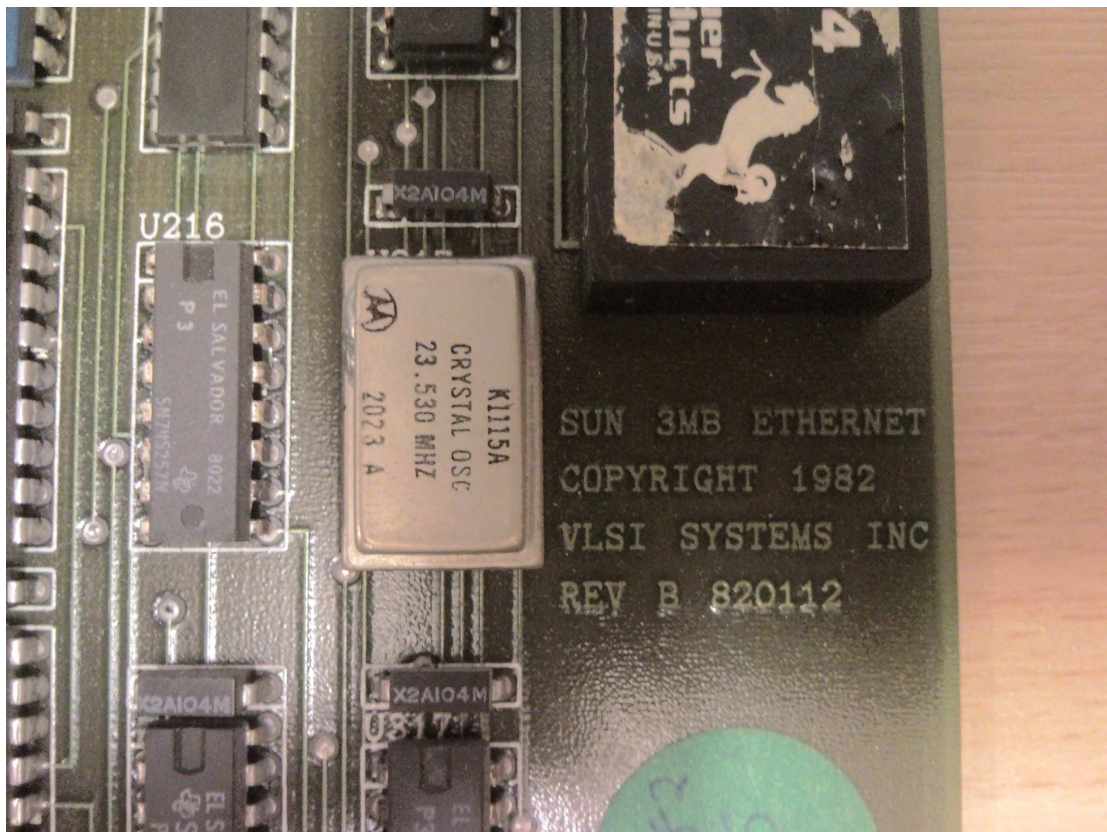
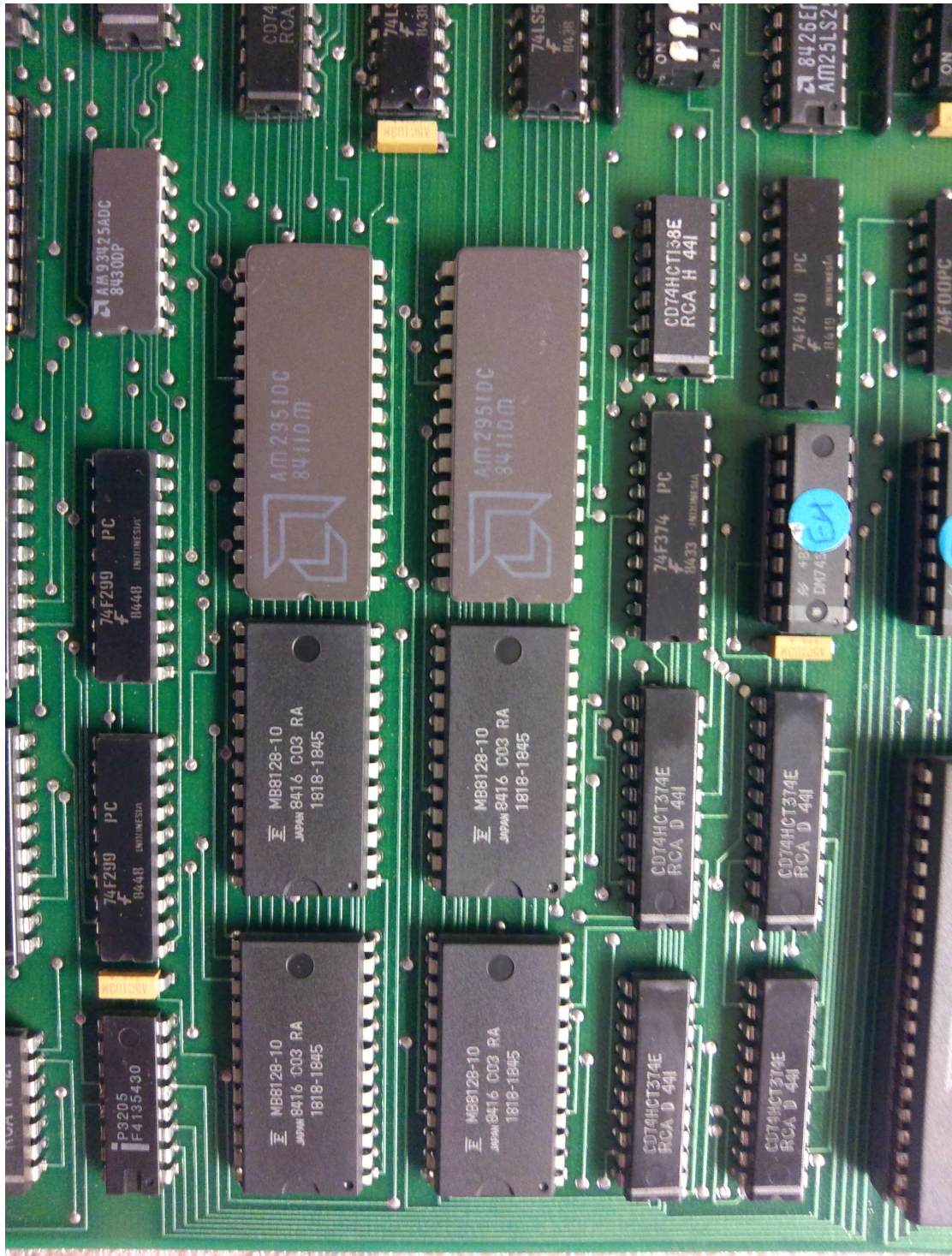*Figure 11: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 label*
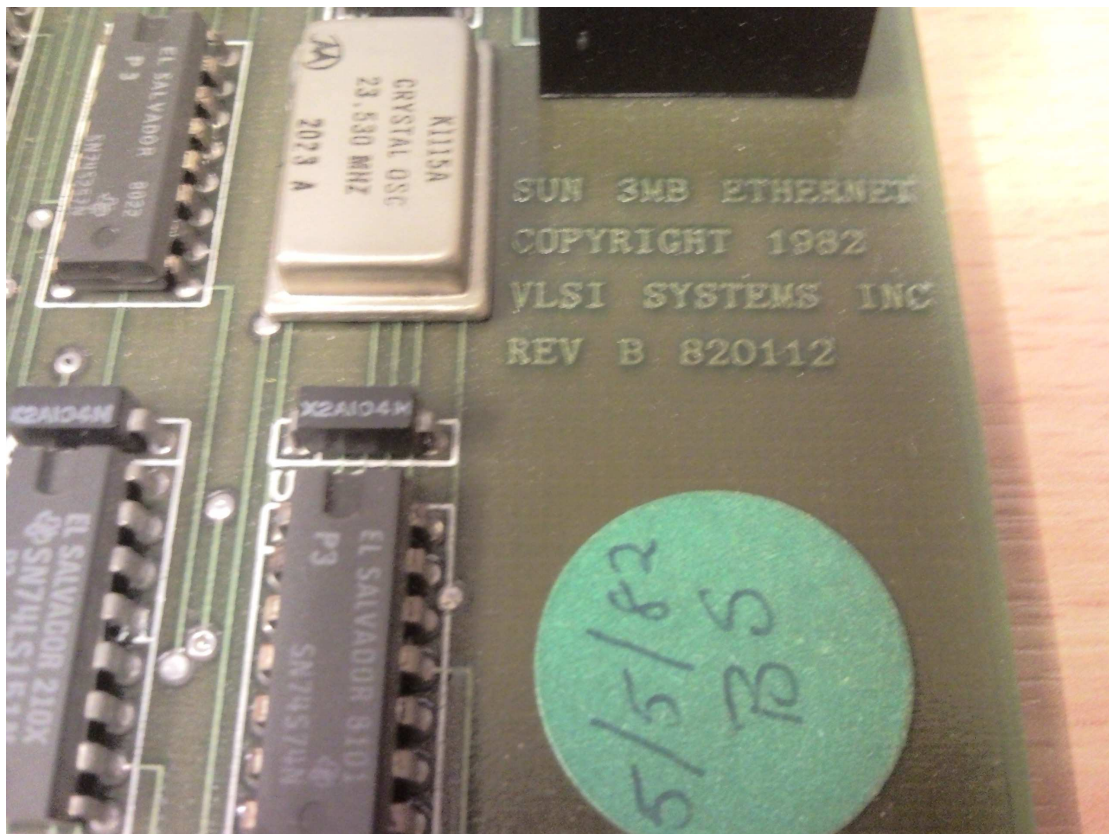
Figure 12: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1
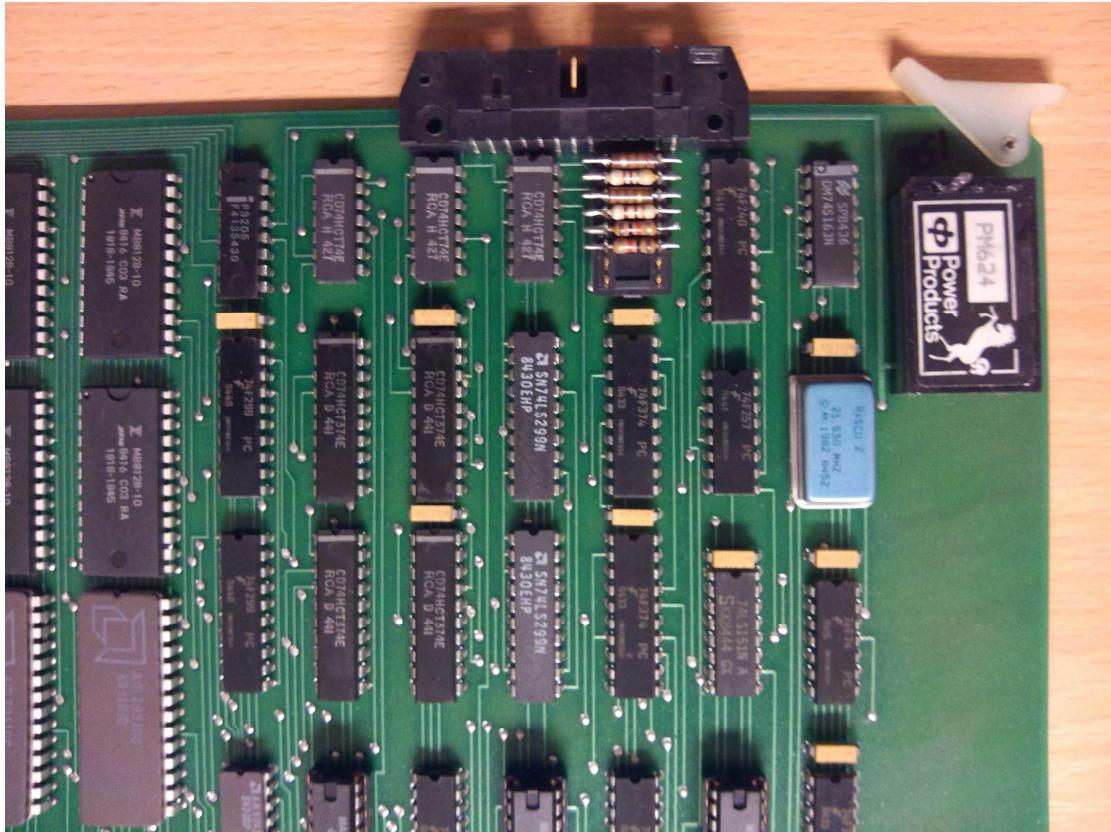*Date stamp: 5-May-1982*
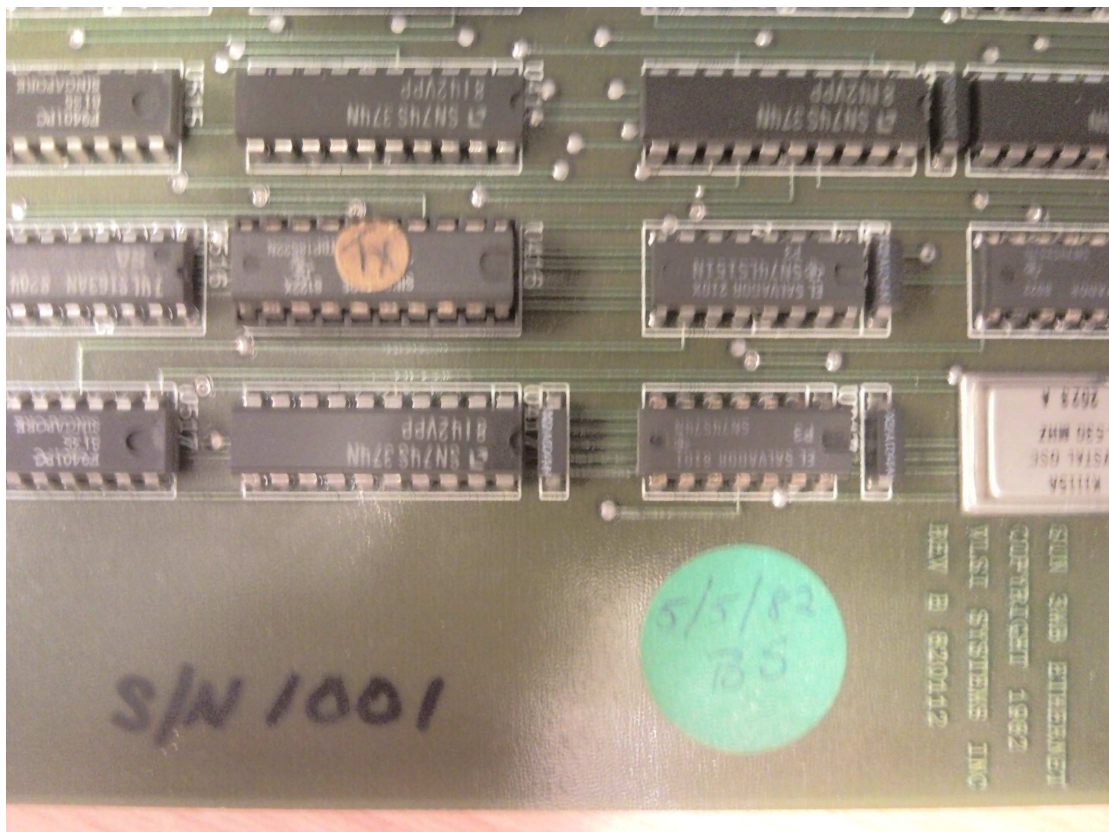
Figure 13: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1
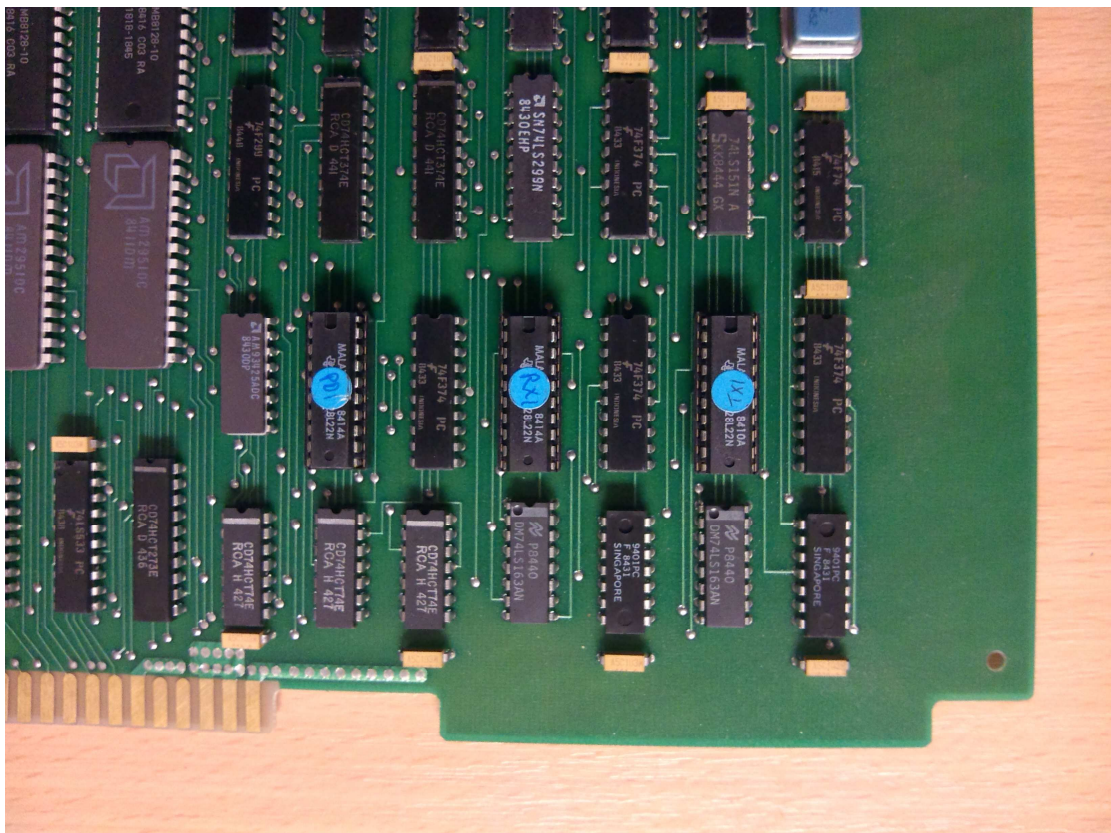*S/N: 1001*
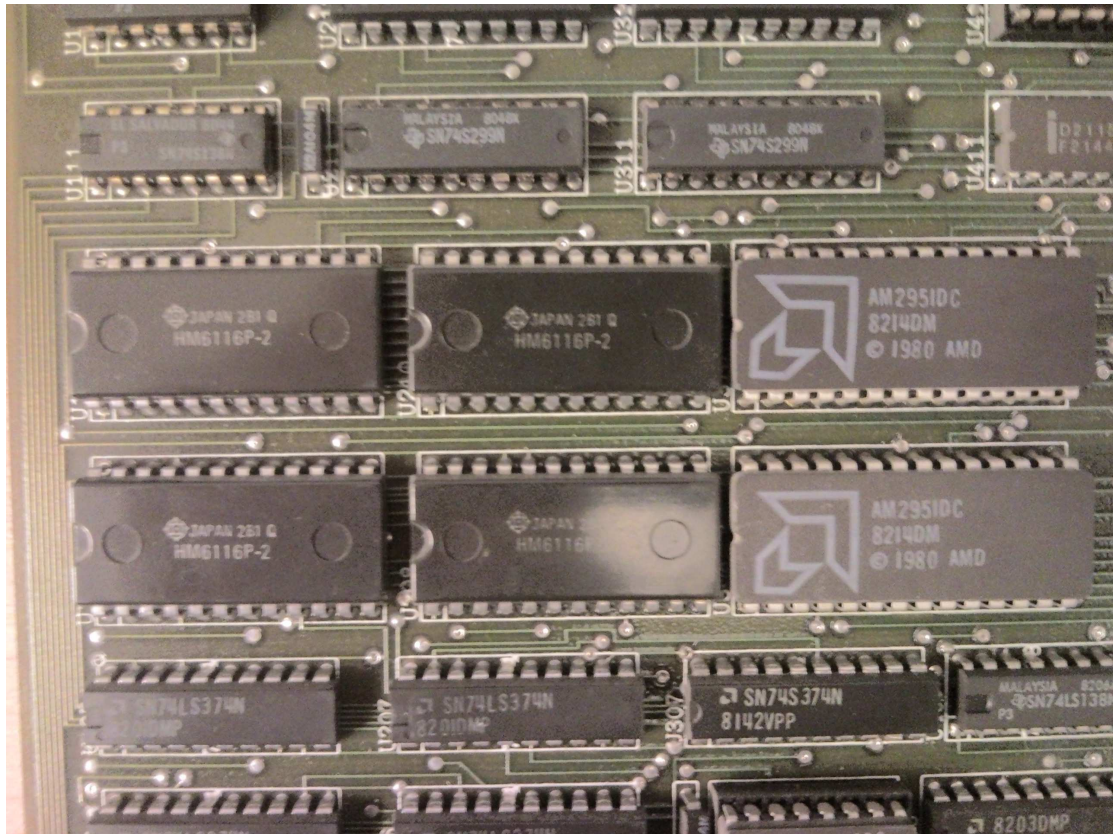
