

AccessionIndex: TCD-SCSS-T.20141212.001

Accession Date: 12-Dec-2014

Accession By: Prof.Neville Harris, Dr.Brian Coghlan, Prof.J.G.Byrne

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 at Stanford University. The two pre-production prototype boards for Sun Microsystems first workstations, a MC68000-based CPU board and a first-generation 3Mbps Ethernet board, were originally designed by Andy Bechtolsheim as a postgraduate project, before he left to found Sun with Vinod Khosla and Scott McNealy.

Trivia1: 'SUN' stands for Stanford University Network

Trivia2: Andy Bechtolsheim was one of the first two investors in Google

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 Hawaiian 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.76 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.75. 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.

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) <<< <i>Missing ???</i> >>>
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: 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: 156, TW 40
TCD-SCSS-T.20141212.001.08	Sun Pre-production SUN-1 Workstation: Graphics Board (2). (Multibus form factor) <<< <i>Missing ???</i> >>>
TCD-SCSS-T.20141212.001.09	Intel PWA460 Multibus Memory Board (2). Was installed into a pre-production SUN-1 Workstation. Includes:

	<p>32 x NEC uPD416D Intel D3242 Intel D8126 Intel B3222 Marking: P/N: 000772, S/N: 05-0632-000-01MC.</p>
TCD-SCSS-T.20141212.001.10	<p>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.</p>
TCD-SCSS-T.20141212.001.11	<p>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: ???</p>
TCD-SCSS-T.20141212.001.12	<p>Sun Pre-production SUN-1 Workstation: Ethernet Board (3). (Multibus form factor) <<< <i>Neville</i> ??? >>></p>
TCD-SCSS-T.20141212.001.13	<p>Sun Pre-production SUN-1 Workstation: Graphics Board (3). (Multibus form factor) <<< <i>Missing</i> ??? >>></p>
TCD-SCSS-T.20141212.001.14	<p>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.</p>
TCD-SCSS-T.20141212.001.15	<p>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: ???</p>
TCD-SCSS-T.20141212.001.16	<p>Sun Pre-production SUN-1 Workstation: Ethernet Board (4). (Multibus form factor) Includes: 3 x Am2901 4-bit CPU bitslices 4 x Fujitsu MB8128 2Kx8 static RAMs 2 x Am2951 8-bit bidirectional I/O ports Markings: S/N: 154, TW 40</p>

TCD-SCSS-T.20141212.001.17	Sun Pre-production SUN-1 Workstation: Graphics Board (4). (Multibus form factor) SUN Graphics, SUN Microsystems Inc, C 1982 SMI Includes: 16 x M5K4164NP-15 64k x 1 DRAMs Front markings: Rev-D 270-0059-02, T.S 1-12-24 Rear markings: "283" "500-0059-01 Rev-K"
TCD-SCSS-V.20141212.001	Diagram for pre-production SUN-1 Workstation 3Mbps Ethernet wiring at TCD. See Fig.75 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.

Early pre-production board sets (4): Prof.J.G.Byrne, 12-Dec-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.

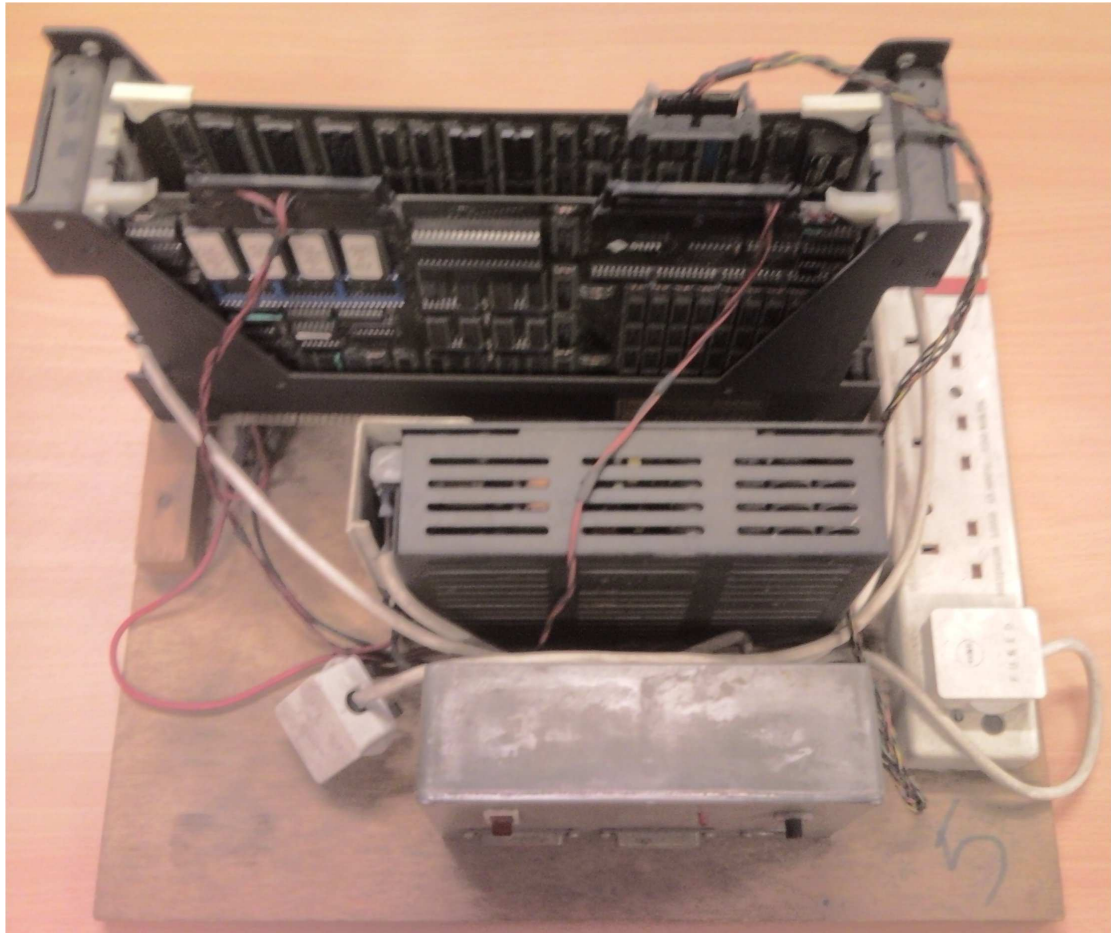


Figure 1: Pre-production SUN-1 Workstation board set 1 front top view

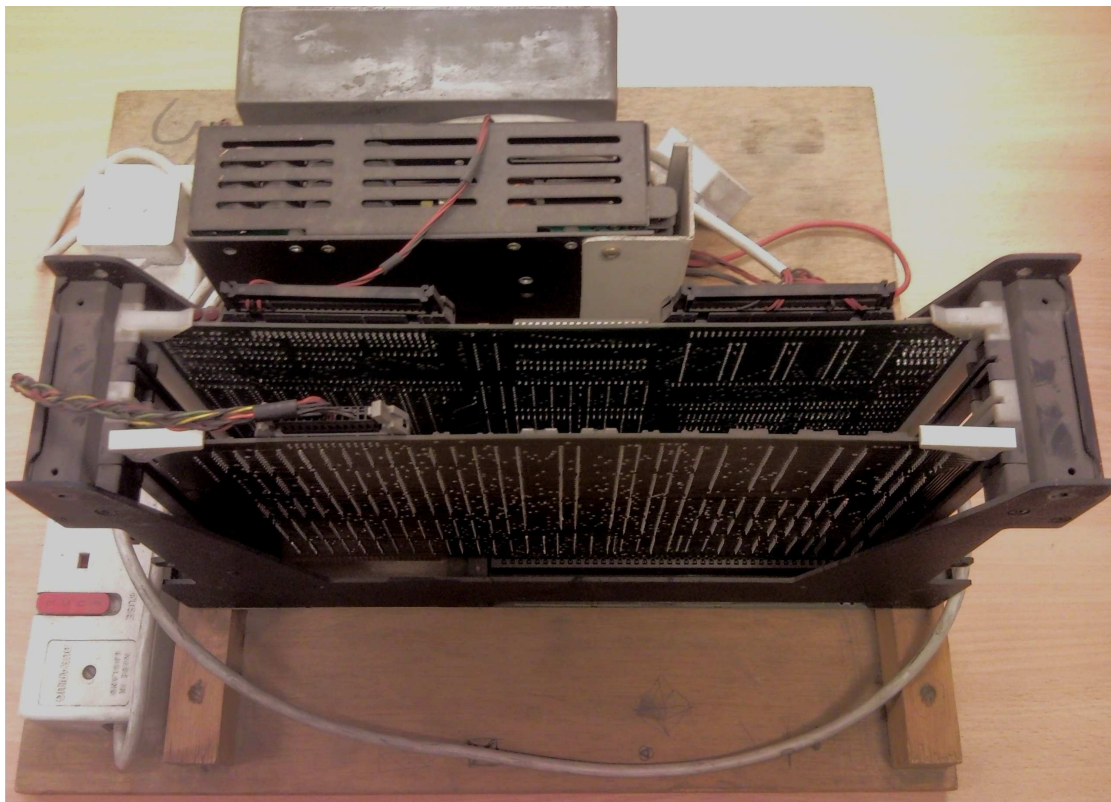


Figure 2: Pre-production SUN-1 Workstation board set 1 rear top view

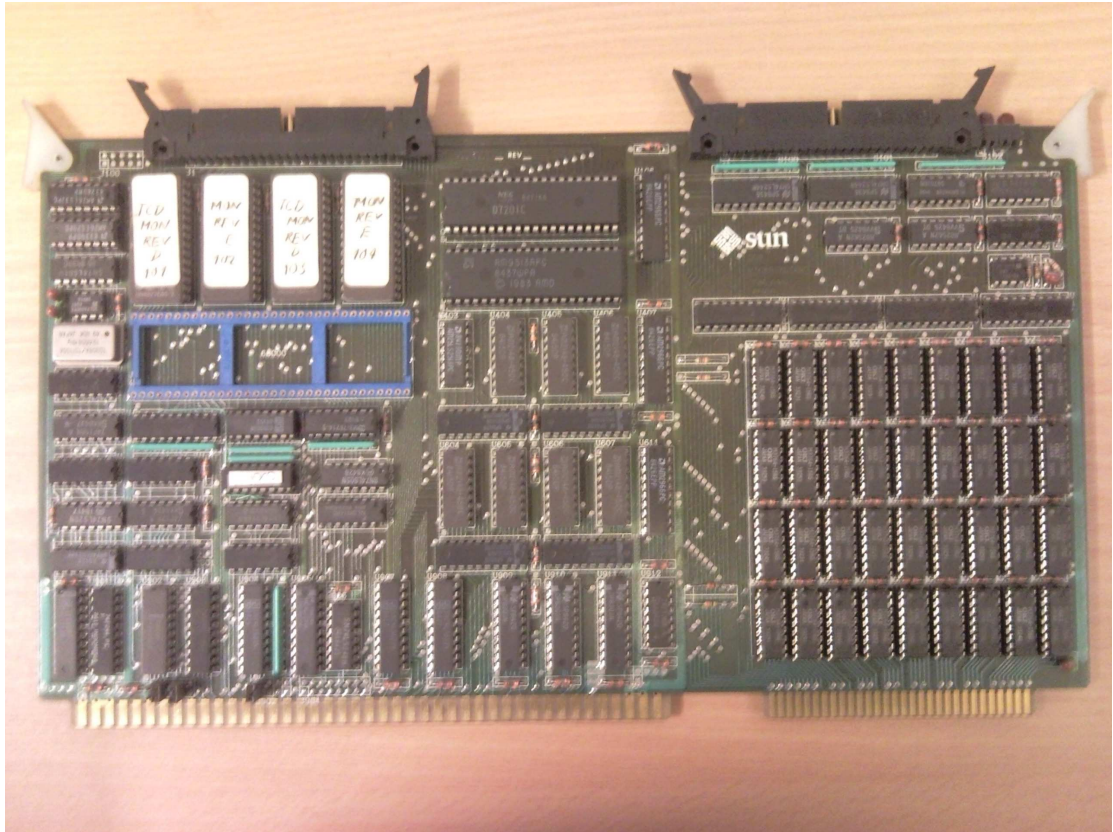


Figure 3: Pre-production SUN-1 Workstation CPU board 1

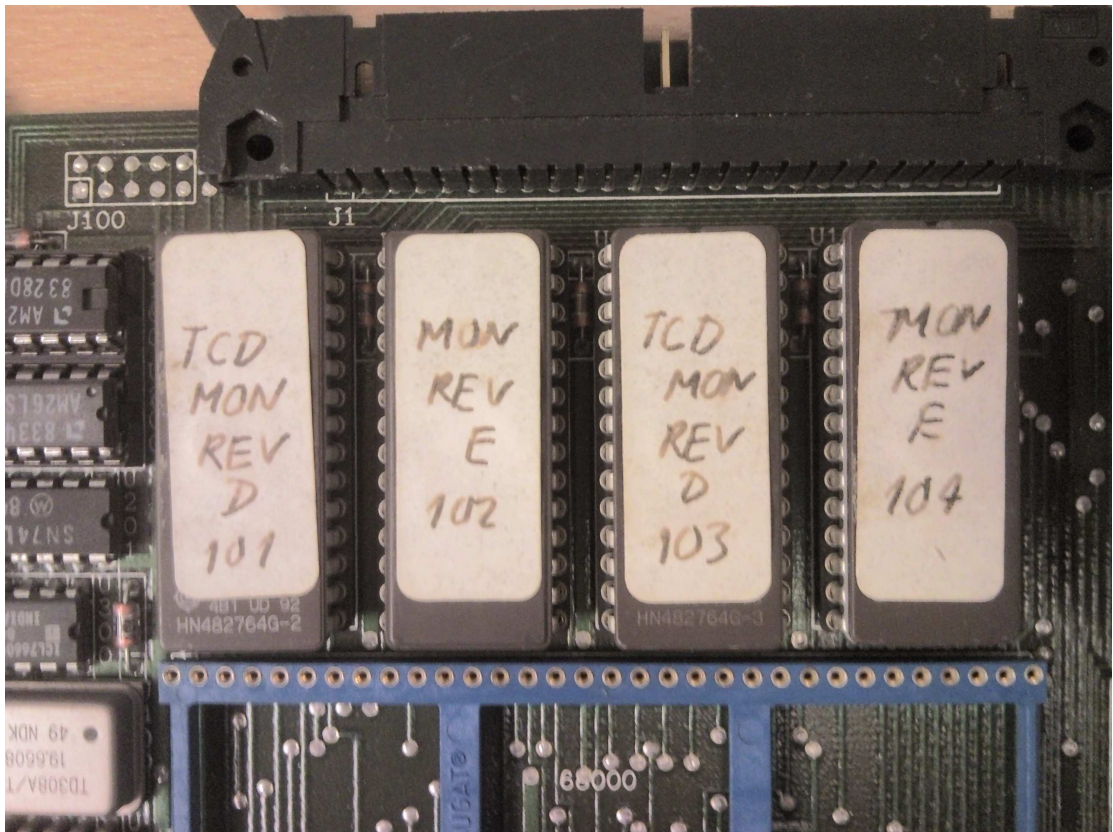


Figure 4: Pre-production SUN-1 Workstation CPU board 1 BIOS EPROM closeup

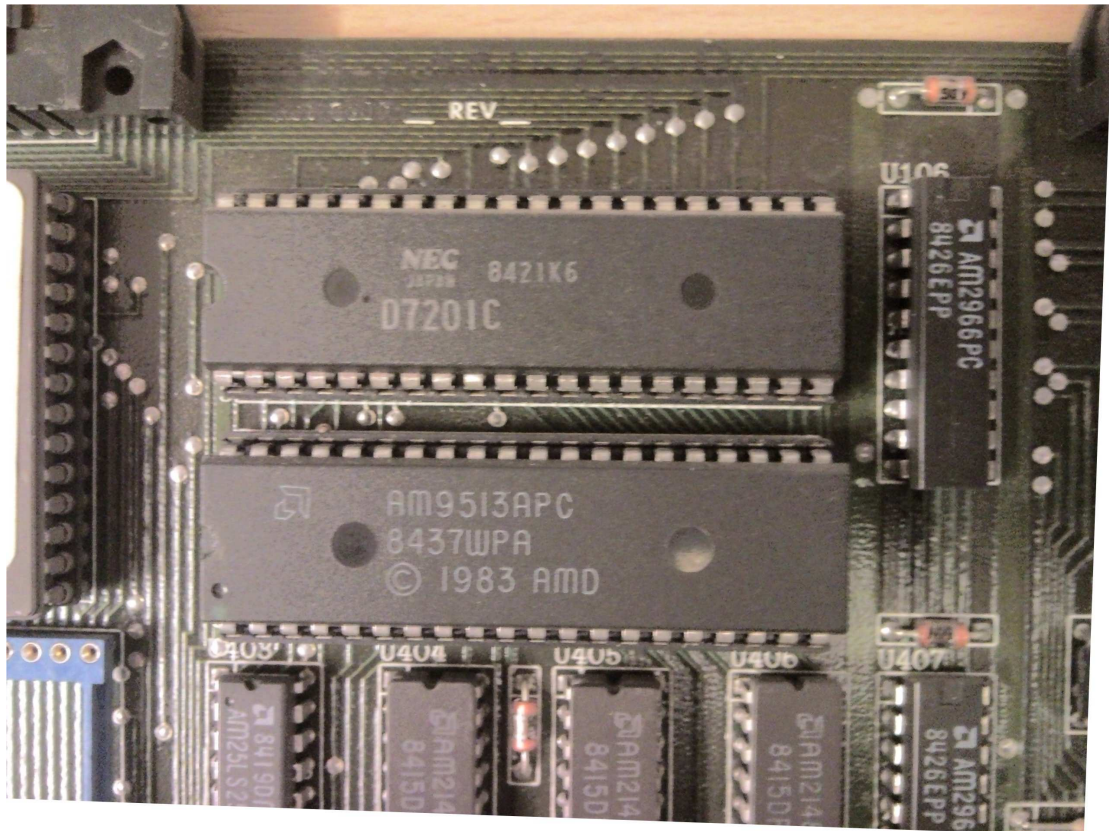


Figure 5: Pre-production SUN-1 Workstation CPU board 1 serial I/O closeup

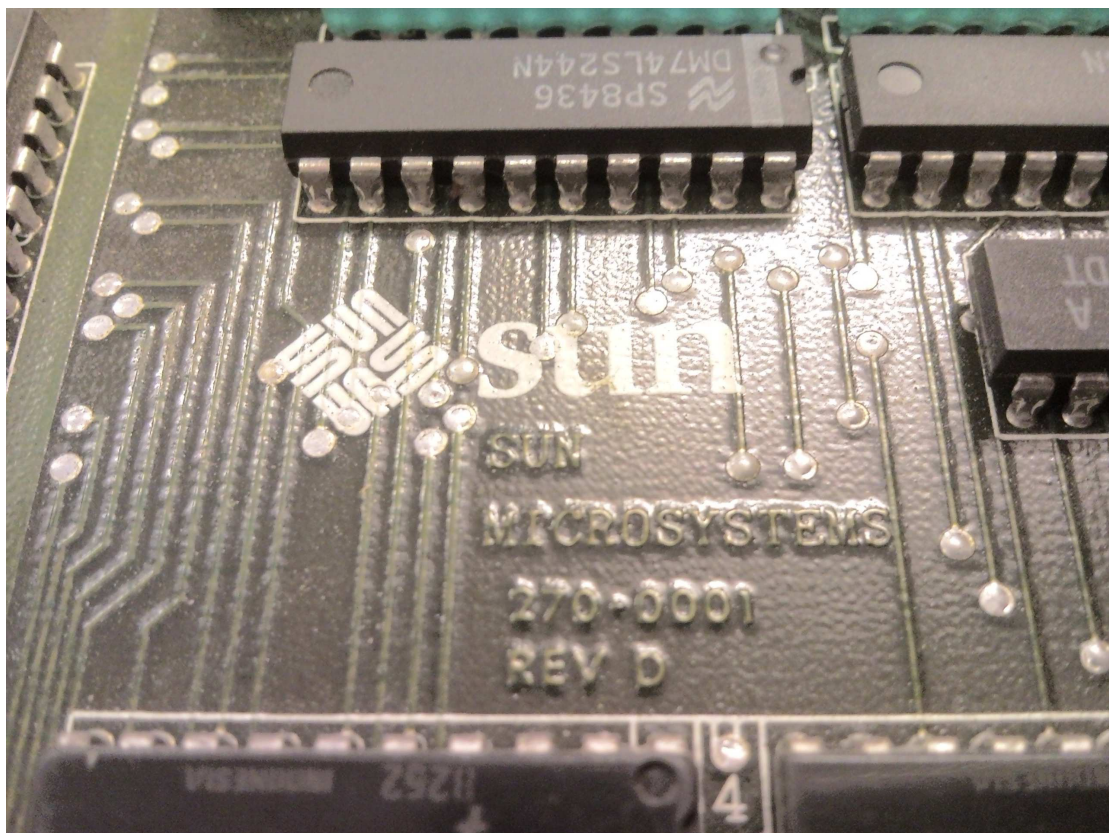


Figure 6: Pre-production SUN-1 Workstation CPU board 1 label
P/N: SUN Microsystems 270-0001 Rev D

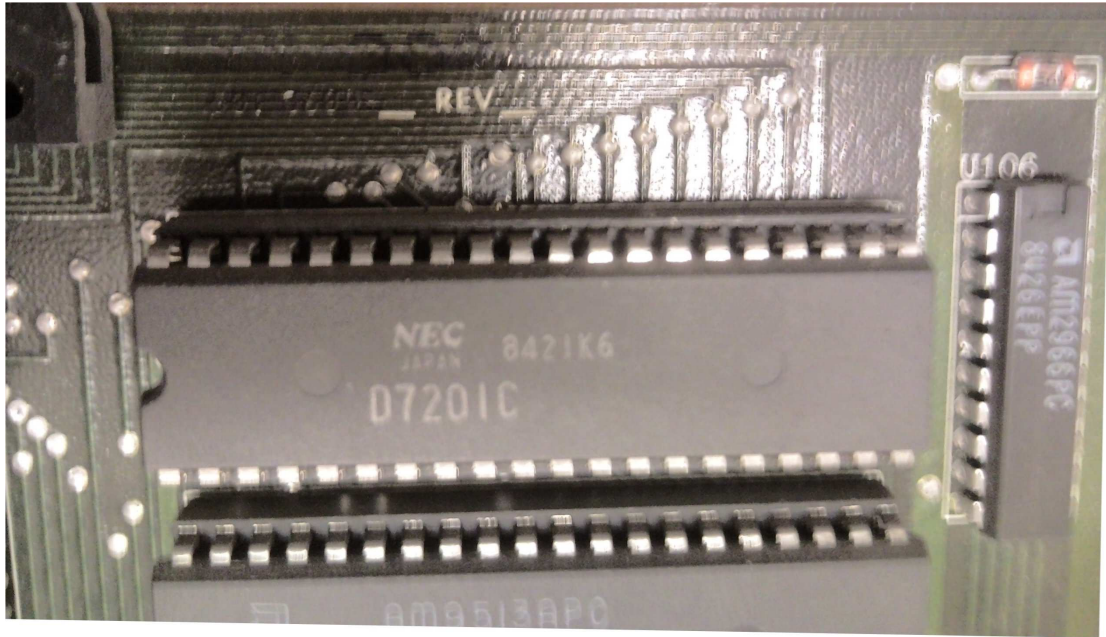


Figure 7: Pre-production SUN-1 Workstation CPU board 1 extra inked markings

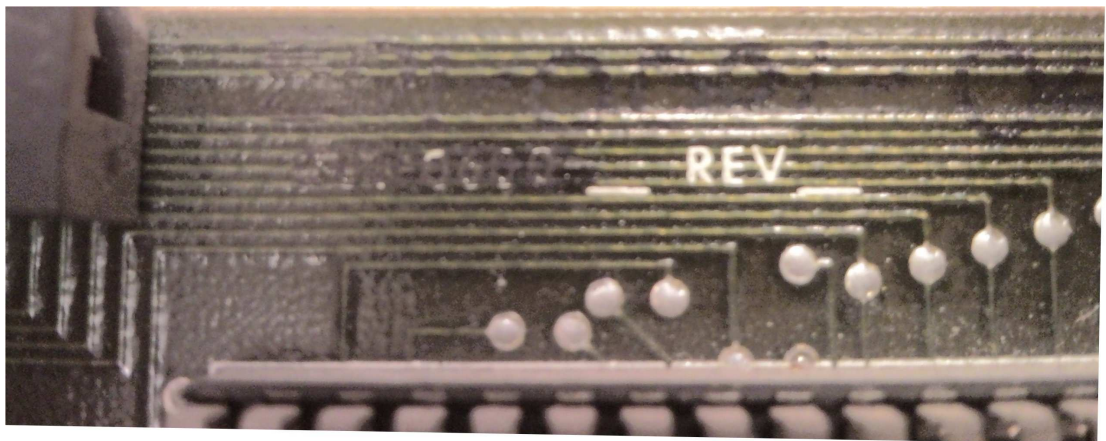


Figure 8: Pre-production SUN-1 Workstation CPU board 1 inked markings closeup, left above D7201C, probably S/N



Figure 9: Pre-production SUN-1 Workstation CPU board 1 inked markings closeup, right above D7201C, "1010"