Figure 14: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 closeup
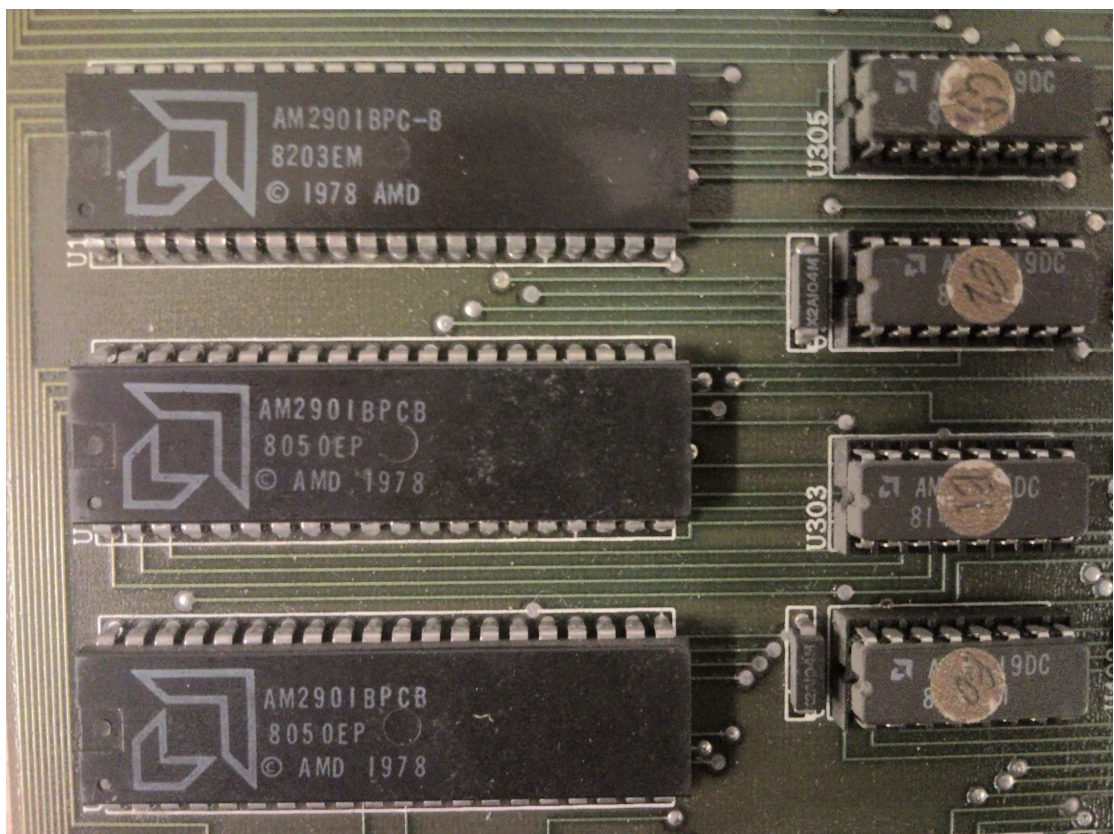
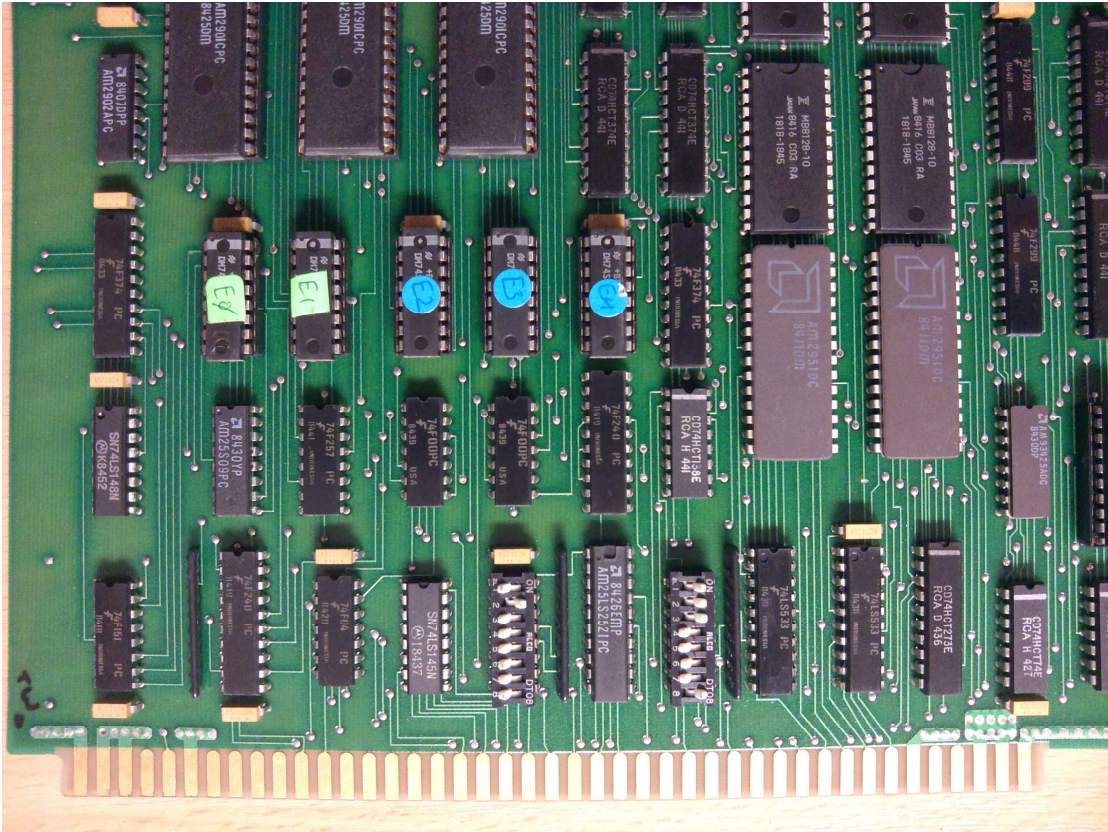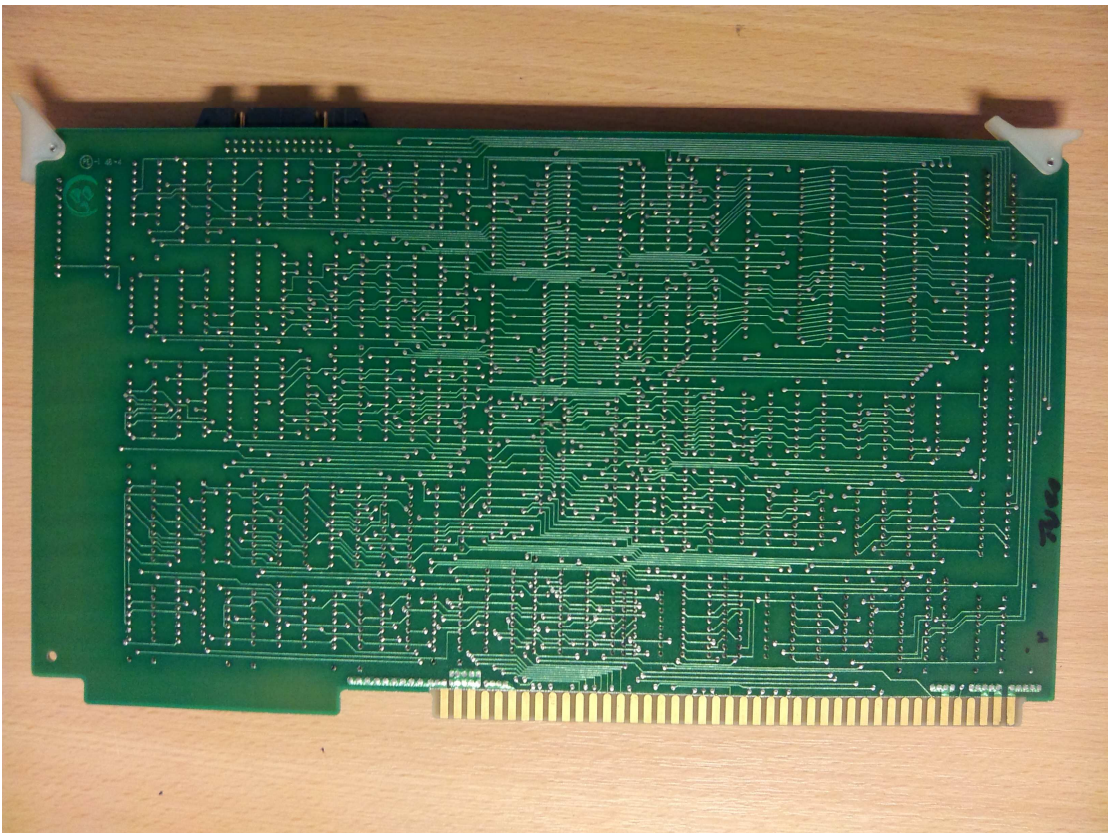*Figure 15: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 closeup*
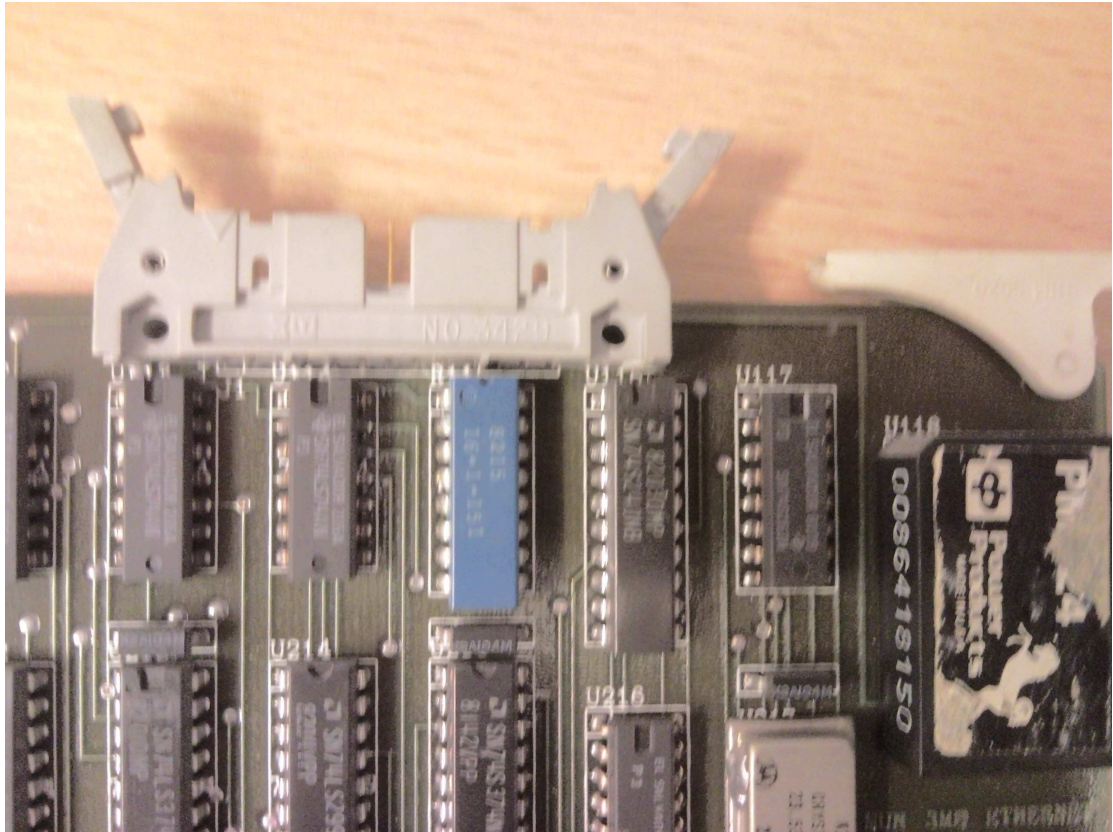
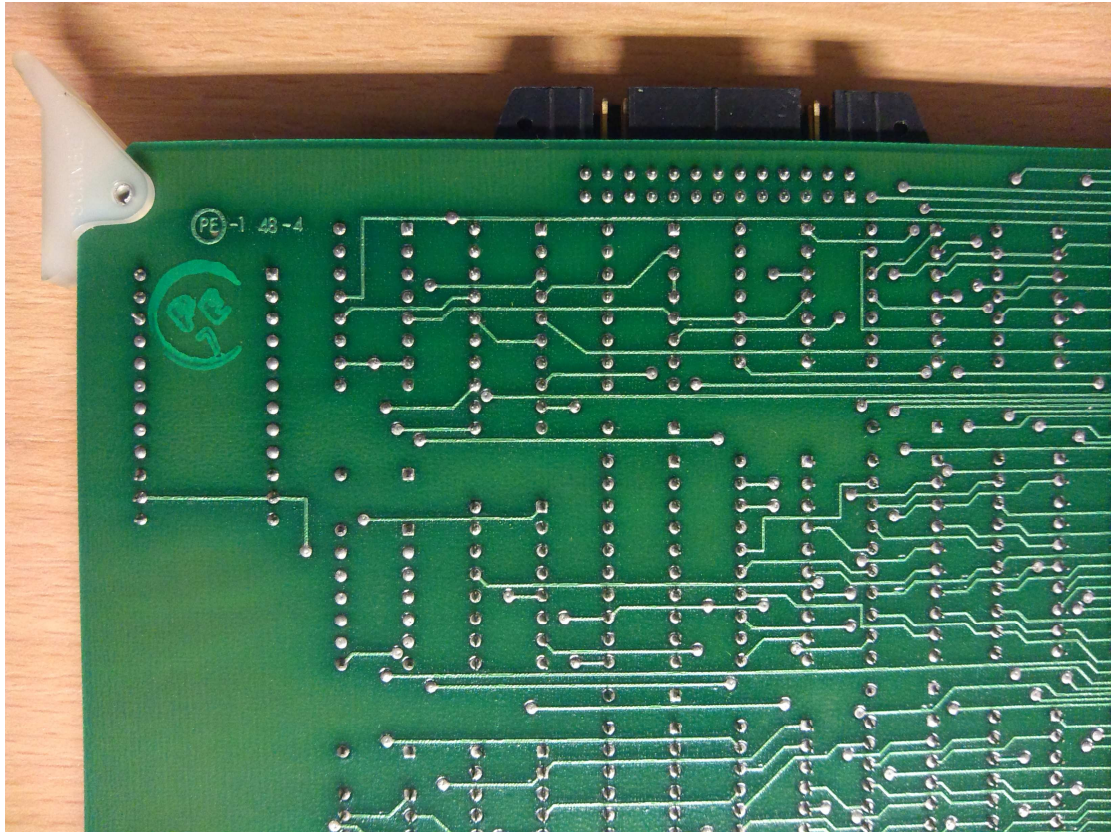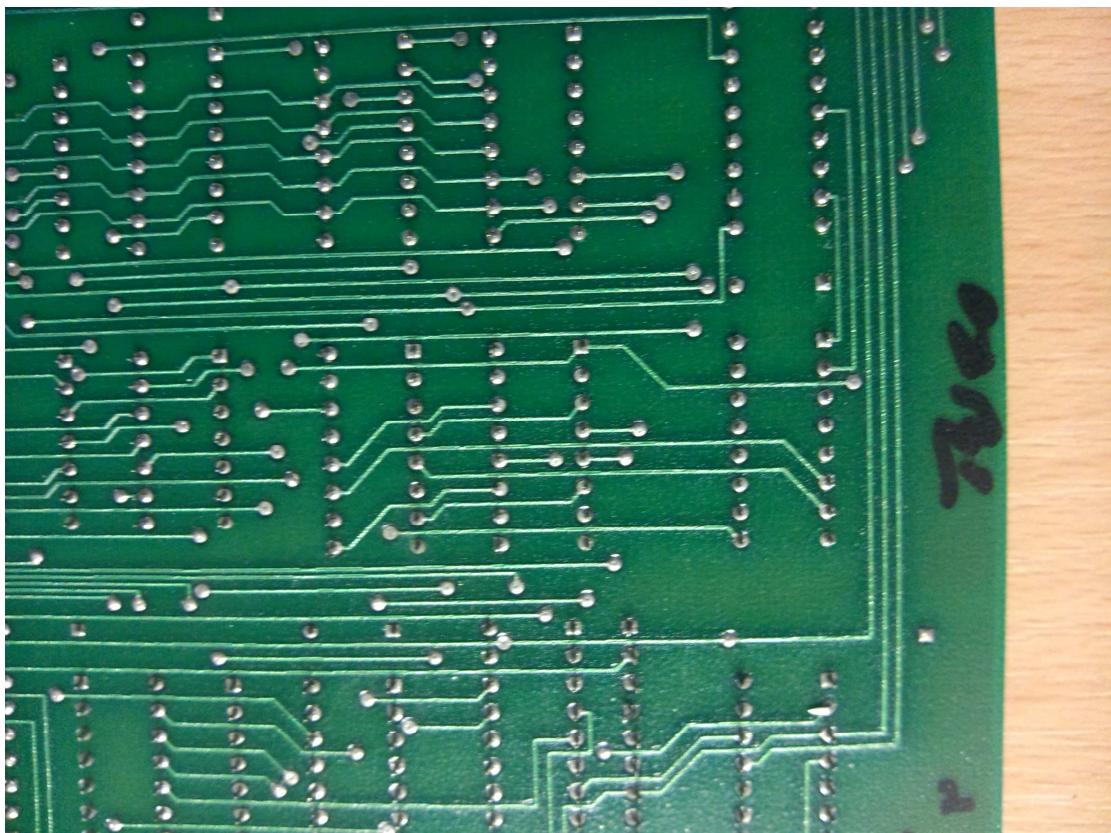*Figure 16: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 net connector*
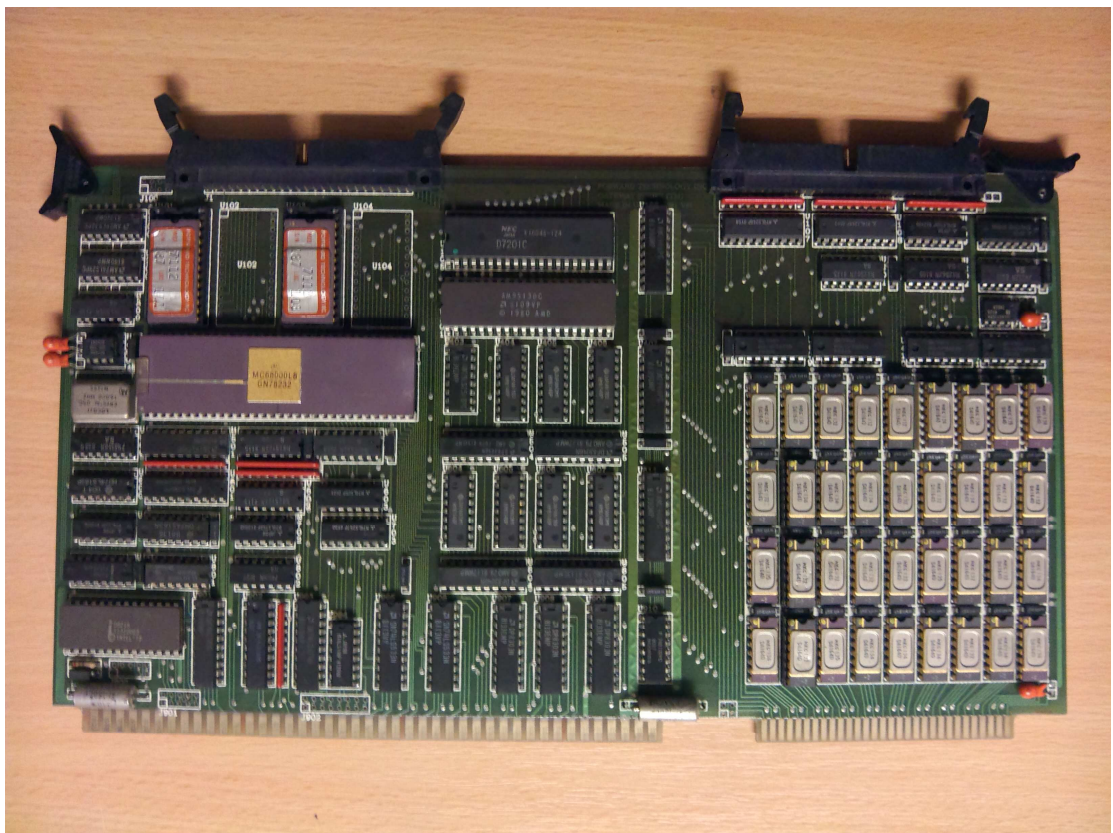