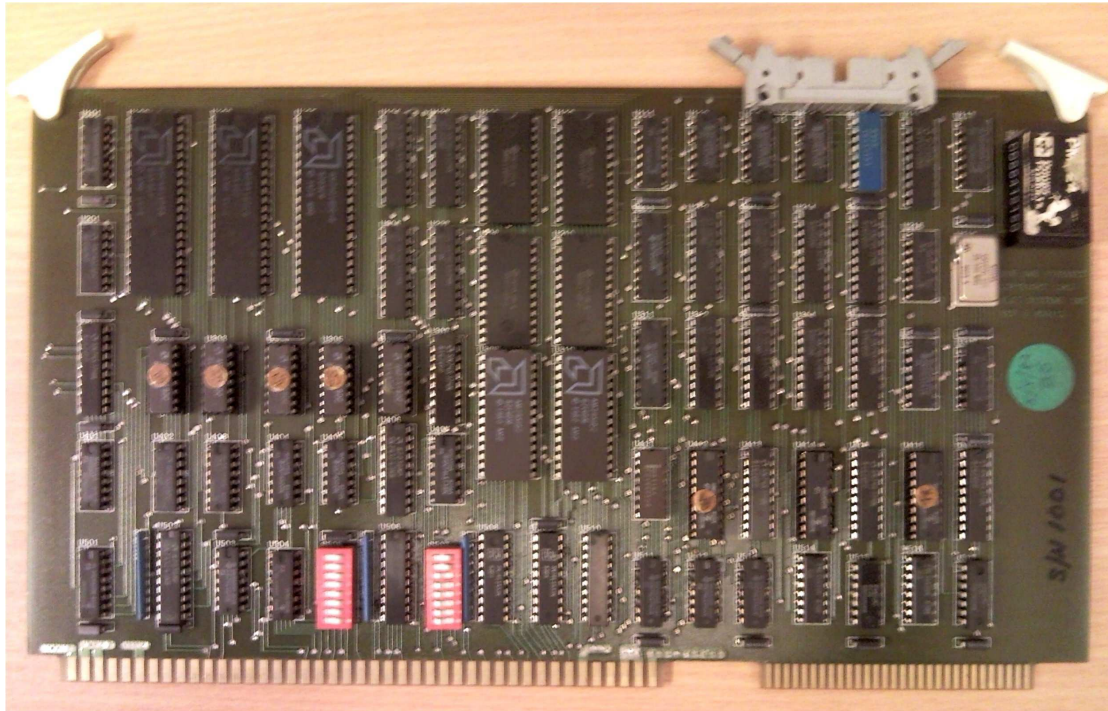


Figure 10: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1

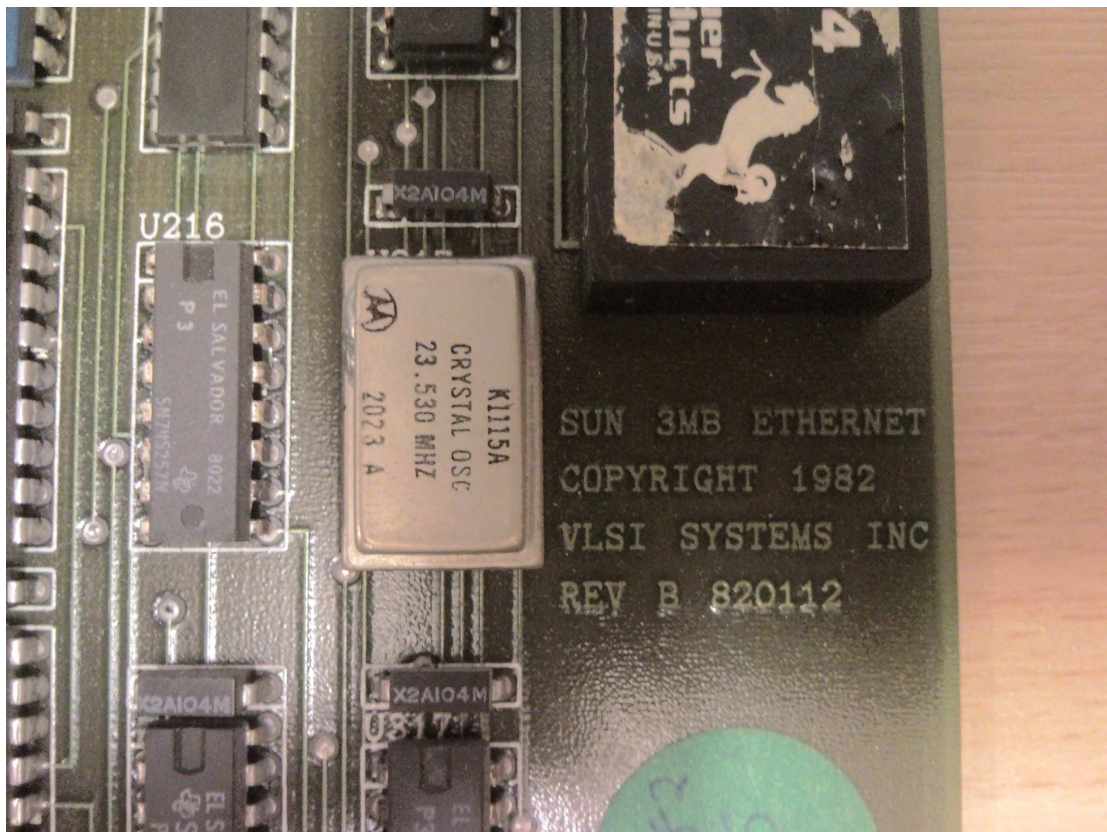


Figure 11: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 label

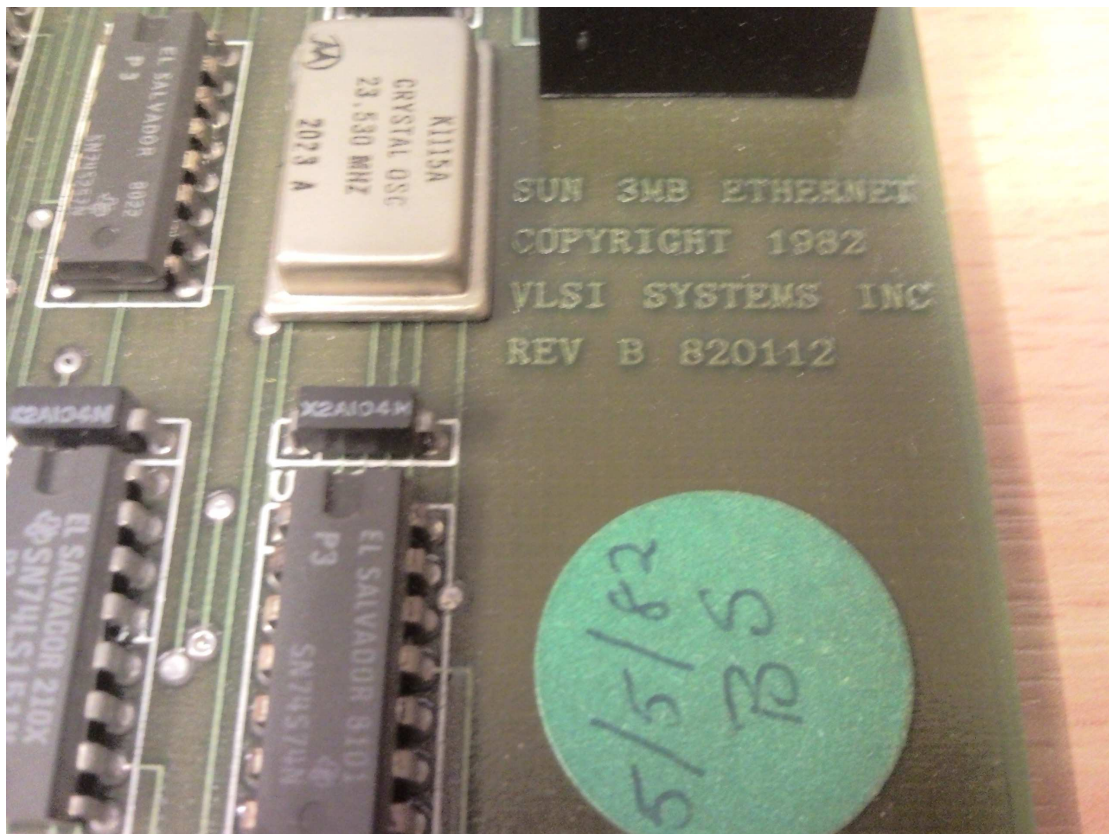


Figure 12: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1
Date stamp: 5-May-1982