Figure 17: Pre-production SUN-1 Workstation CPU board 2 front view
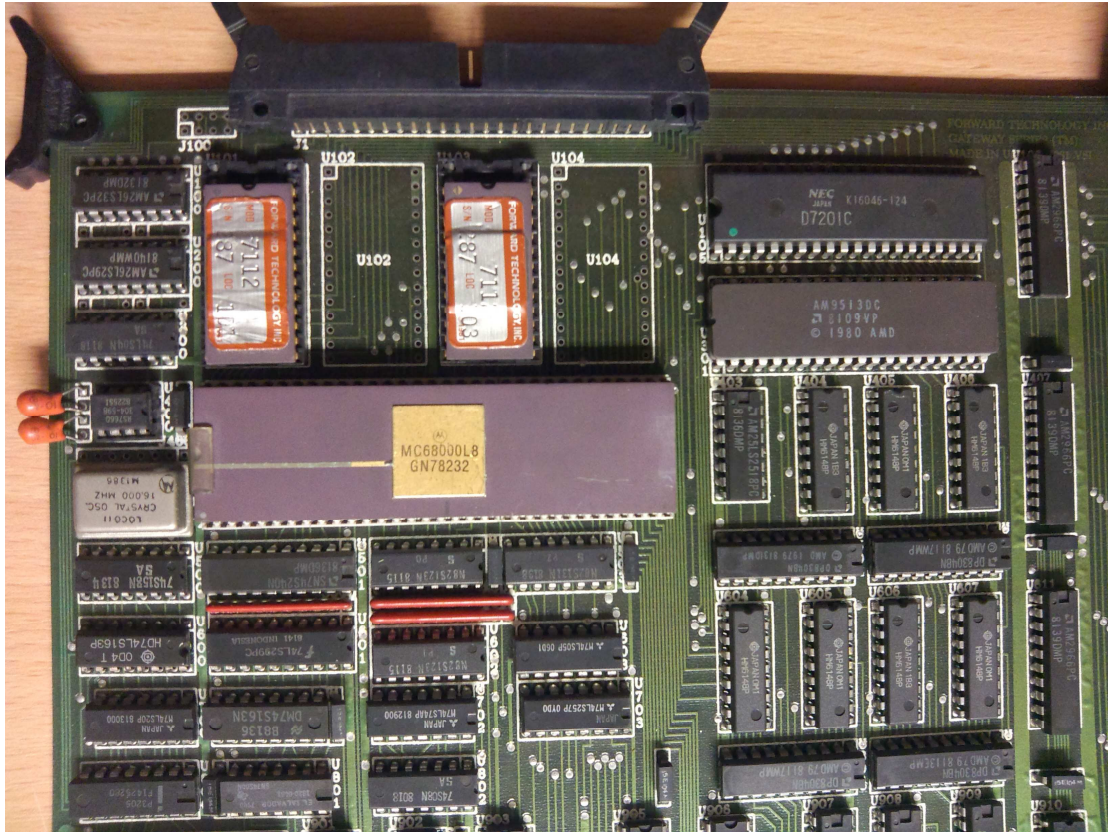
Figure 18: Pre-production SUN-1 Workstation CPU board 2 closeup
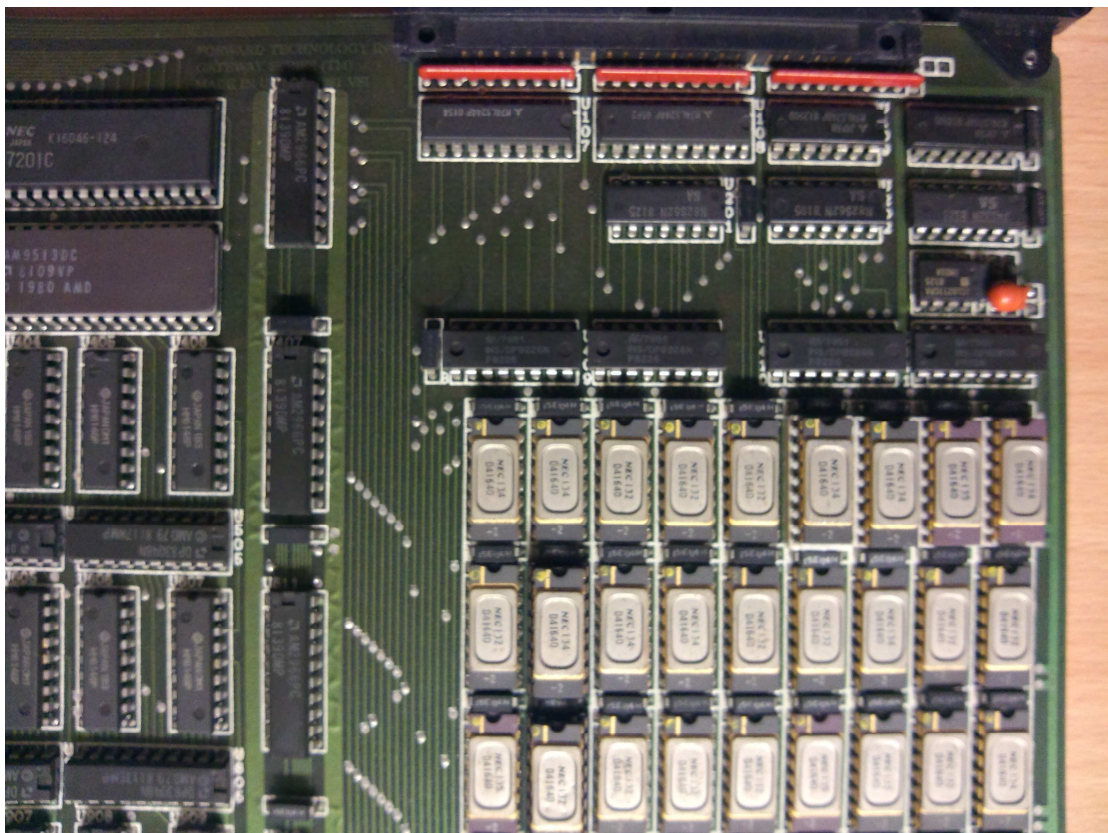
Figure 19: Pre-production SUN-1 Workstation CPU board 2 closeup
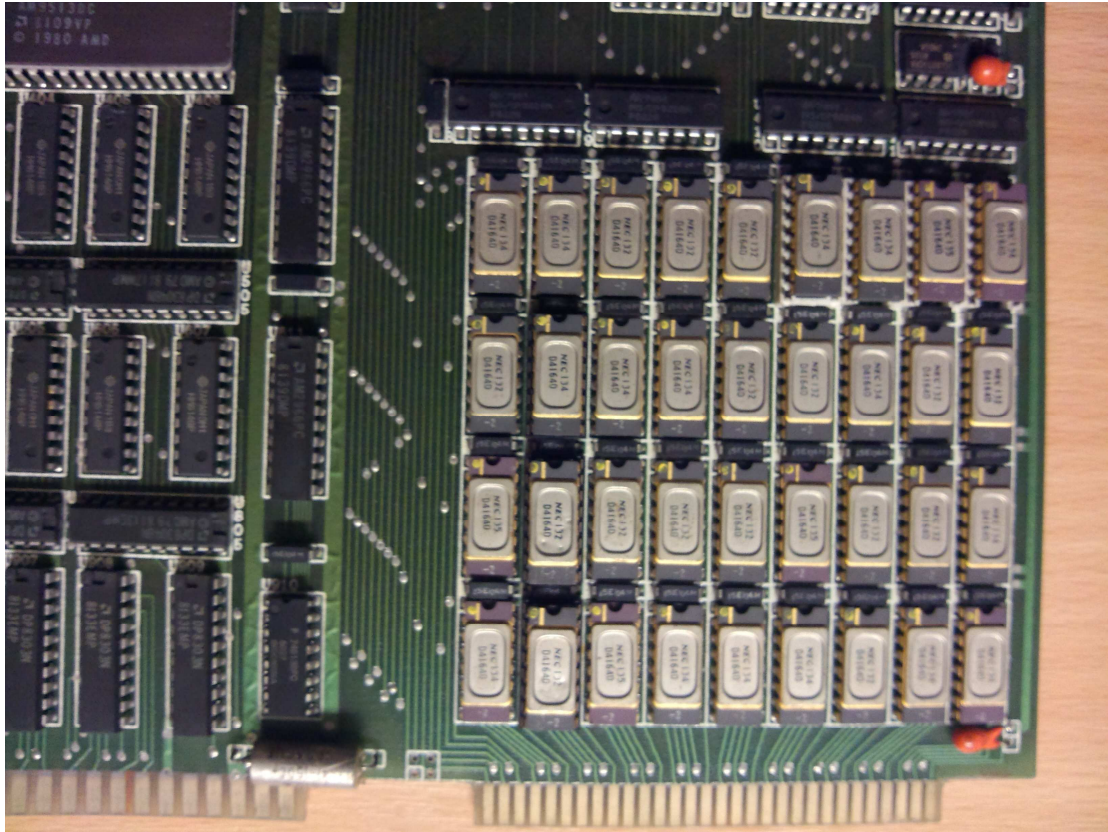
Figure 20: Pre-production SUN-1 Workstation CPU board 2 closeup