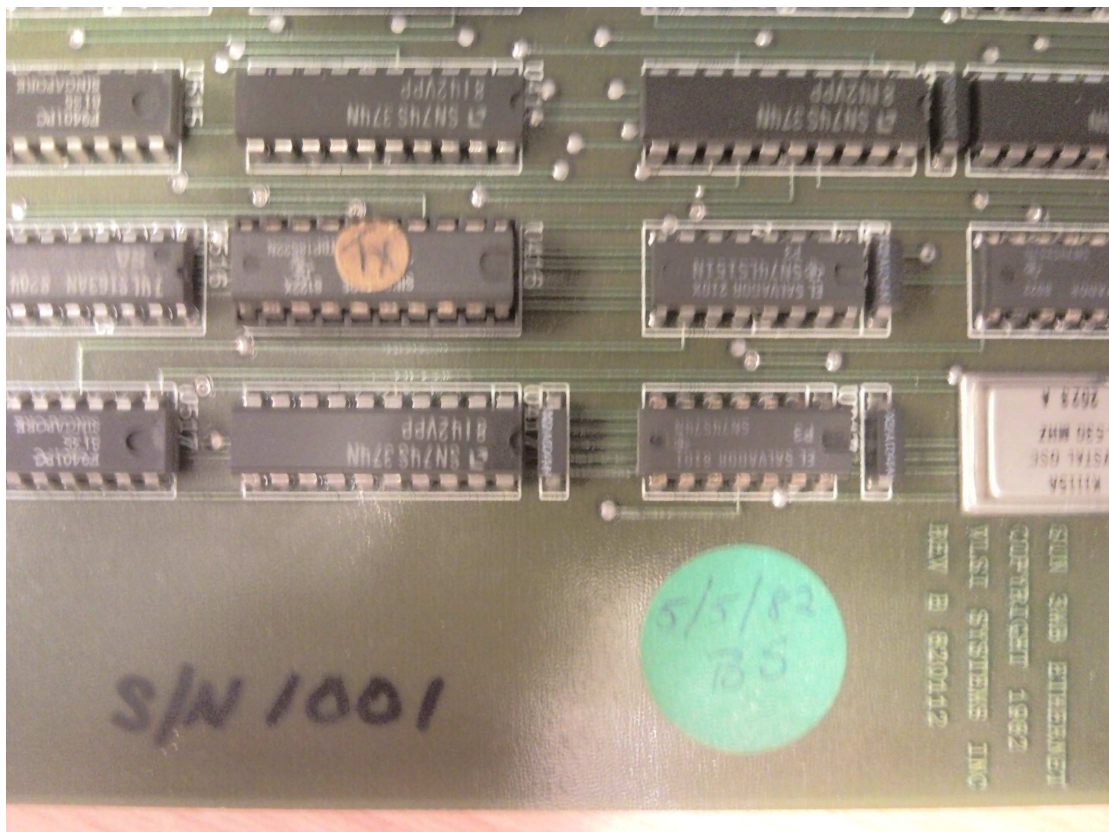


Figure 13: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1
S/N: 1001

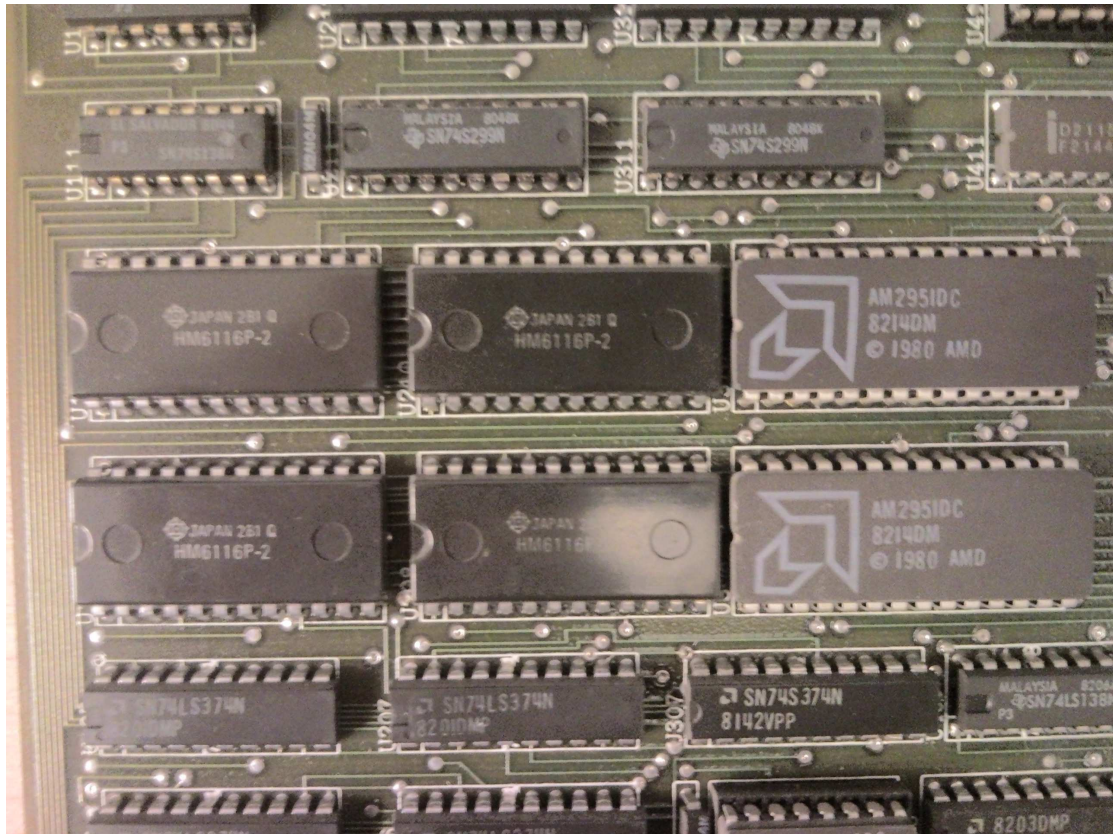


Figure 14: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 closeup

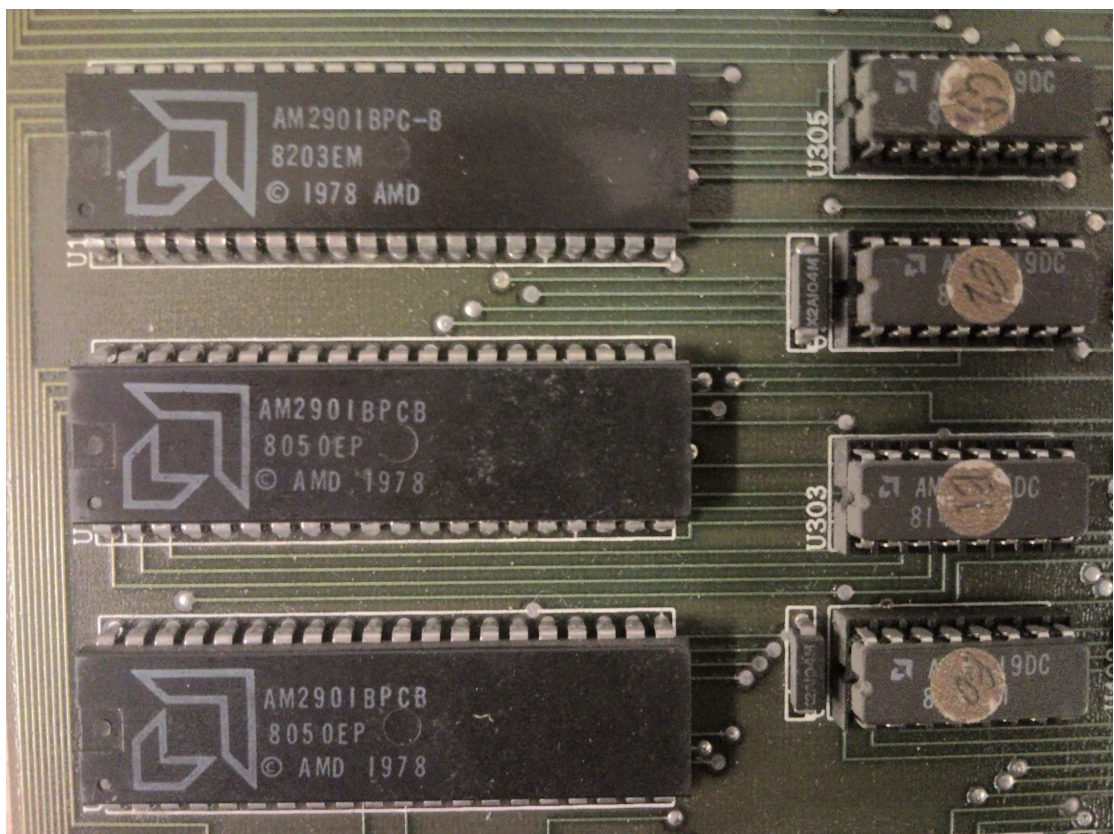


Figure 15: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 closeup

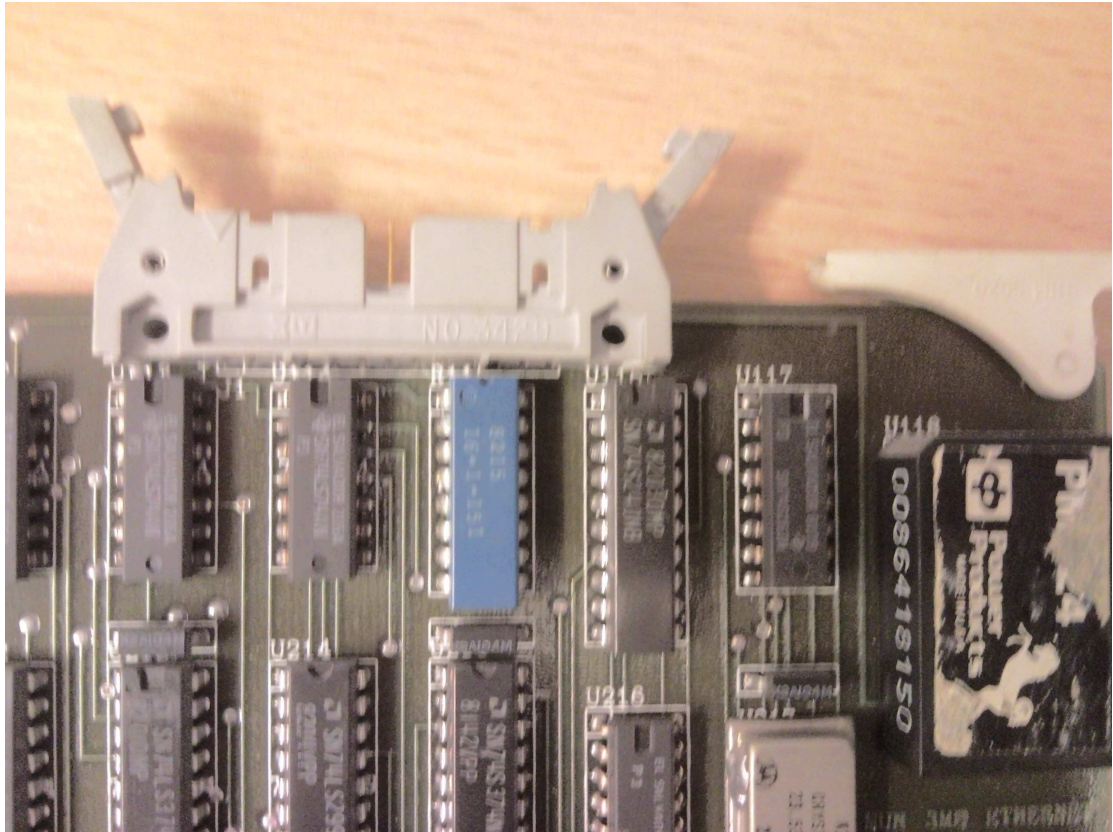


Figure 16: Pre-production SUN-1 Workstation 3Mbps Ethernet board 1 net connector

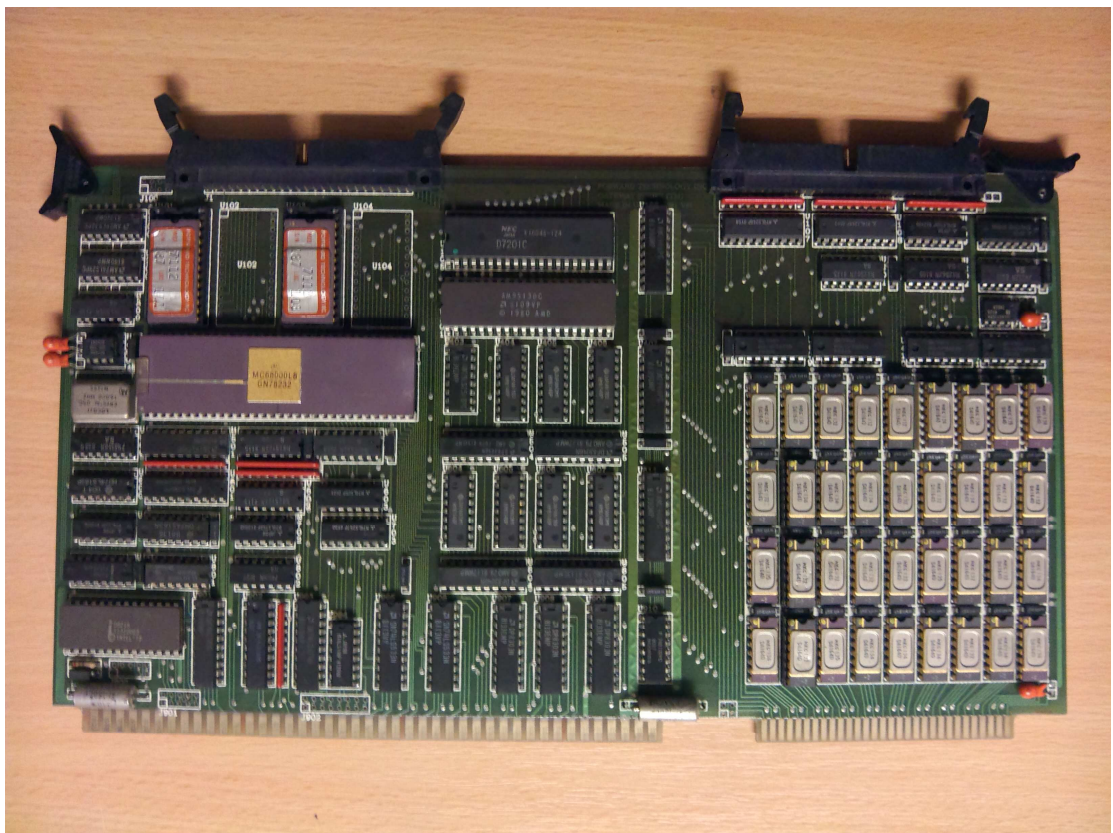


Figure 17: Pre-production SUN-1 Workstation CPU board 2 front view

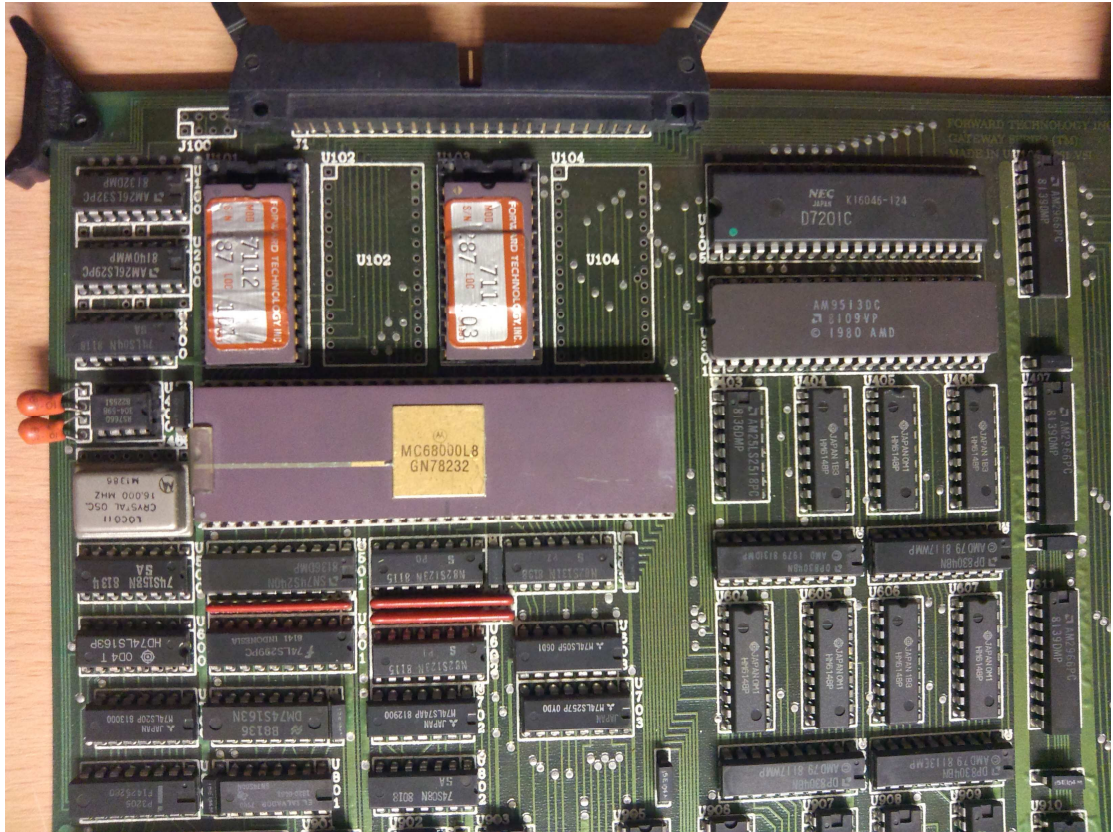


Figure 18: Pre-production SUN-1 Workstation CPU board 2 closeup

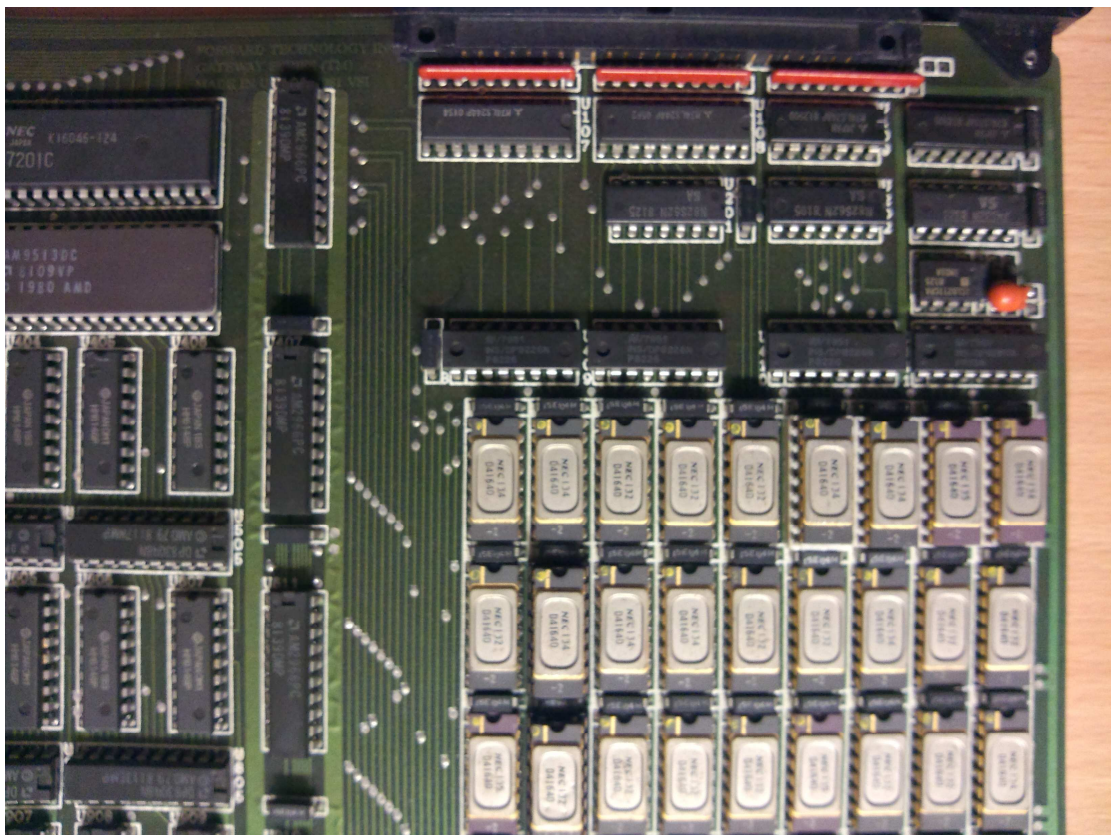


Figure 19: Pre-production SUN-1 Workstation CPU board 2 closeup

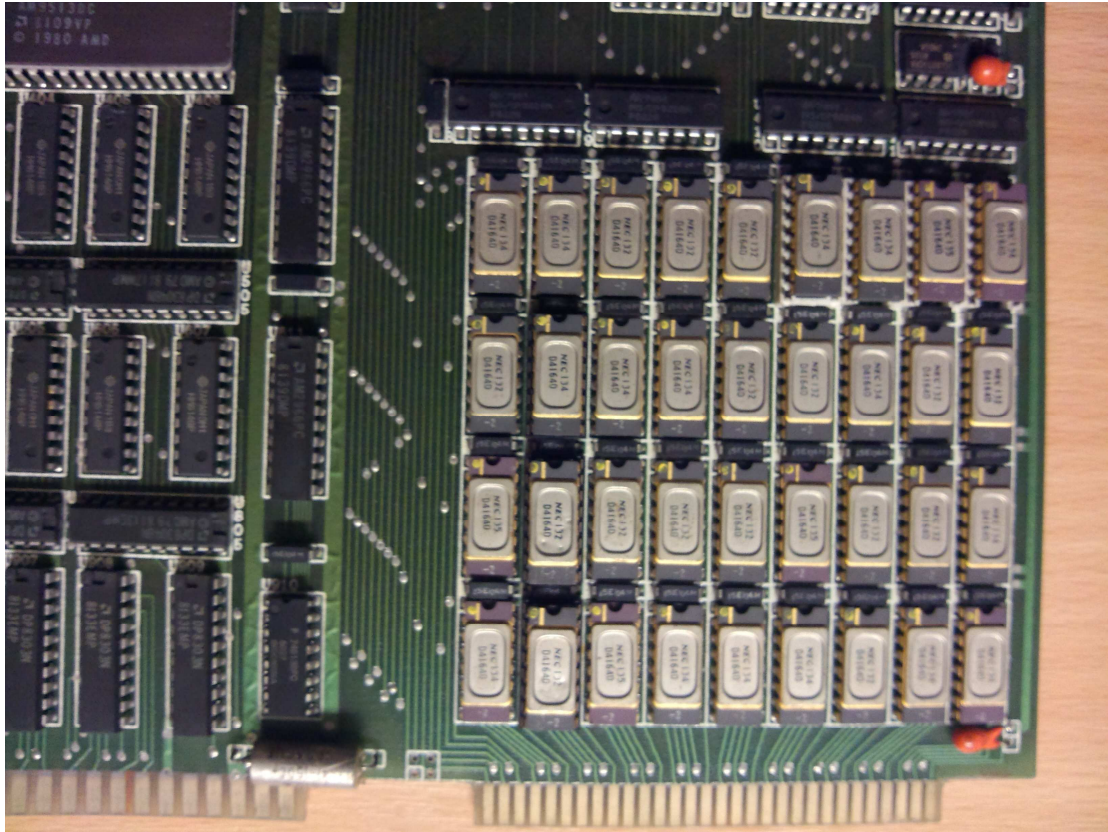


Figure 20: Pre-production SUN-1 Workstation CPU board 2 closeup

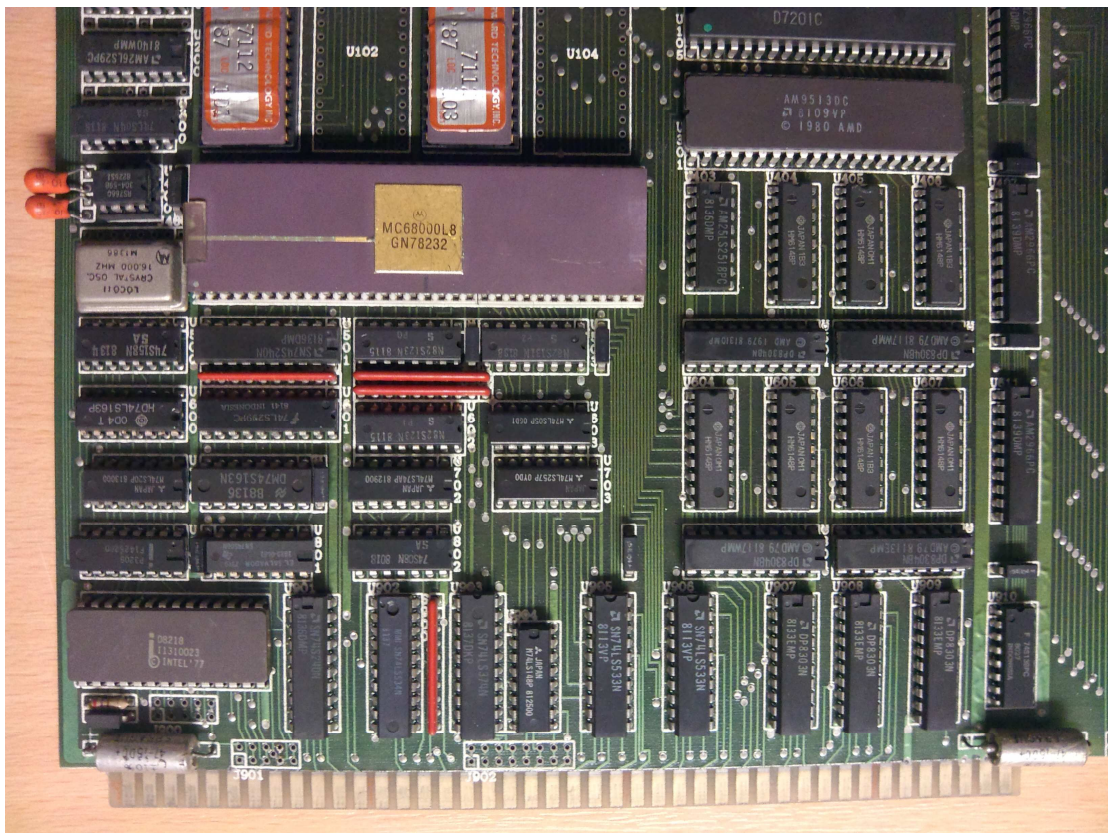


Figure 21: Pre-production SUN-1 Workstation CPU board 2 closeup

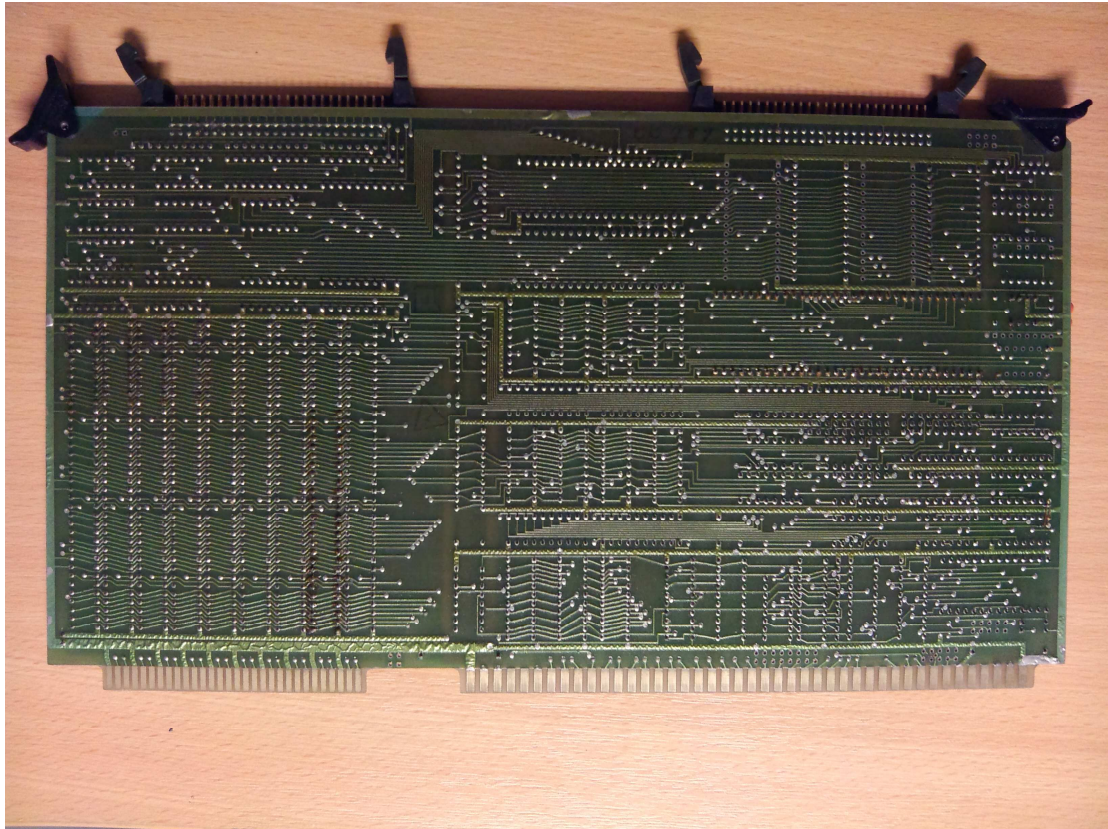


Figure 22: Pre-production SUN-1 Workstation CPU board 2 rear view