Figure 21: Pre-production SUN-1 Workstation CPU board 2 closeup

Figure 22: Pre-production SUN-1 Workstation CPU board 2 rear view

Figure 23: Pre-production SUN-1 Workstation CPU board 2 manufacturing label

Figure 24: Pre-production SUN-1 Workstation CPU board 3 front view

Figure 25: Pre-production SUN-1 Workstation CPU board 3 closeup

Figure 26: Pre-production SUN-1 Workstation CPU board 3 closeup

Figure 27: Pre-production SUN-1 Workstation CPU board 3 closeup

Figure 28: Pre-production SUN-1 Workstation CPU board 3 closeup

Figure 29: Pre-production SUN-1 Workstation CPU board 3 manufacturing label

Figure 30: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 front view

Figure 31: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

Figure 32: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

Figure 33: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

Figure 34: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

Figure 35: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

Figure 36: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 rear view

Figure 37: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 label

Figure 38: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 label
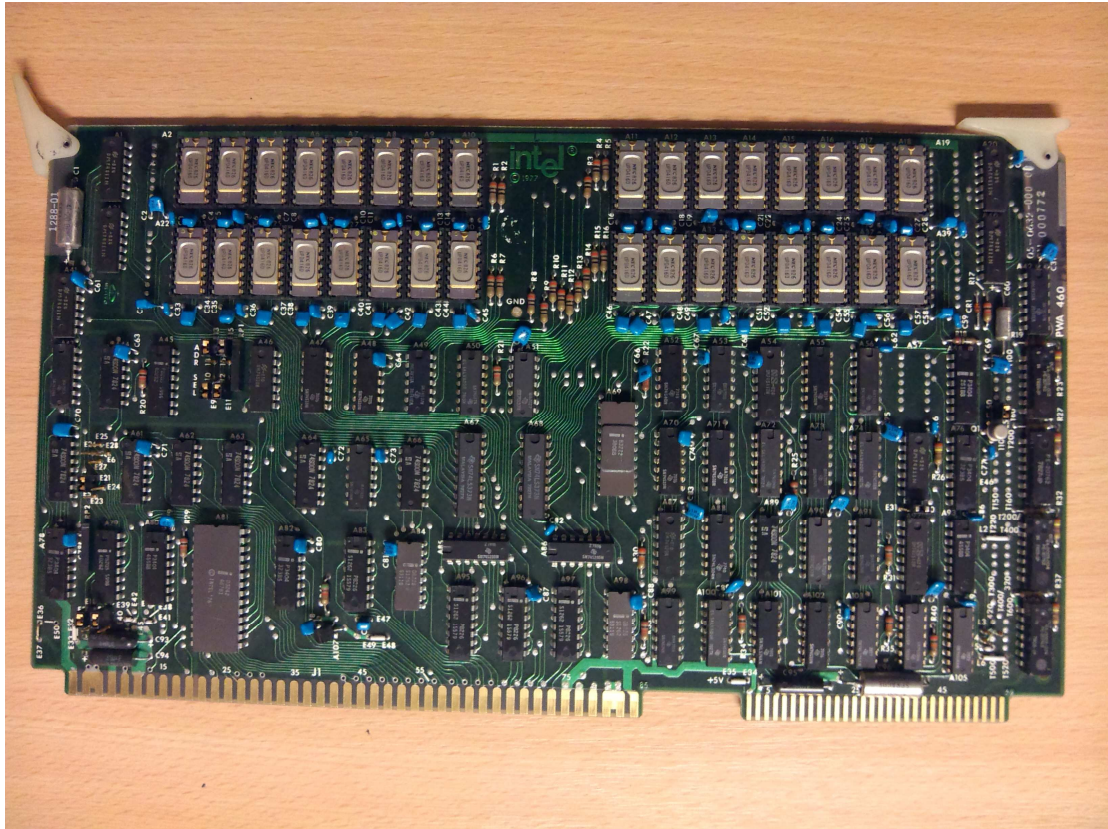
Figure 39: Intel PWA460 Multibus Memory board 2 front view
NB: numbered as per its board set
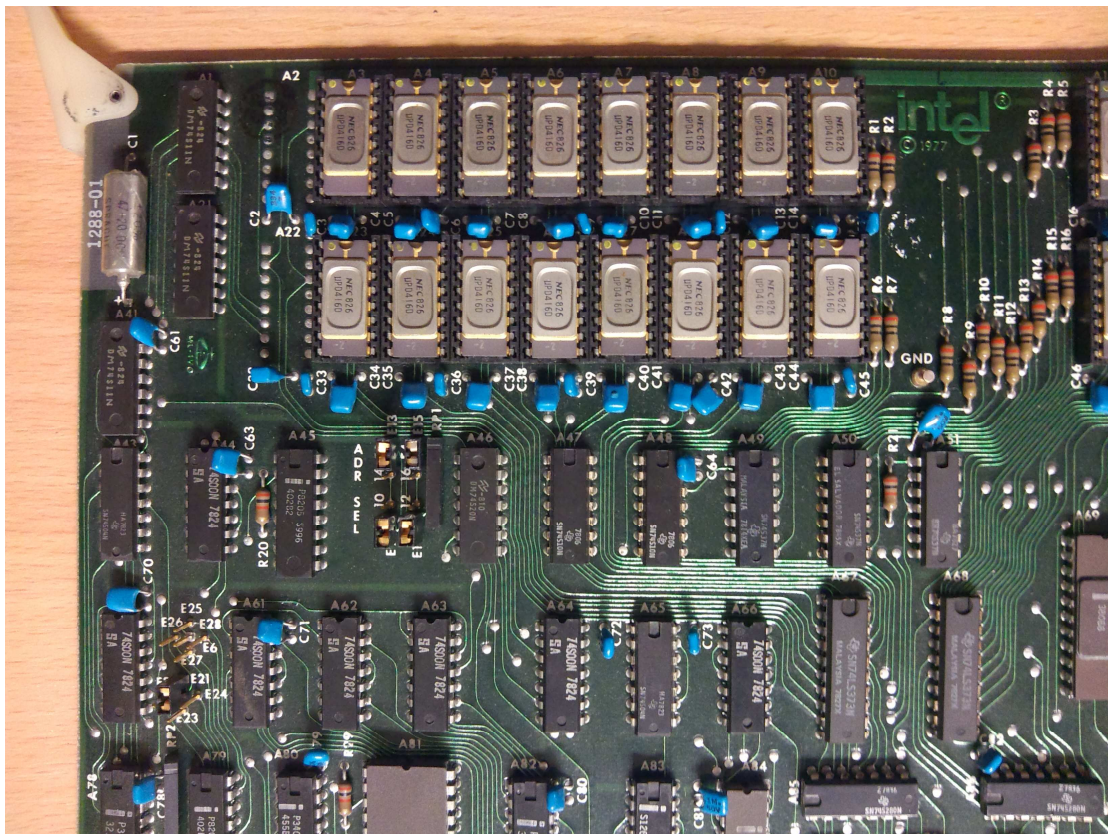
Figure 40: Intel PWA460 Multibus Memory board 2 closeup
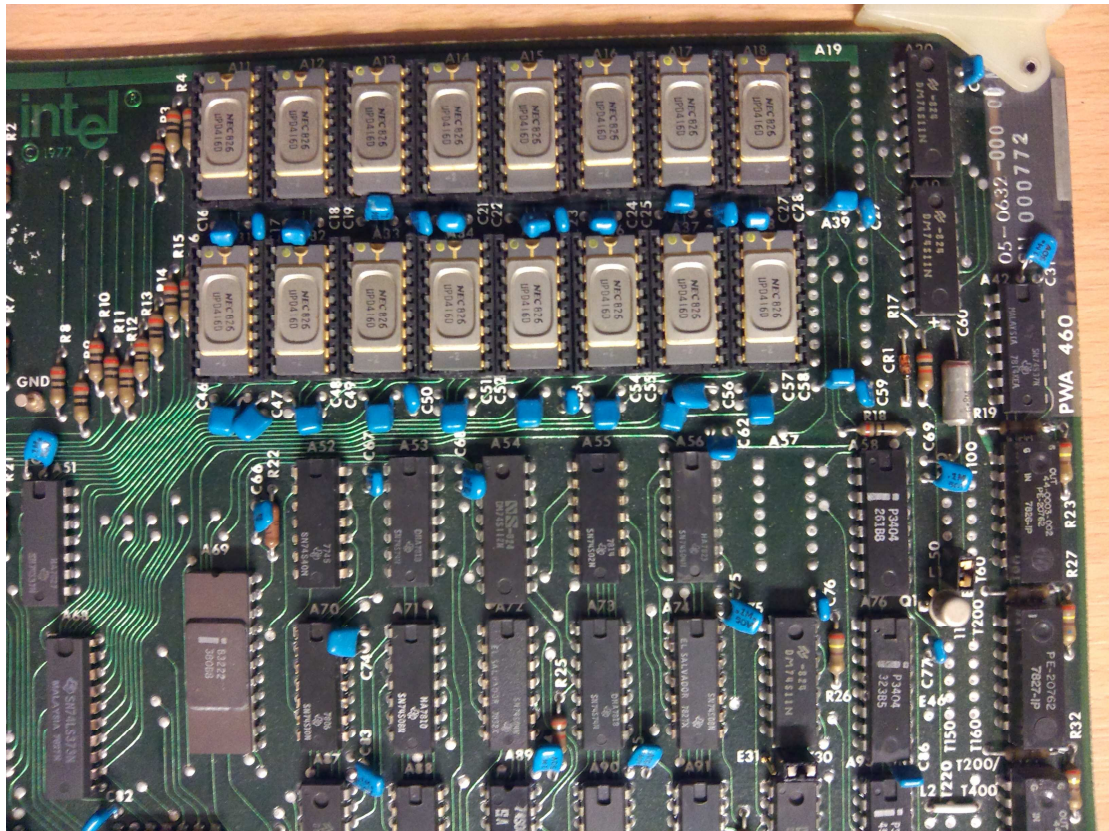
Figure 41: Intel PWA460 Multibus Memory board 2 closeup
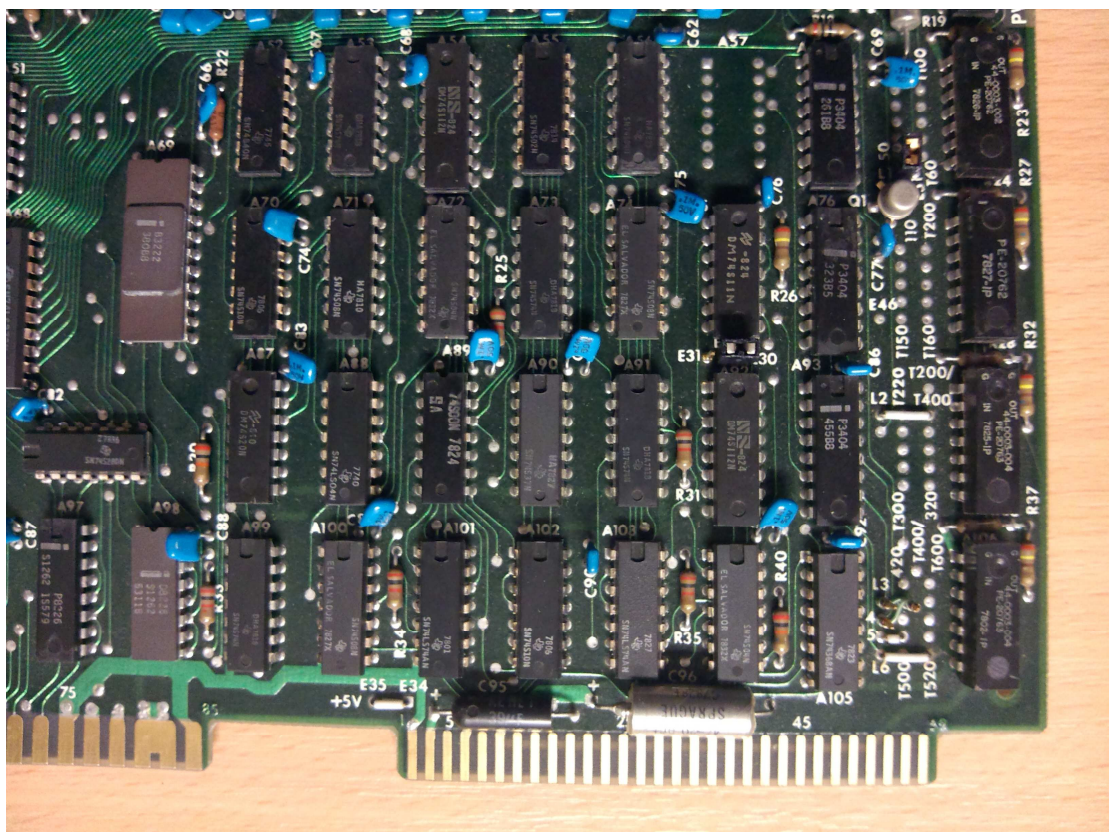
Figure 42: Intel PWA460 Multibus Memory board 2 closeup
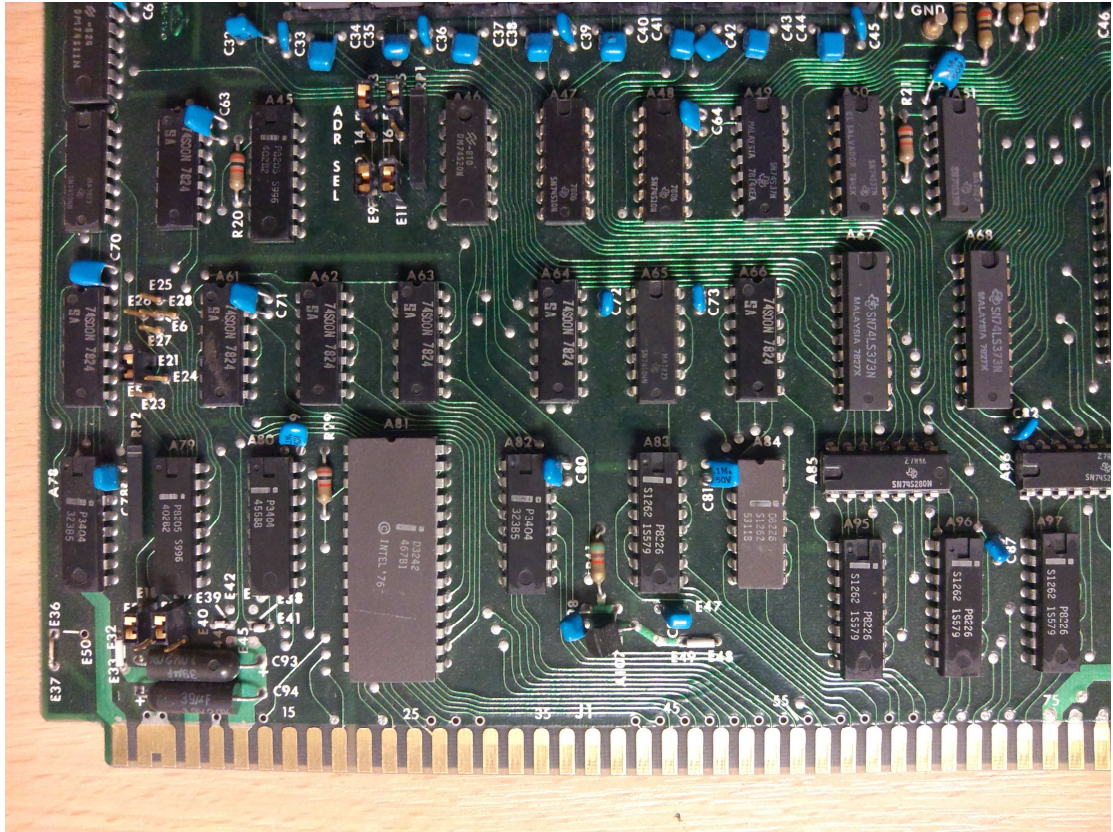
Figure 43: Intel PWA460 Multibus Memory board 2 closeup
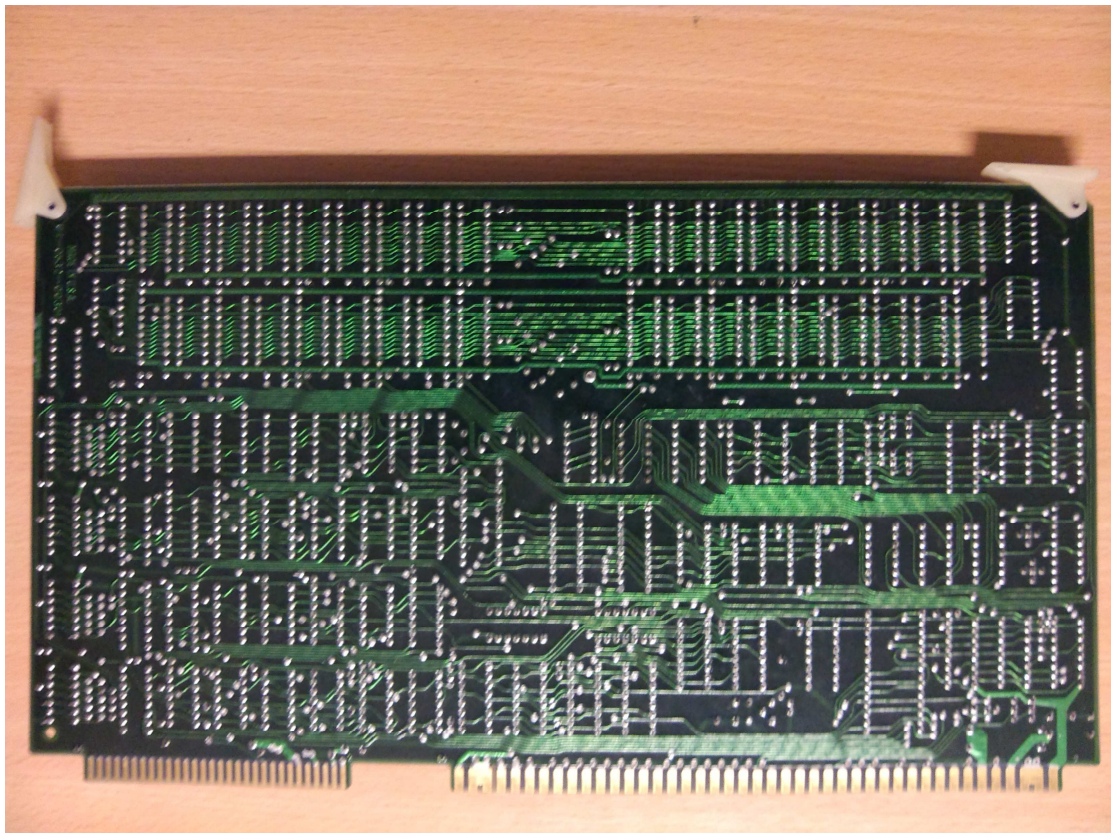
Figure 44: Intel PWA460 Multibus Memory board 2 rear view
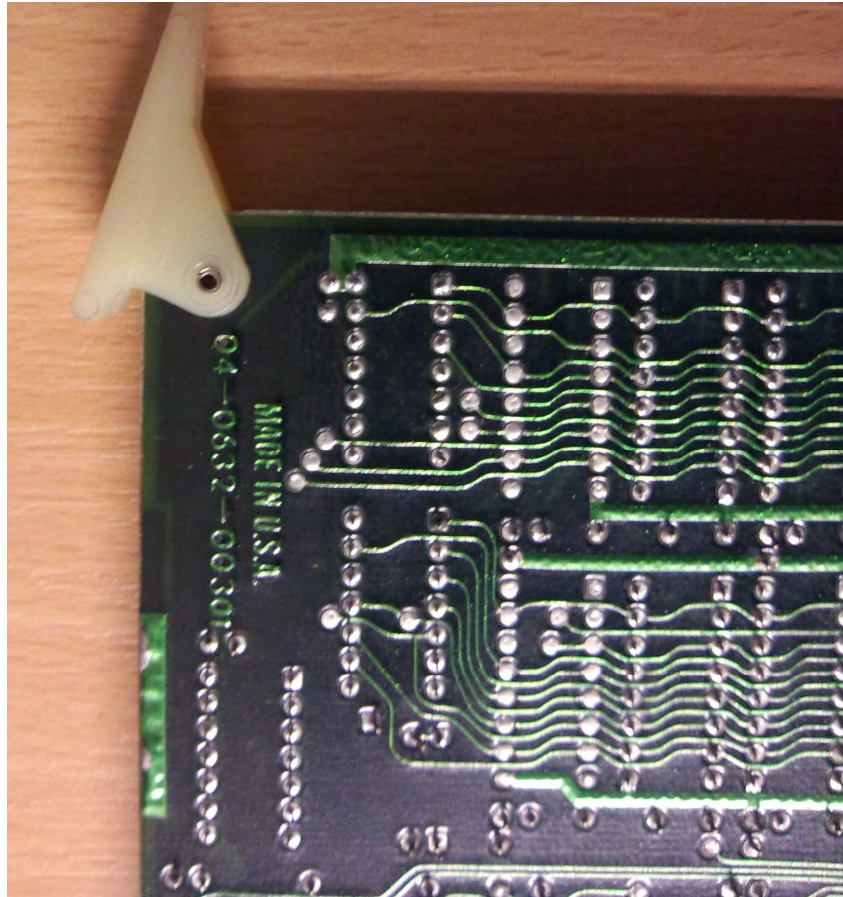
Figure 45: Intel PWA460 Multibus Memory board 2 manufacturing label
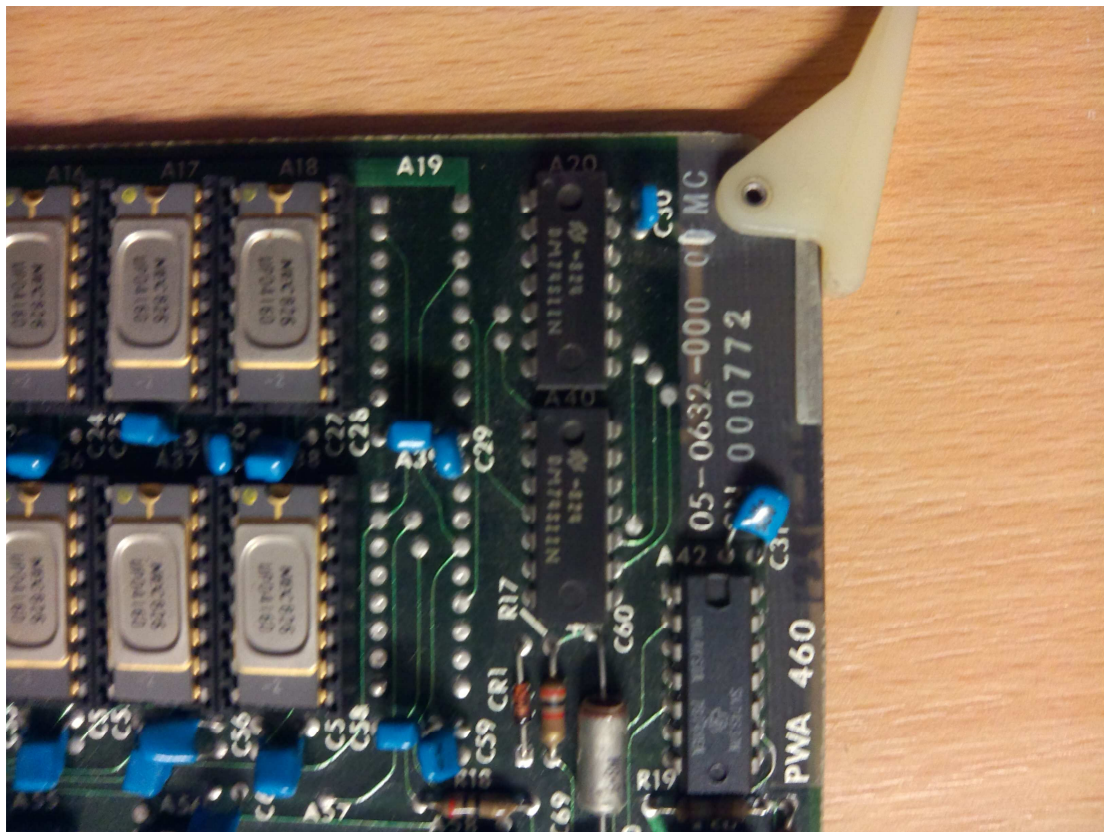
Figure 46: Intel PWA460 Multibus Memory board 2 manufacturing label
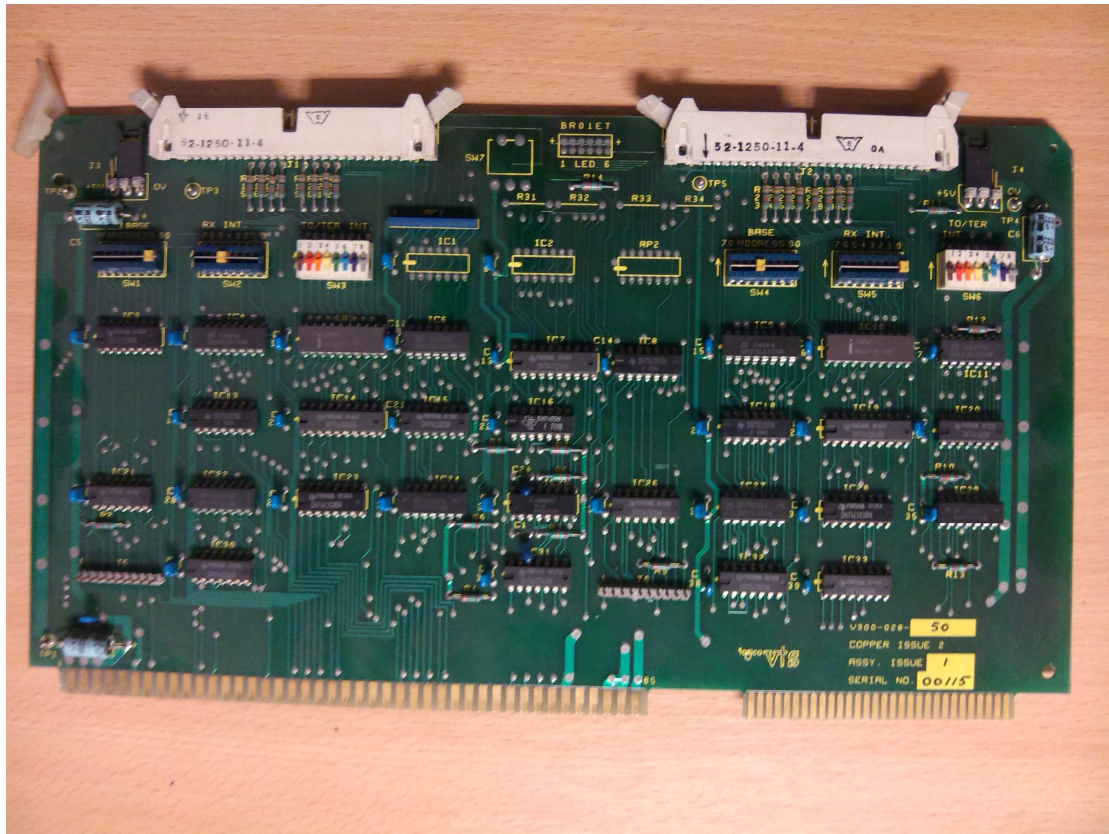
Figure 47: Logica VTS V300-028-50 Multibus I/O Board 2 front view
NB: numbered as per its board set
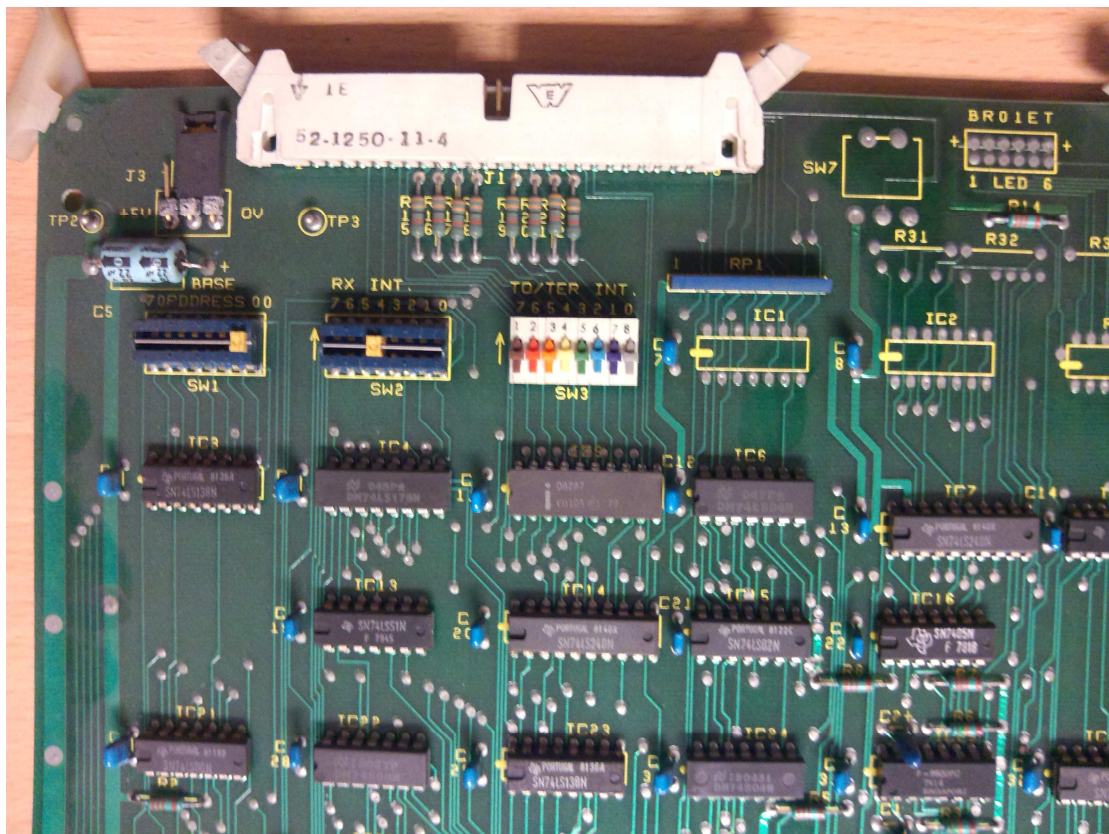
Figure 48: Logica VTS V300-028-50 Multibus I/O Board 2 closeup
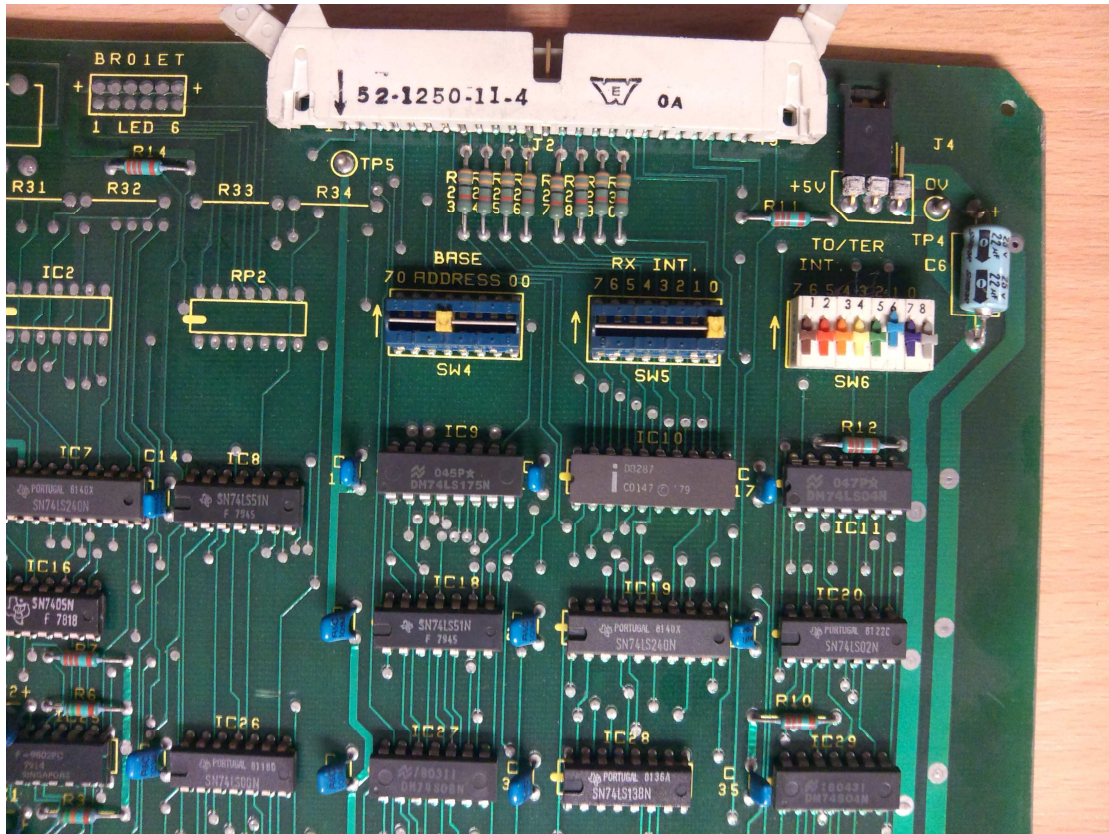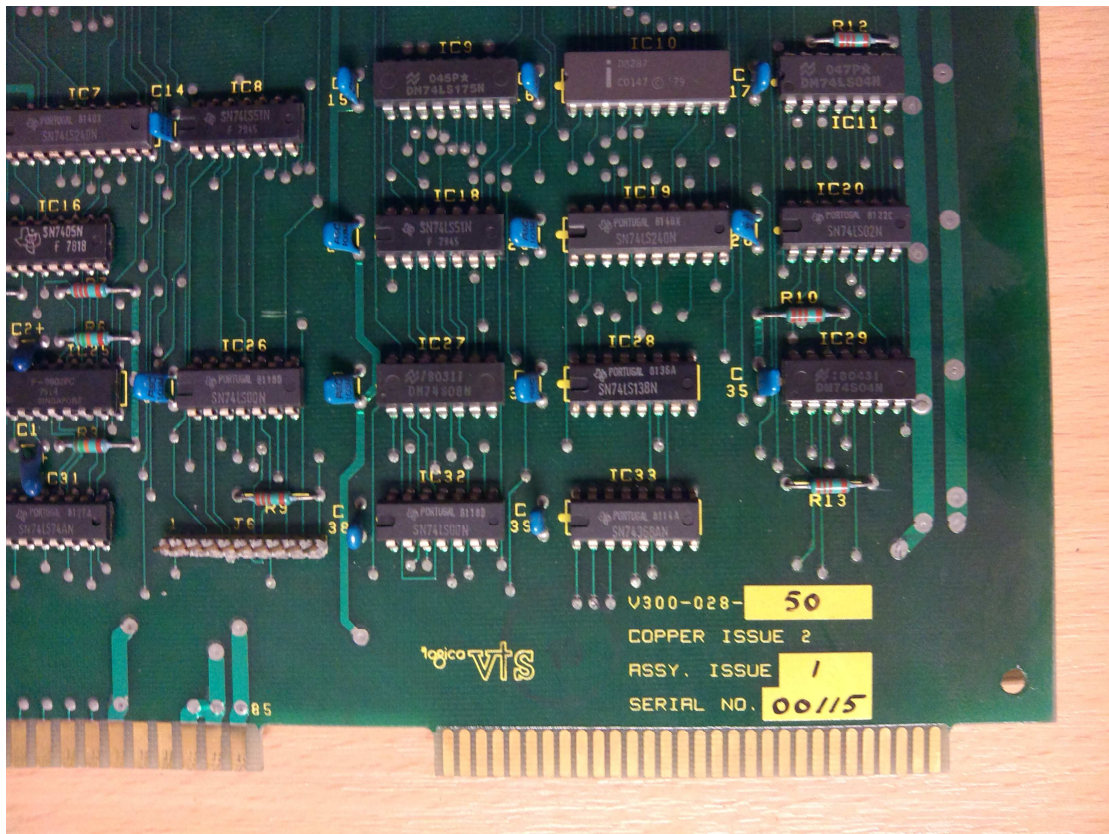
Figure 49: Logica VTS V300-028-50 Multibus I/O Board 2 closeup

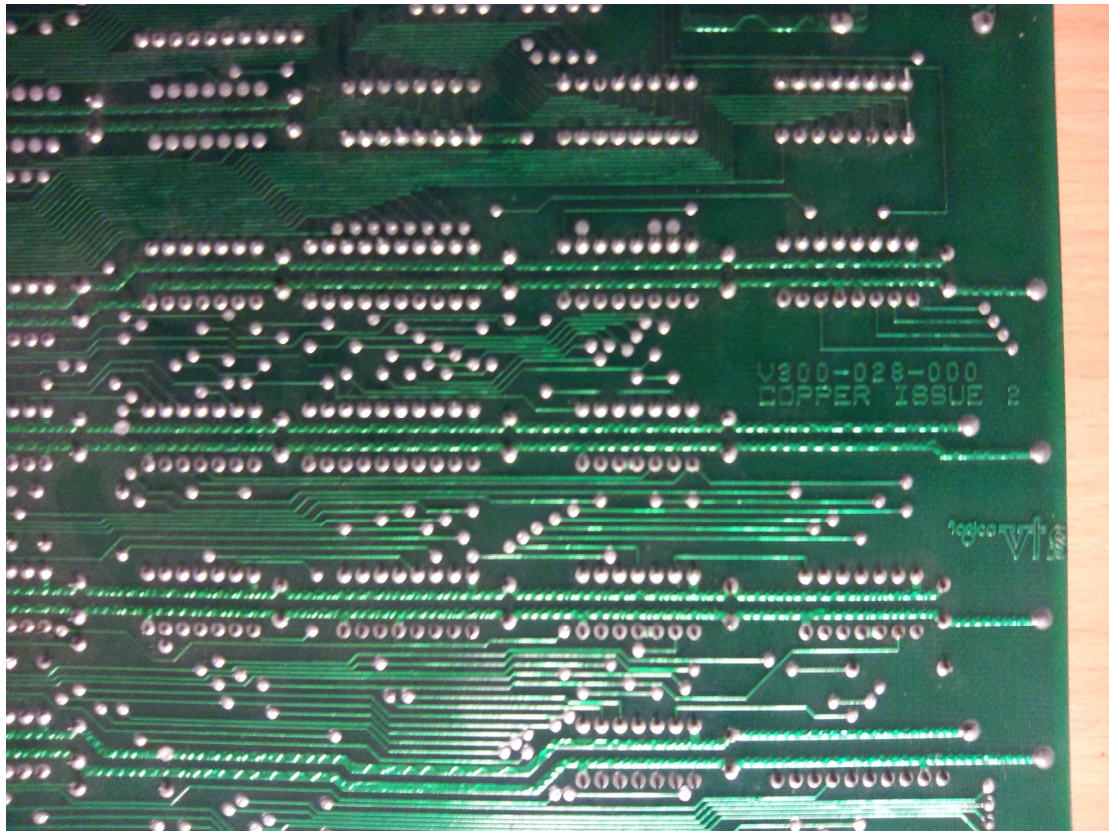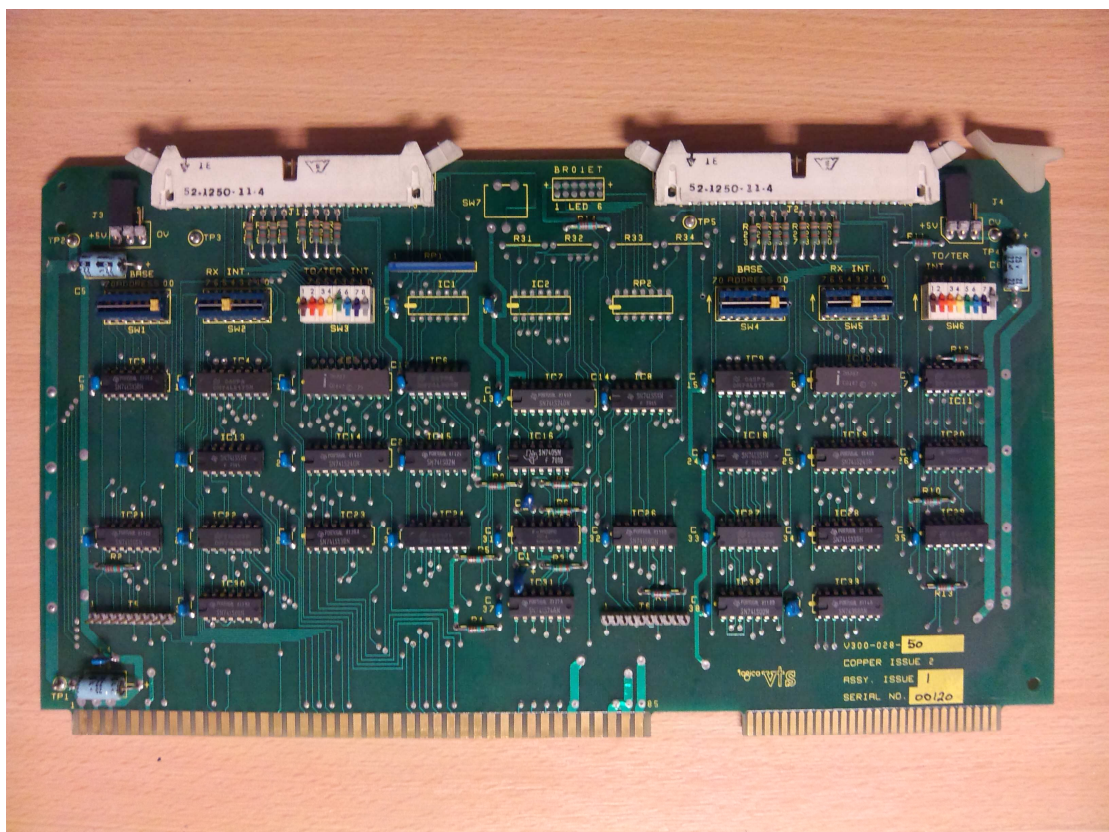*Figure 50: Logica VTS V300-028-50 Multibus I/O Board 2 closeup*