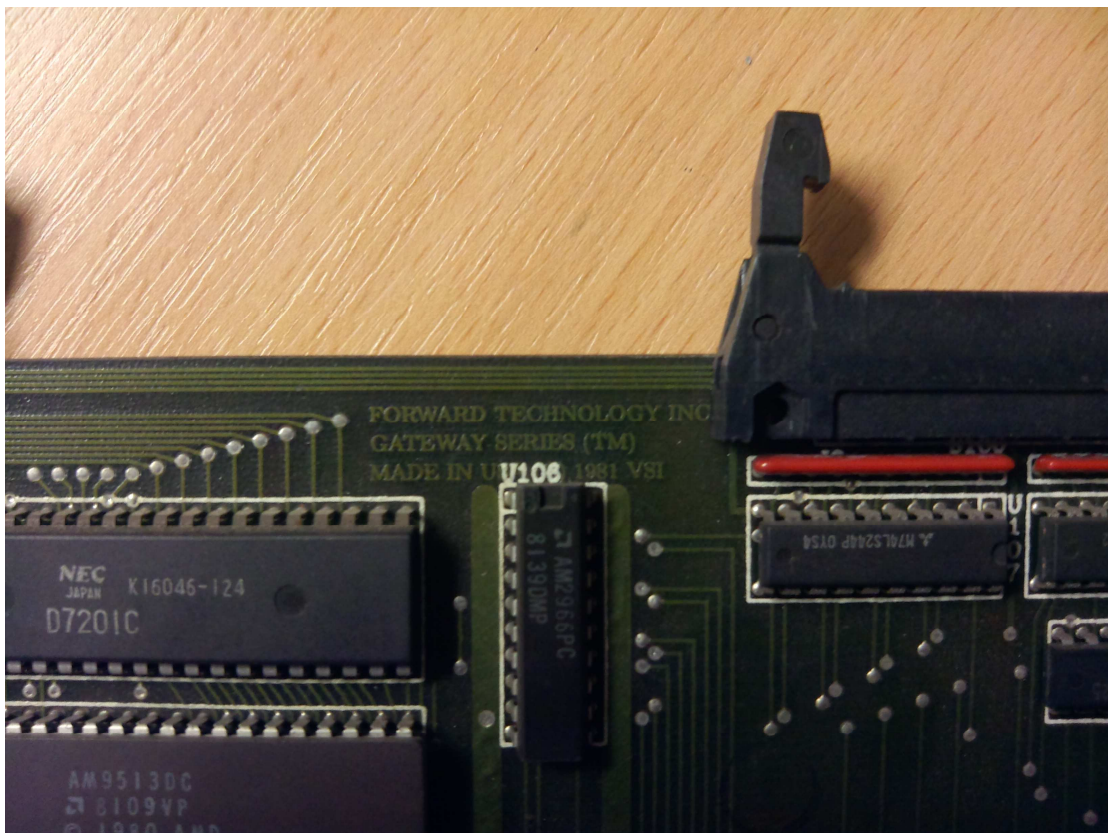


Figure 23: Pre-production SUN-1 Workstation CPU board 2 manufacturing label

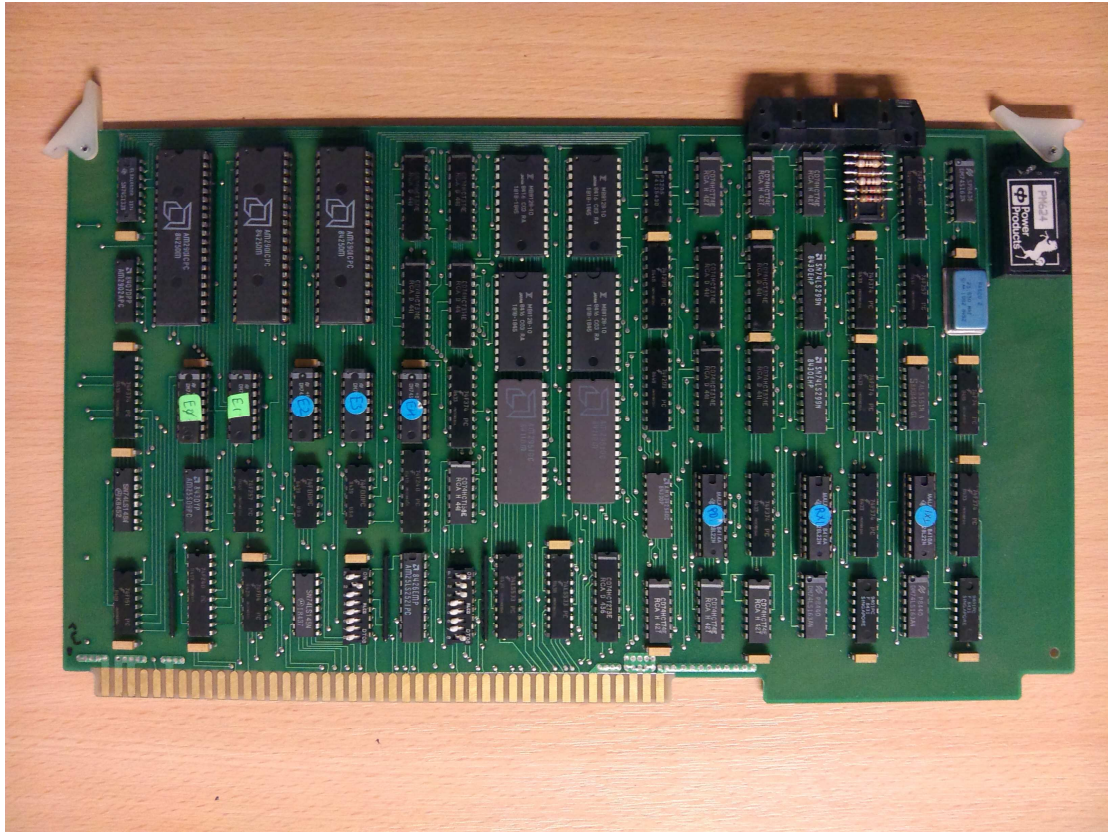


Figure 24: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 front view

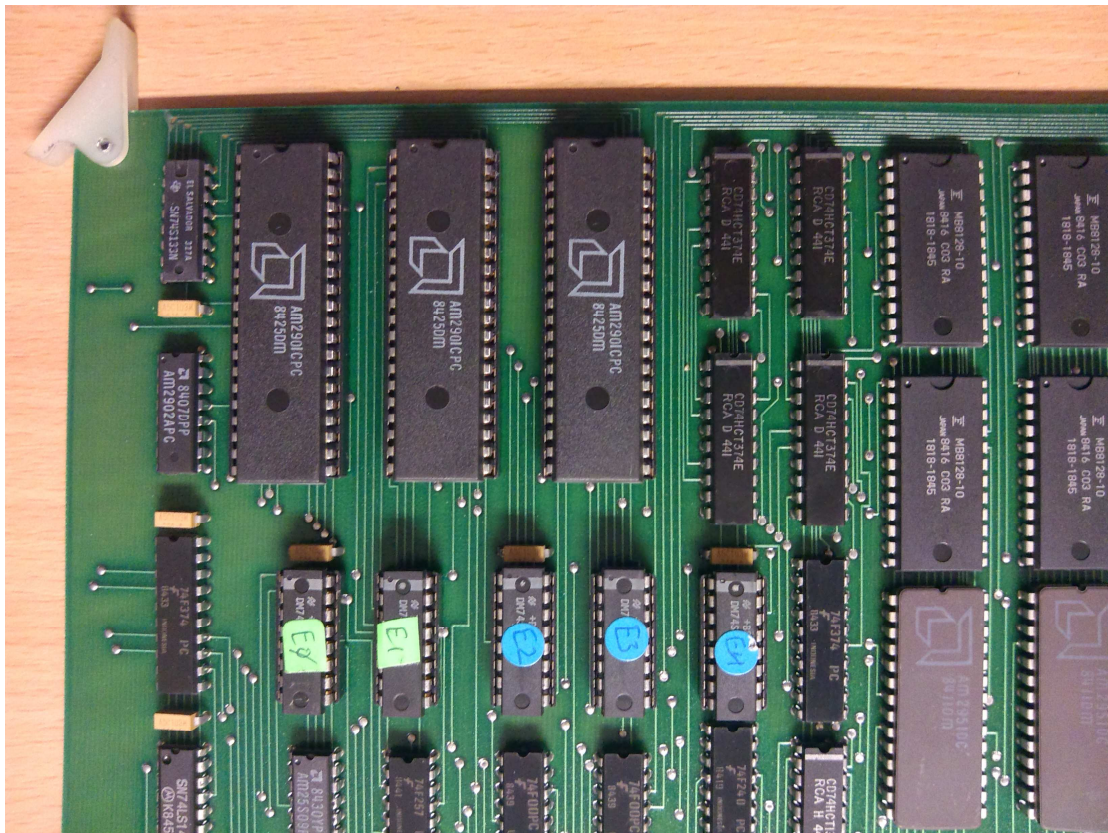


Figure 25: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

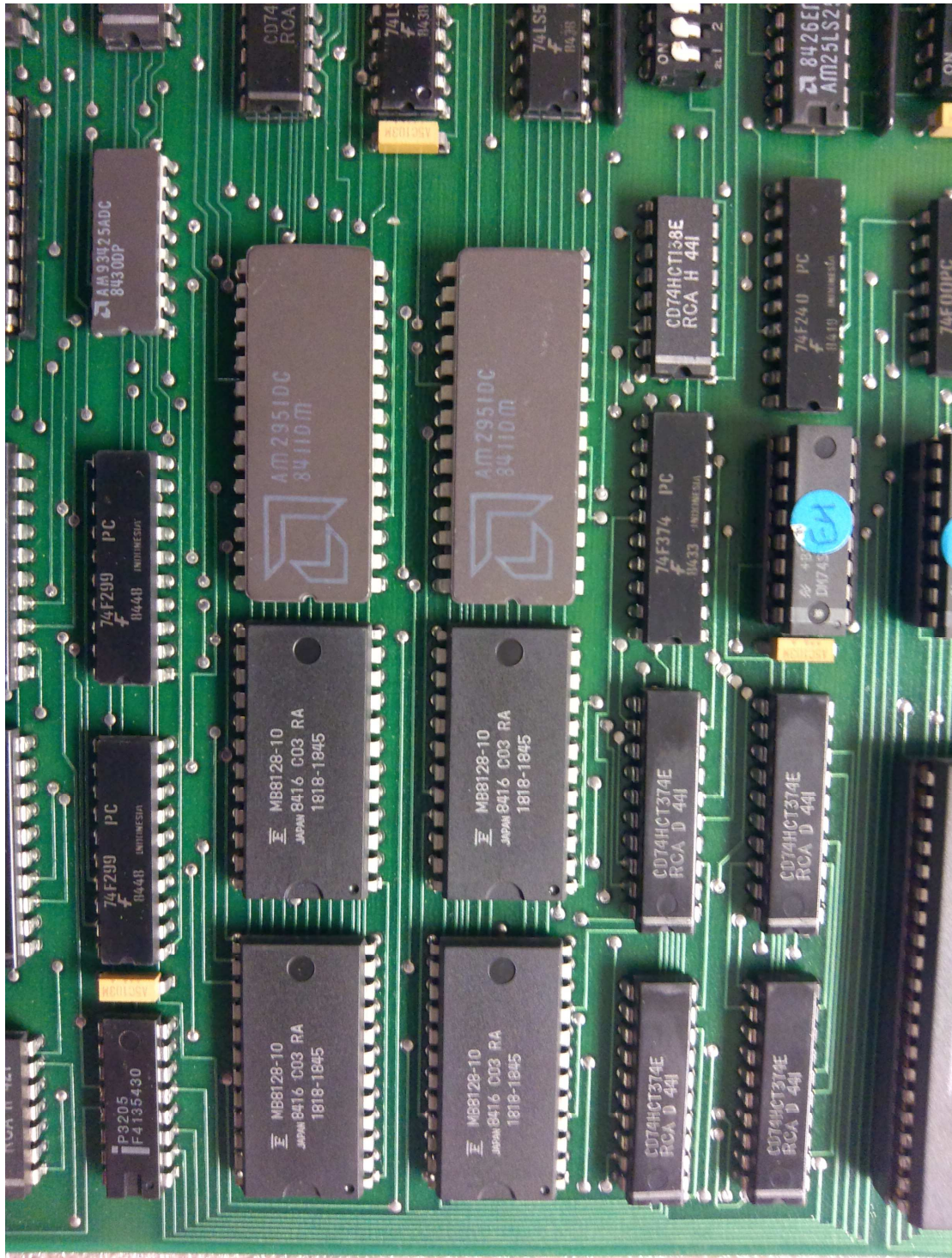


Figure 26: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

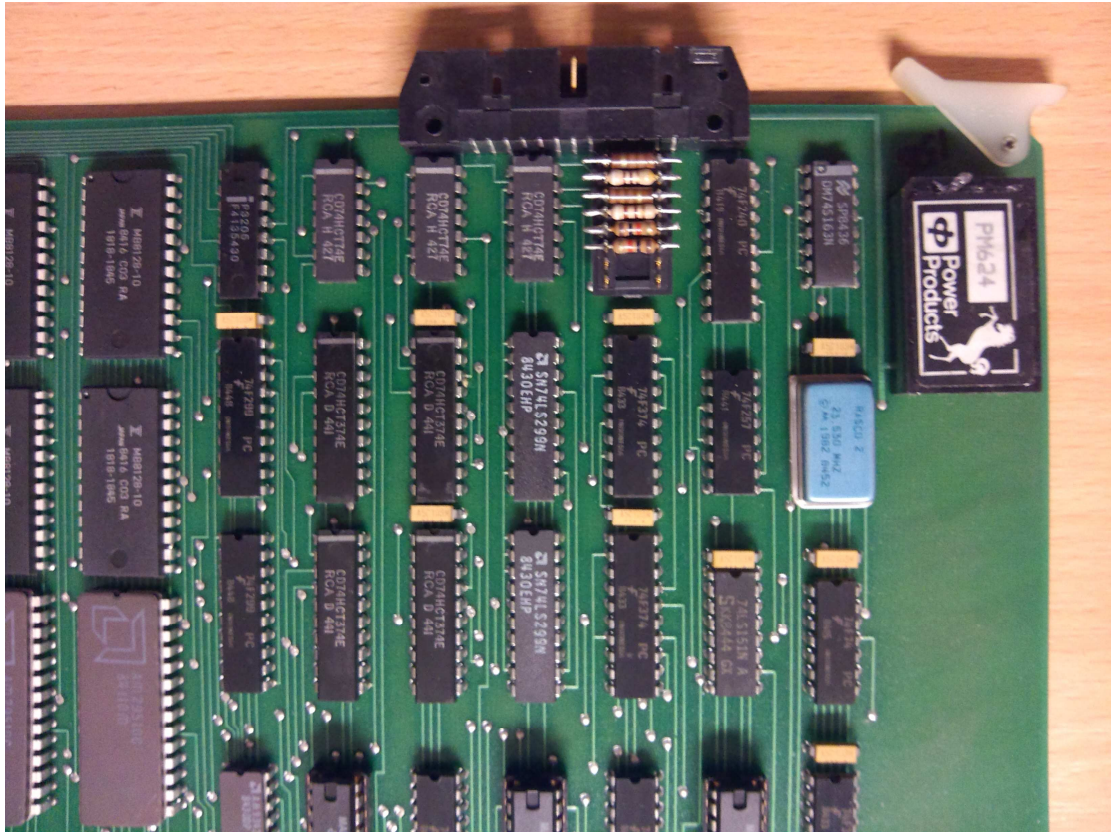


Figure 27: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup
Marking: "156"