Figure 51: Logica VTS V300-028-50 Multibus I/O Board 2 closeup

Figure 52: Logica VTS V300-028-50 Multibus I/O Board 2 rear view

Figure 53: Logica VTS V300-028-50 Multibus I/O Board 2 manufacturing label

Figure 54: Logica VTS V300-028-50 Multibus I/O Board 3 front view
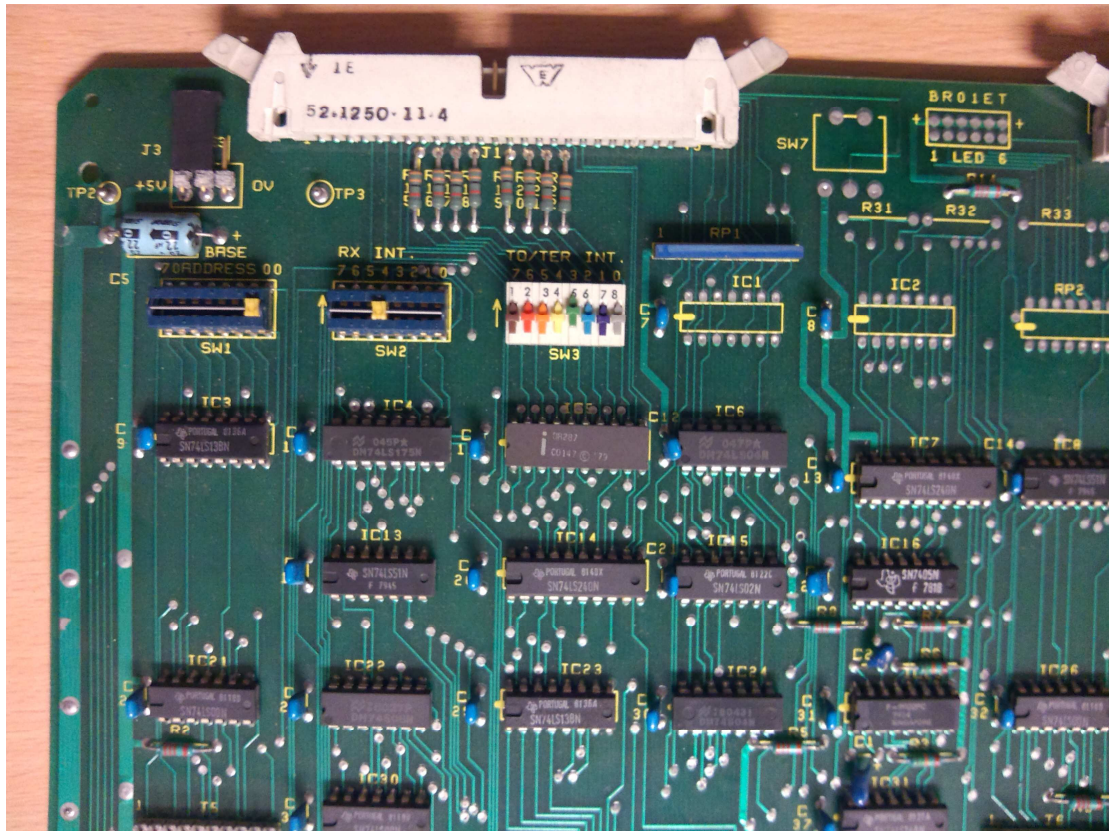*NB: numbered as per its board set*

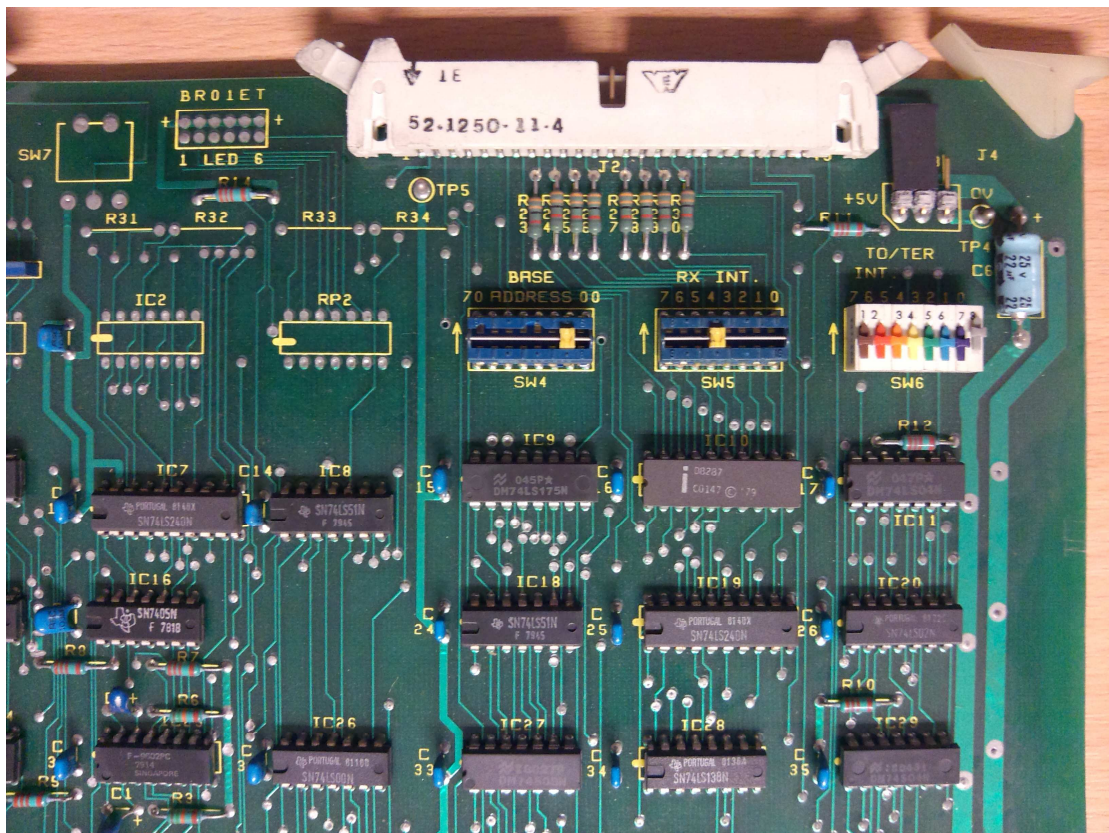*Figure 55: Logica VTS V300-028-50 Multibus I/O Board 3 closeup*