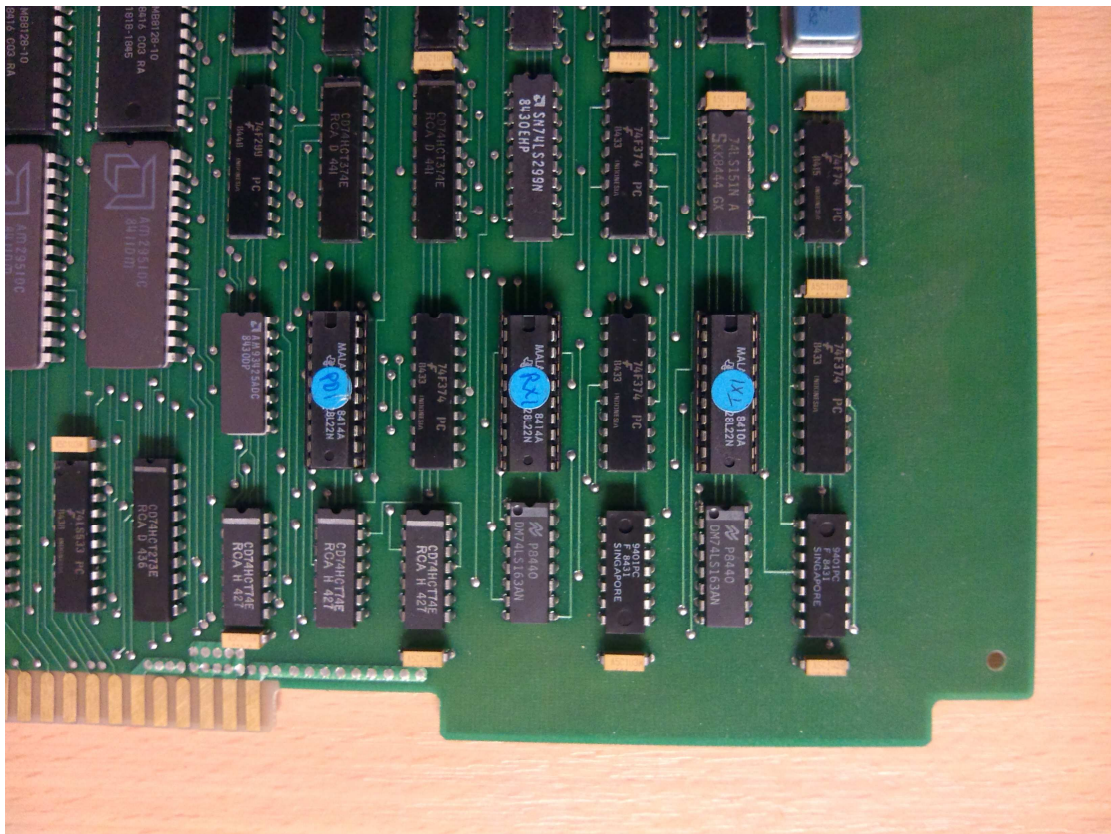


Figure 28: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

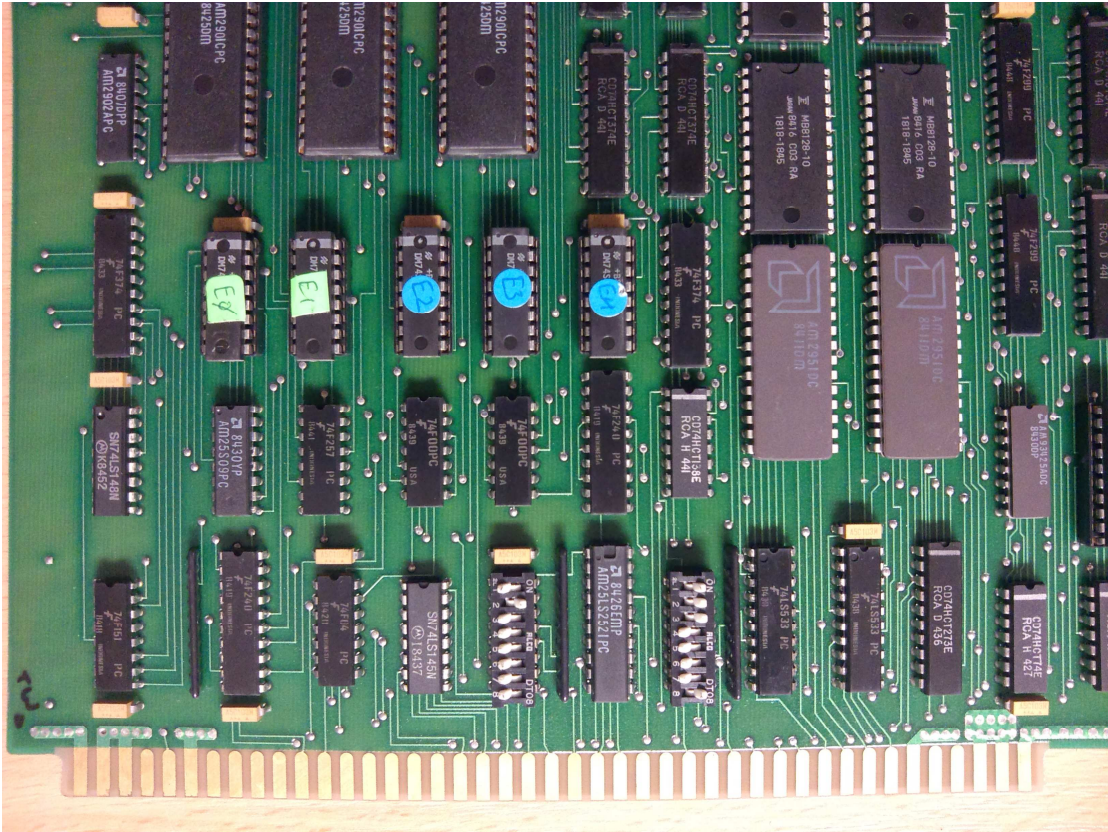


Figure 29: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 closeup

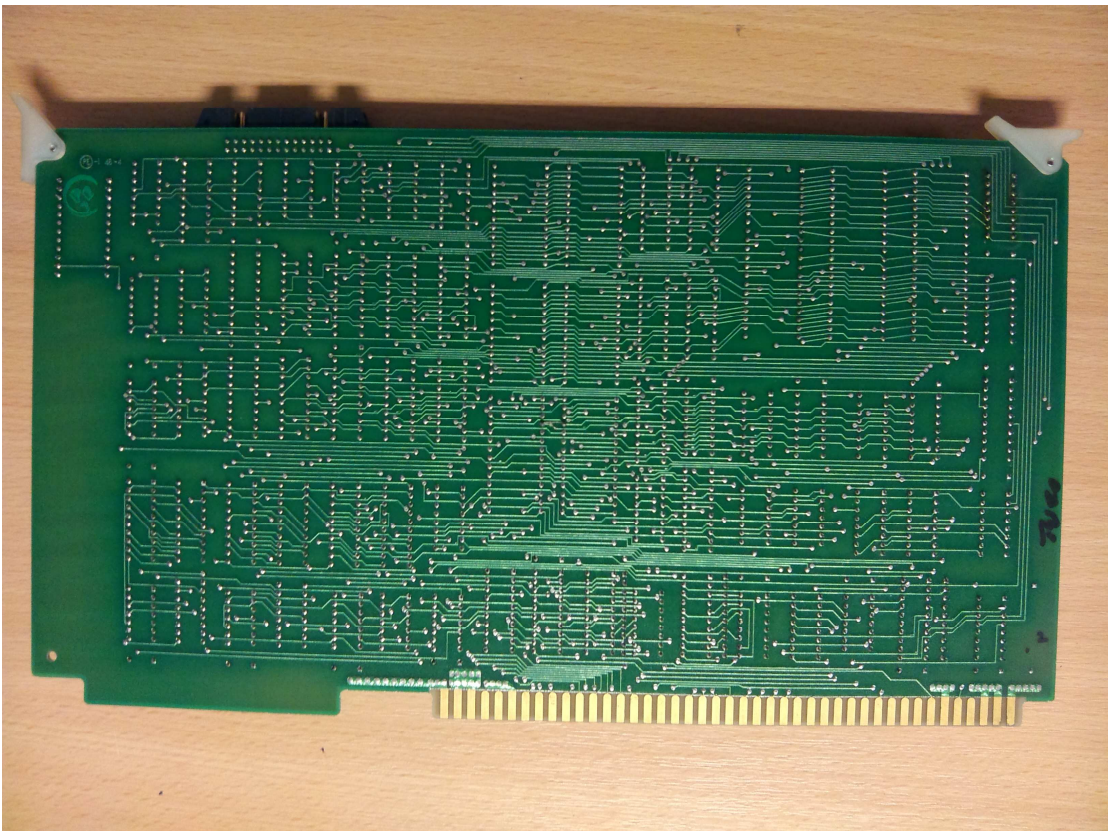


Figure 30: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 rear view

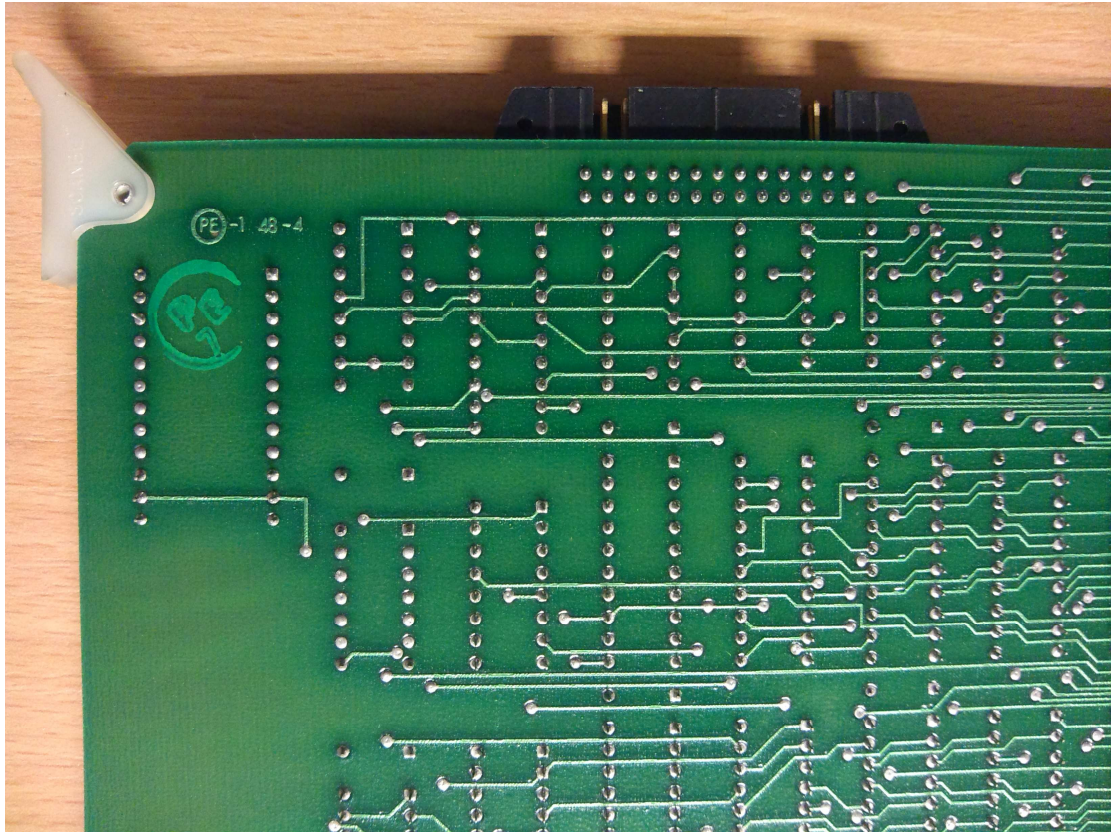
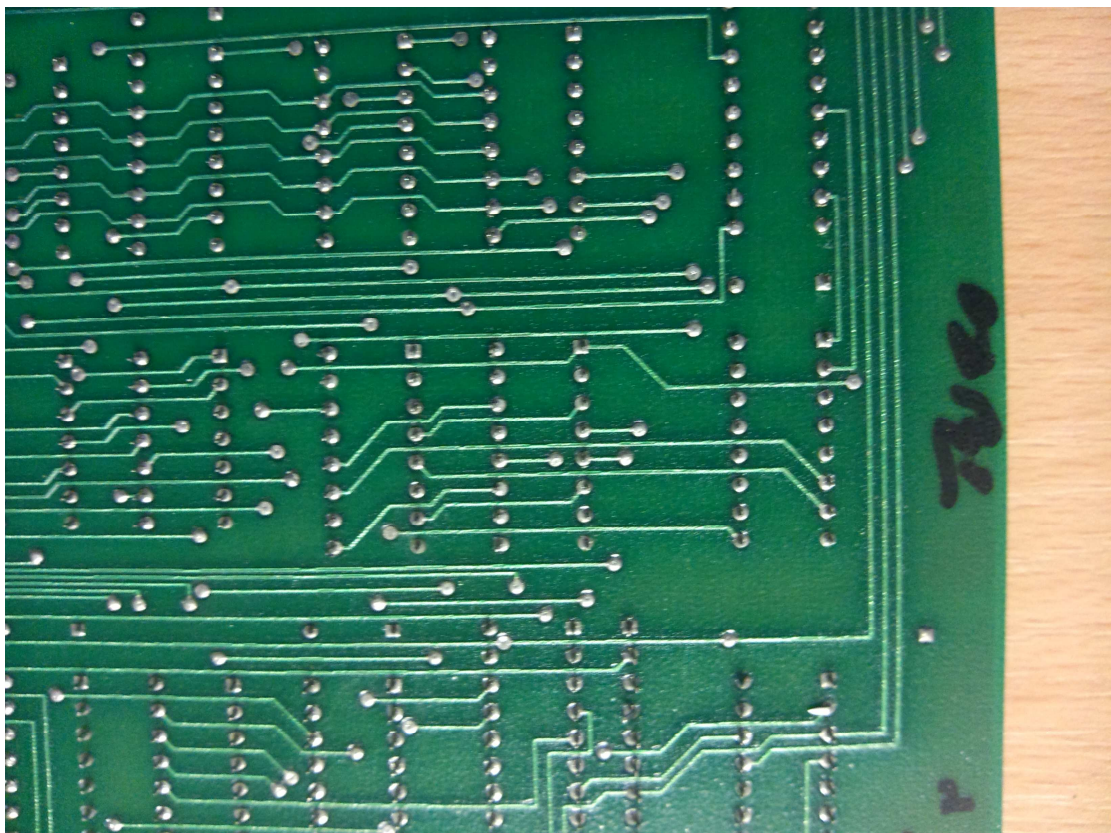


Figure 31: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 label



*Figure 32: Pre-production SUN-1 Workstation 3Mbps Ethernet board 2 label
Marking: "TW 40"*

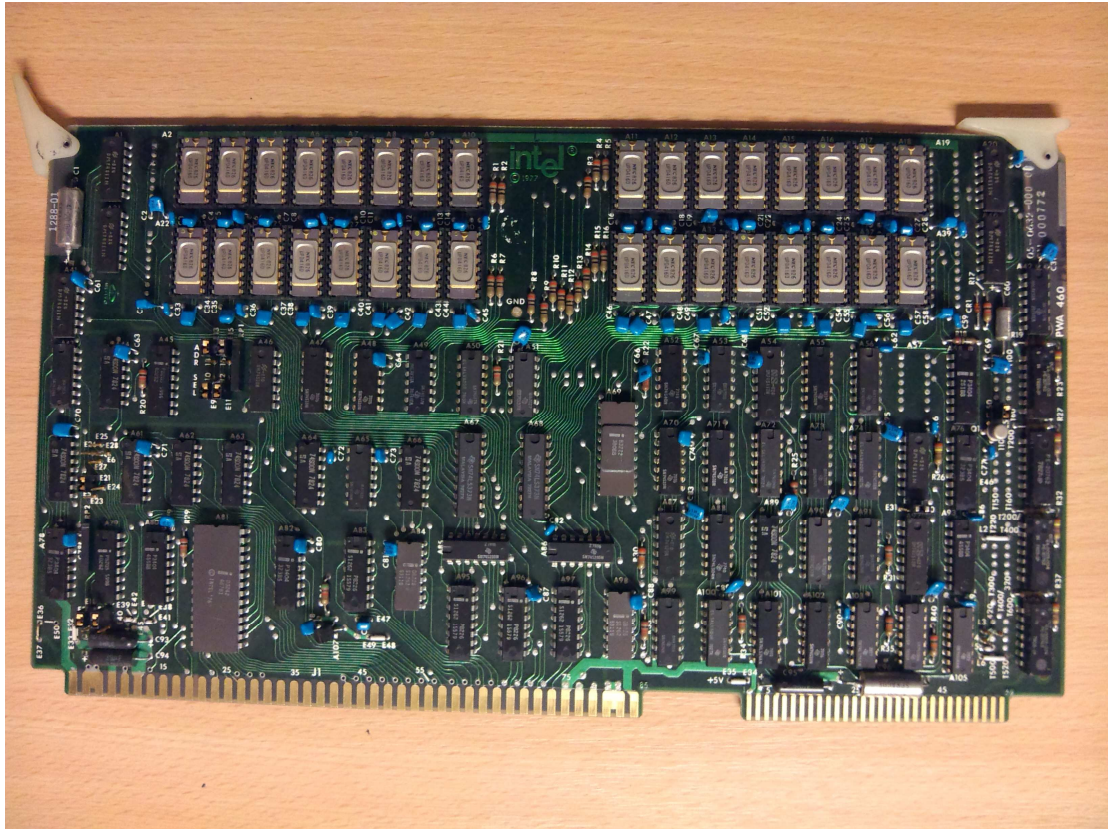


Figure 33: Intel PWA460 Multibus Memory board 2 front view
 NB: numbered as per its board set