Figure 56: Logica VTS V300-028-50 Multibus I/O Board 3 closeup
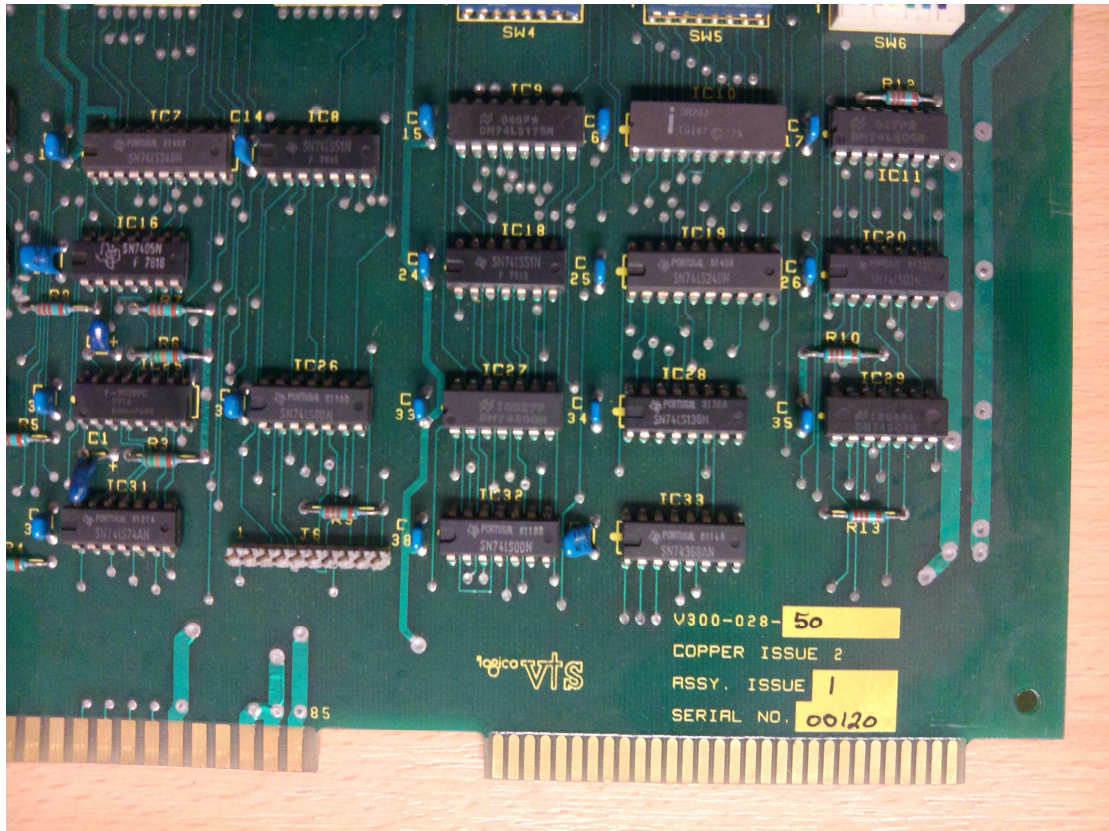
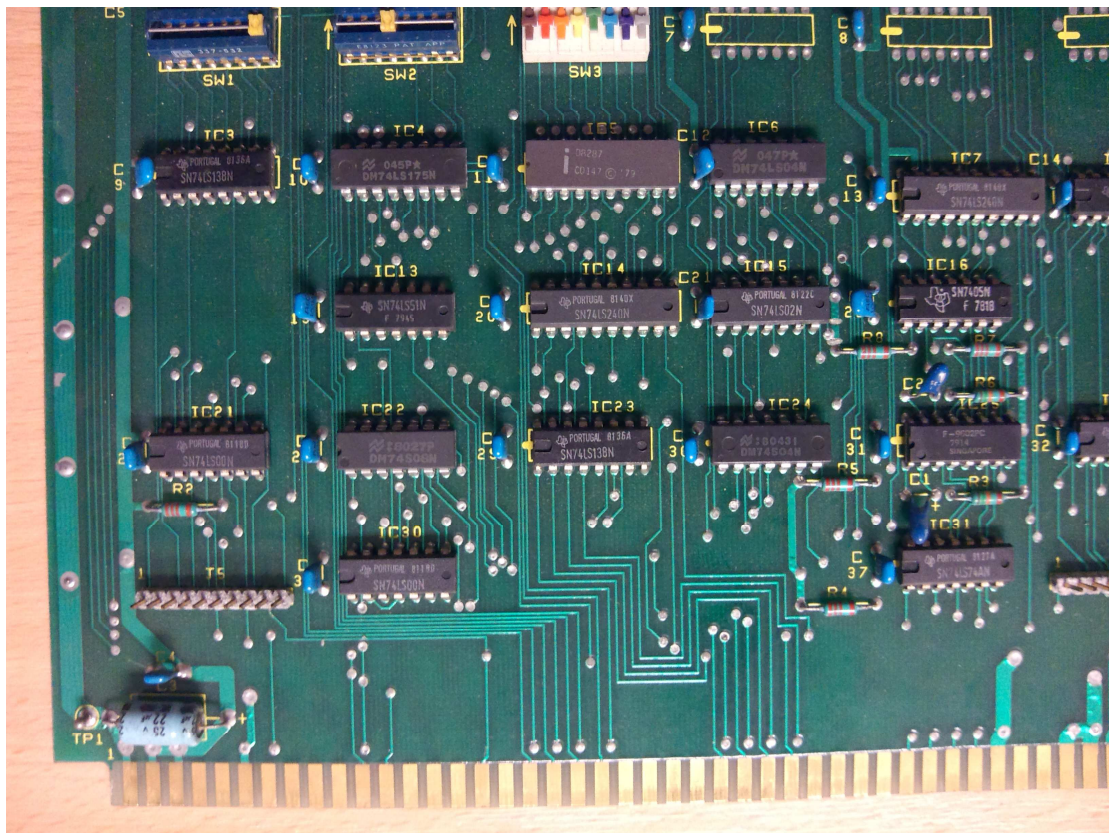*Figure 57: Logica VTS V300-028-50 Multibus I/O Board 3 closeup*

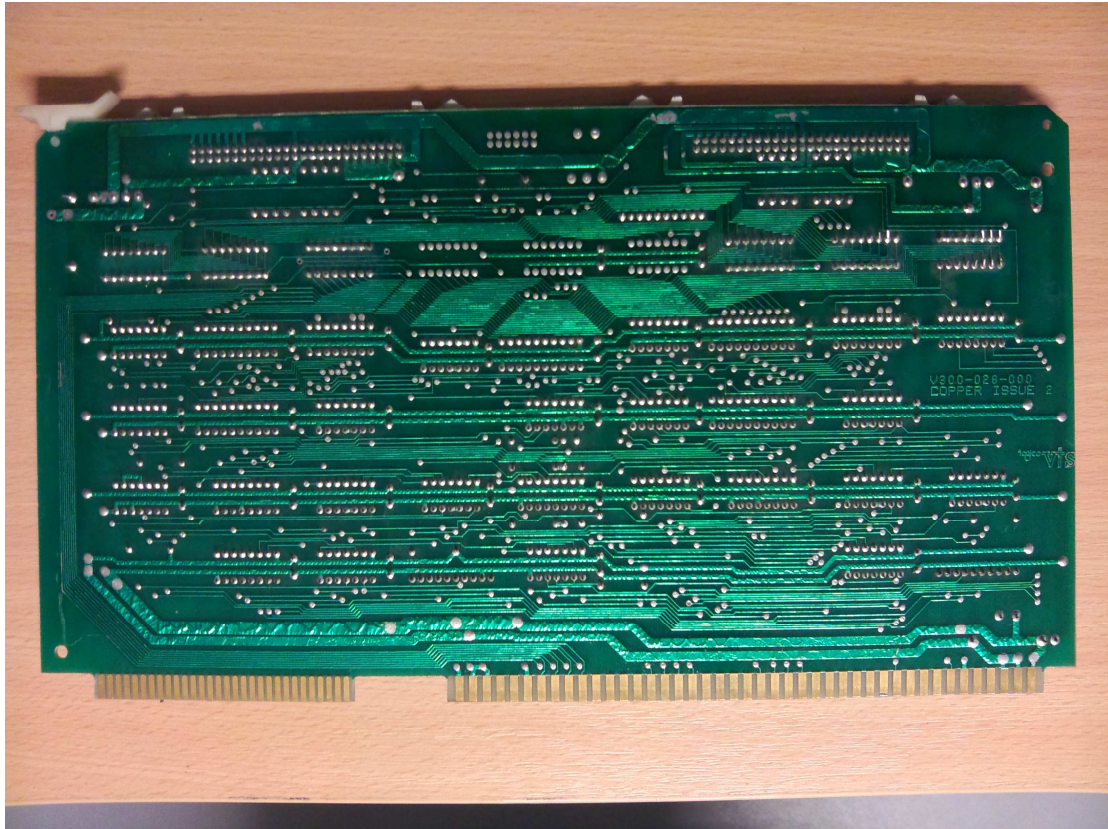*Figure 58: Logica VTS V300-028-50 Multibus I/O Board 3 closeup*

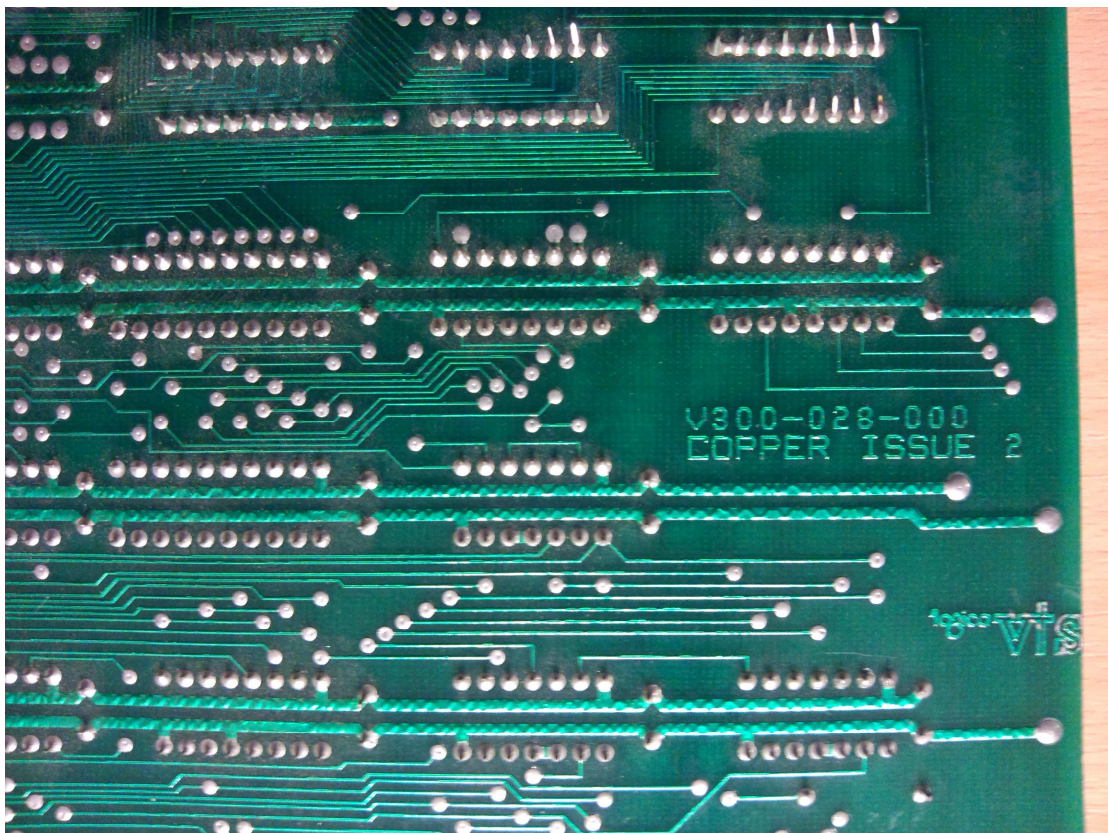*Figure 59: Logica VTS V300-028-50 Multibus I/O Board 3 rear view*

Figure 60: Logica VTS V300-028-50 Multibus I/O Board 3 manufacturing label
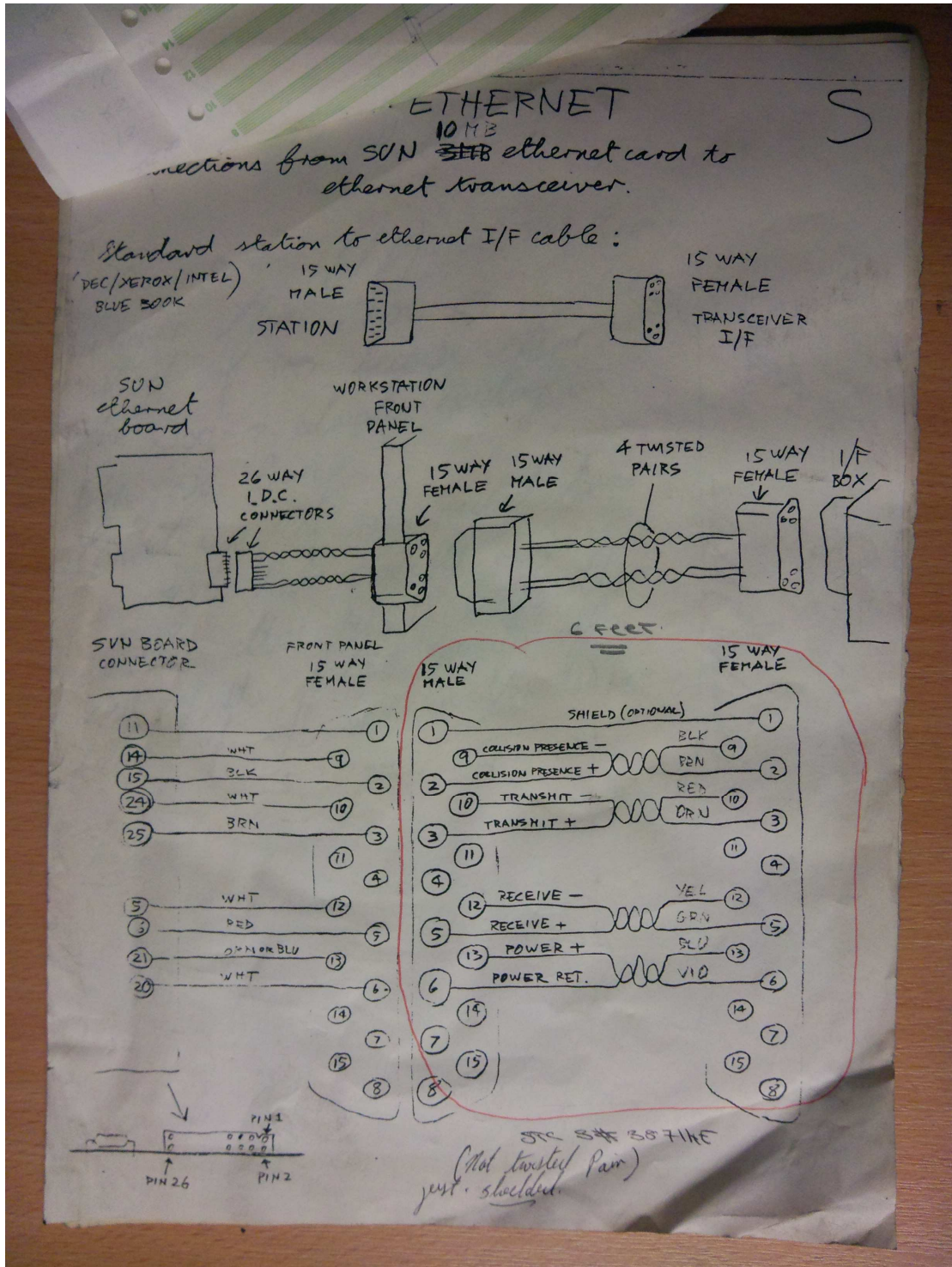
Figure 61: Pre-production SUN-1 Workstation 3Mbps Ethernet wiring at TCD
Note update from 3Mbps to 10Mbps Ethernet
(handwriting appears to be that of Dr.Neville Harris)

Figure 62: 3Mbps Ethernet cabling at Dept.Computer Science, TCD
Photo courtesy Mike Nowlan

Figure 63: Pre-production SUN-1 Workstation CPU board 4 front view

Figure 64: Pre-production SUN-1 Workstation 3Mbps Ethernet board 4 front view

Figure 64: Pre-production SUN-1 Workstation Graphics board 4 front view