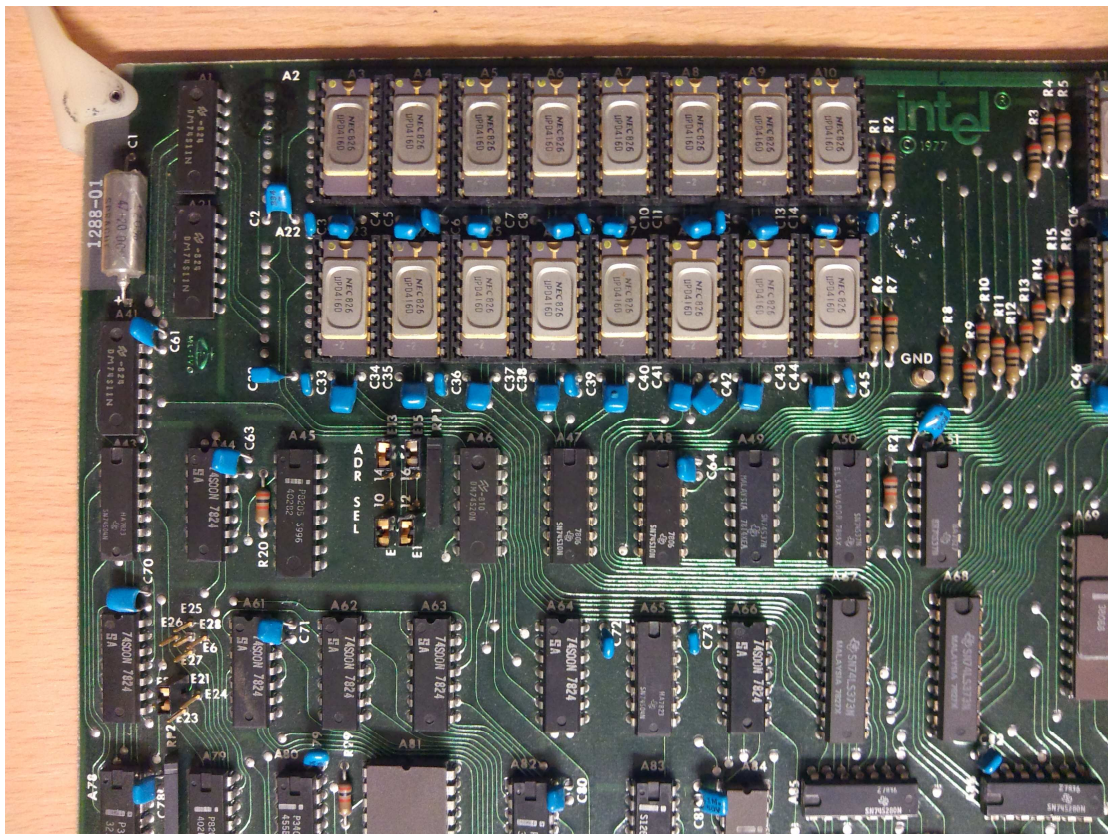


Figure 34: Intel PWA460 Multibus Memory board 2 closeup

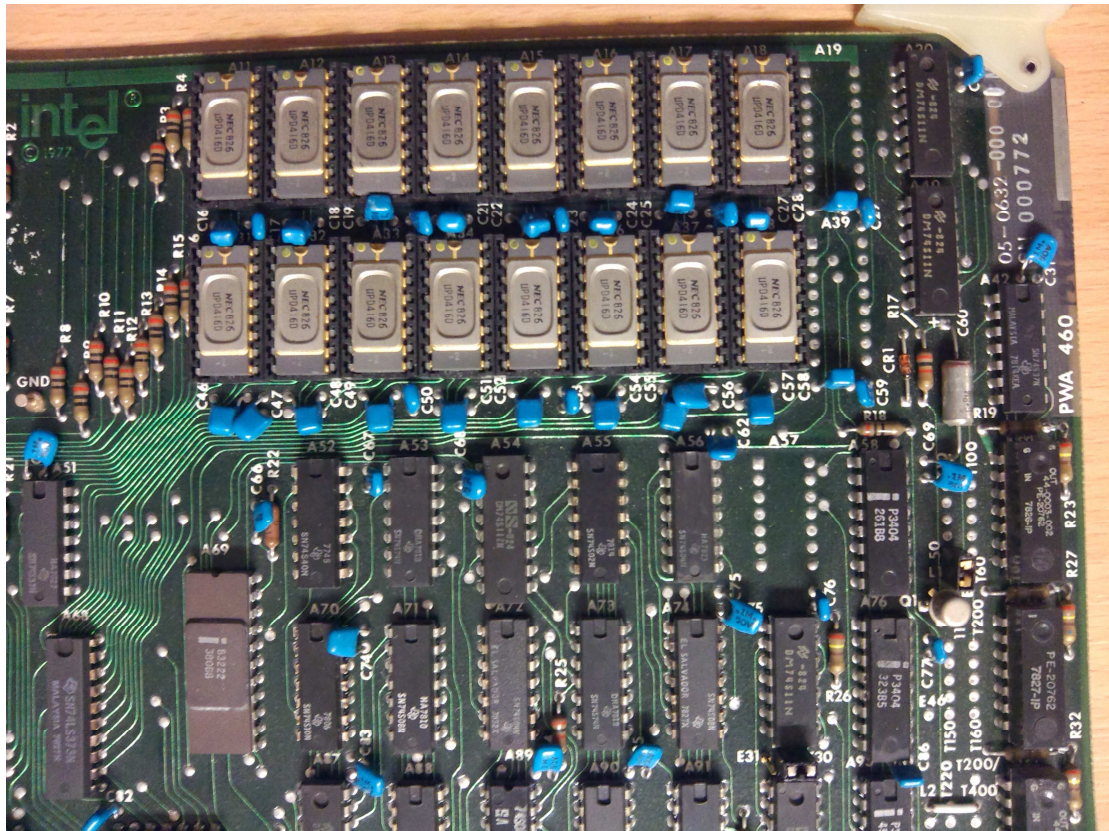


Figure 35: Intel PWA460 Multibus Memory board 2 closeup

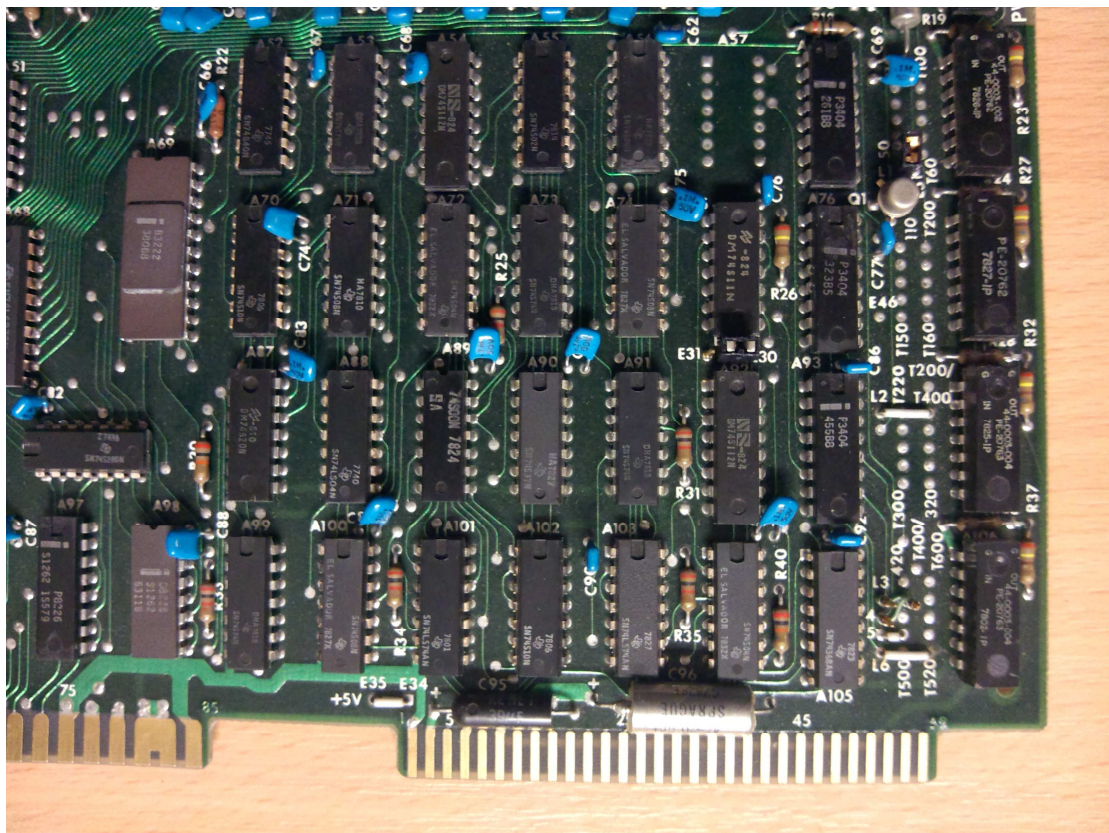


Figure 36: Intel PWA460 Multibus Memory board 2 closeup

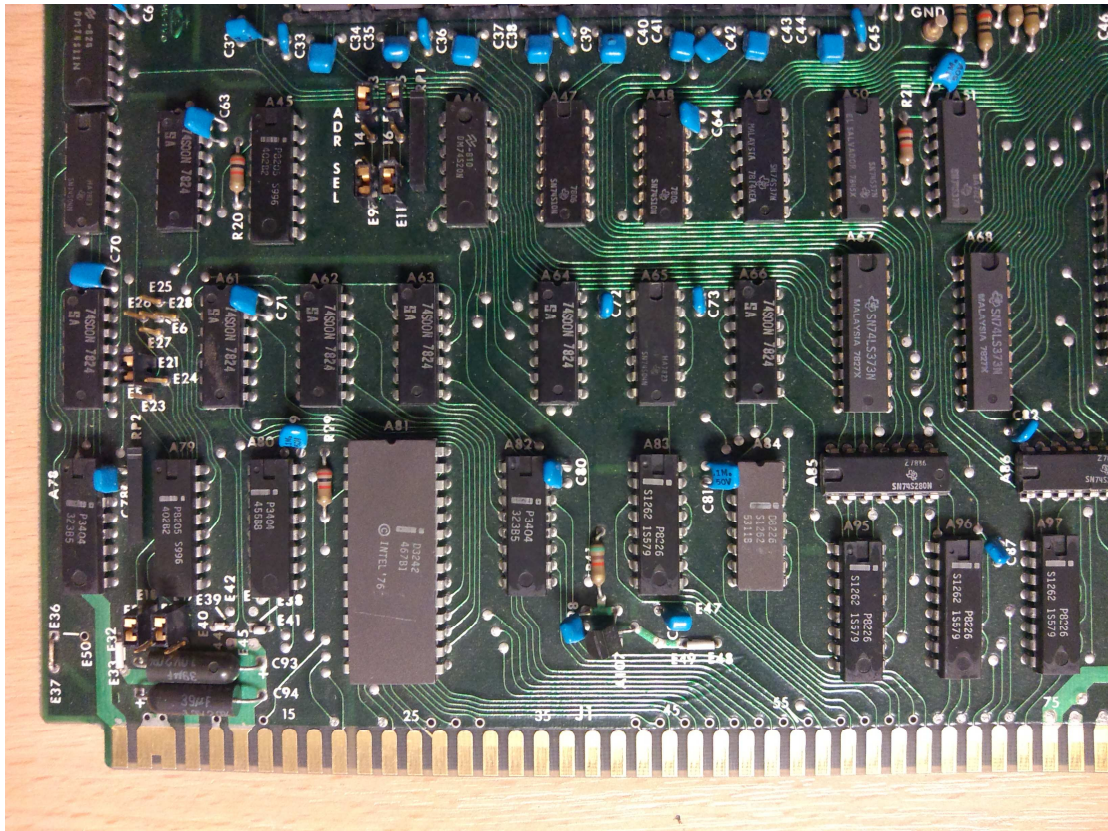


Figure 37: Intel PWA460 Multibus Memory board 2 closeup

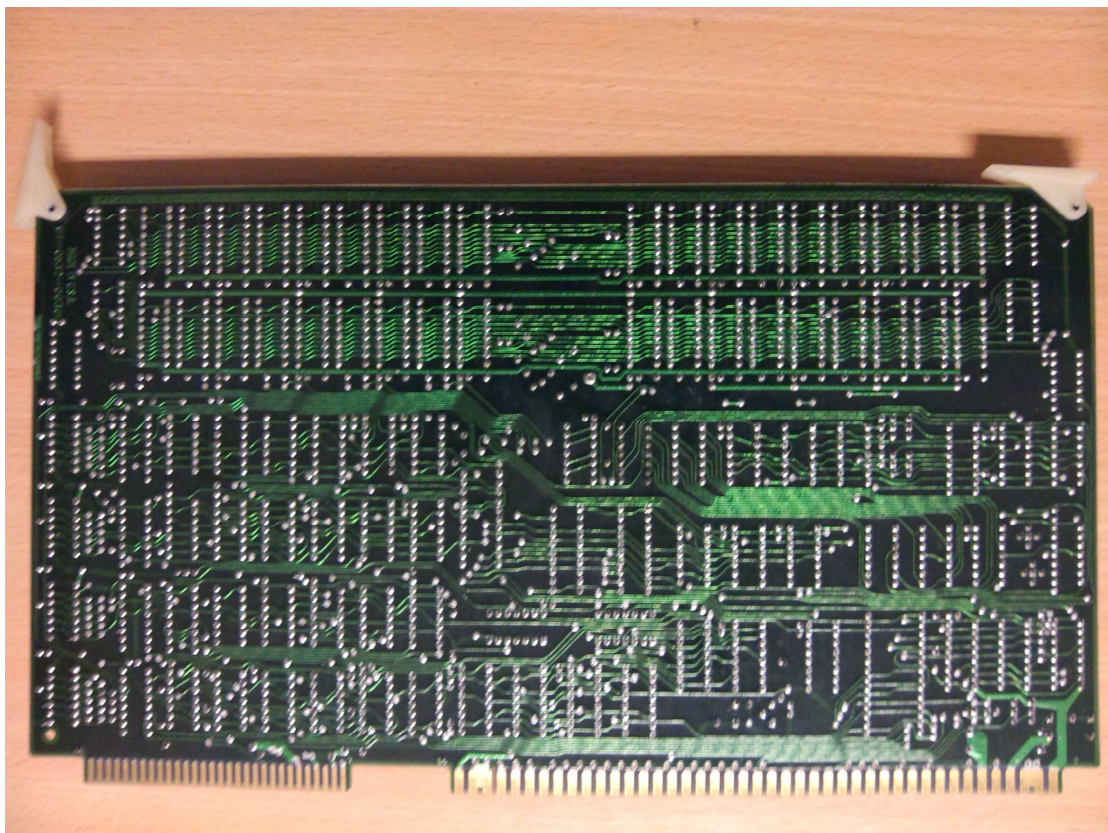


Figure 38: Intel PWA460 Multibus Memory board 2 rear view

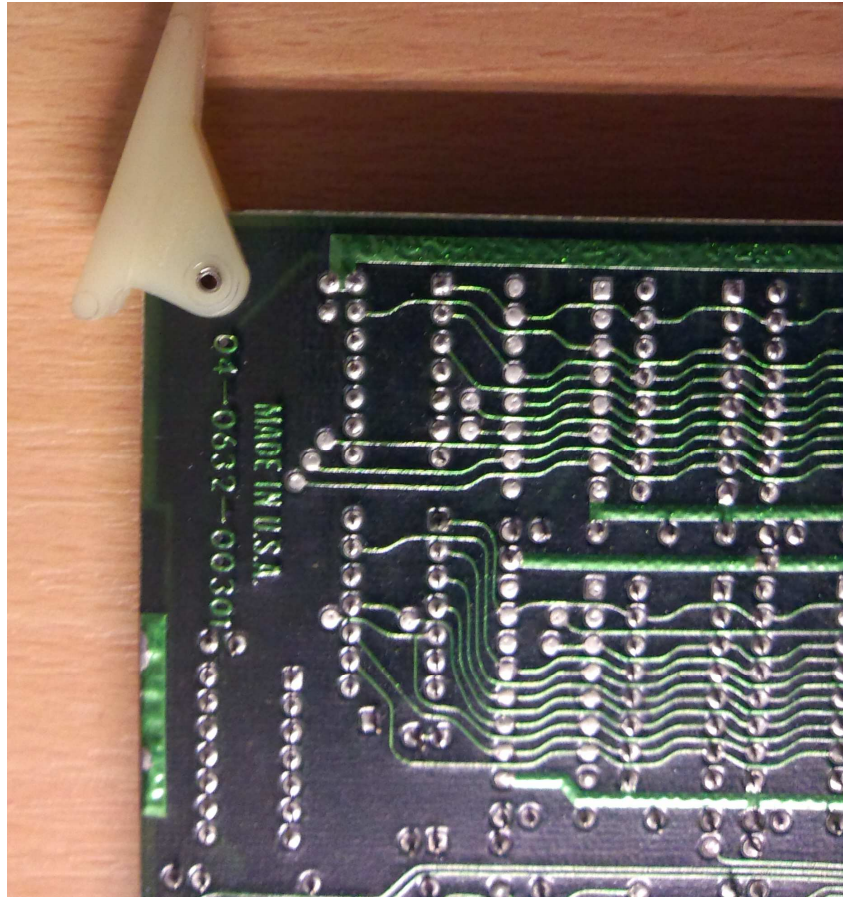


Figure 39: Intel PWA460 Multibus Memory board 2 manufacturing label

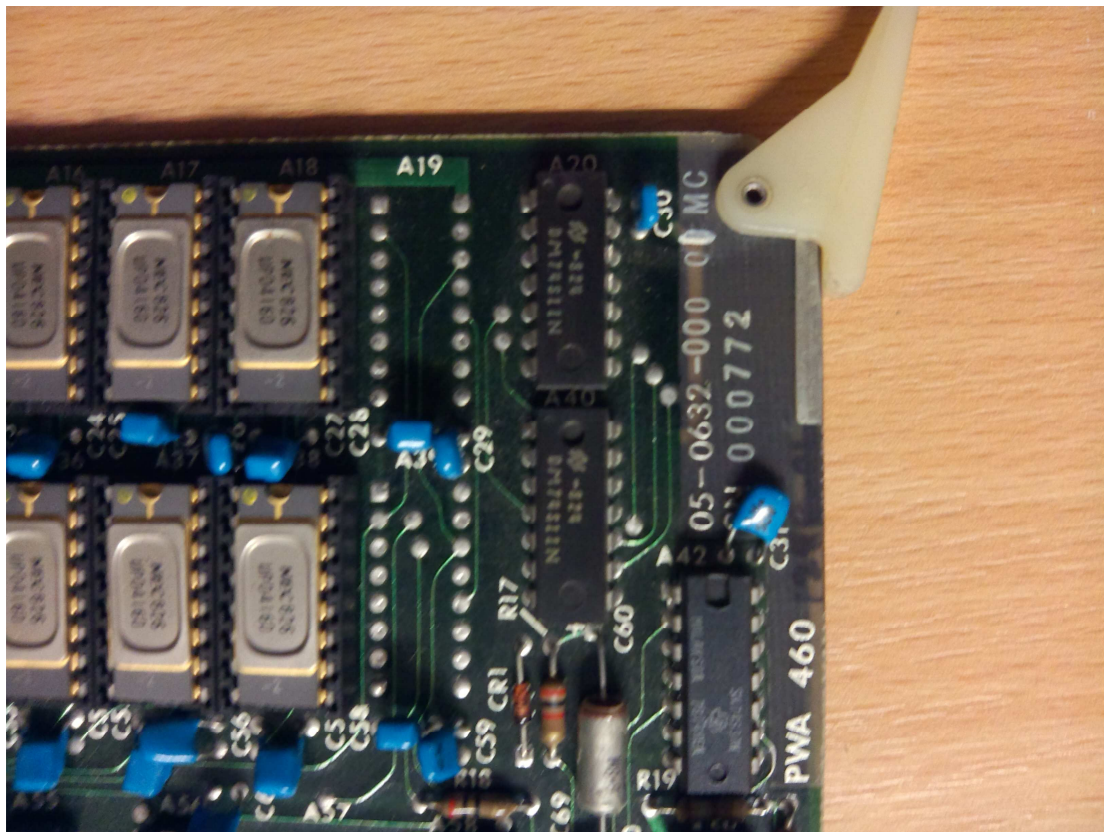


Figure 40: Intel PWA460 Multibus Memory board 2 manufacturing label

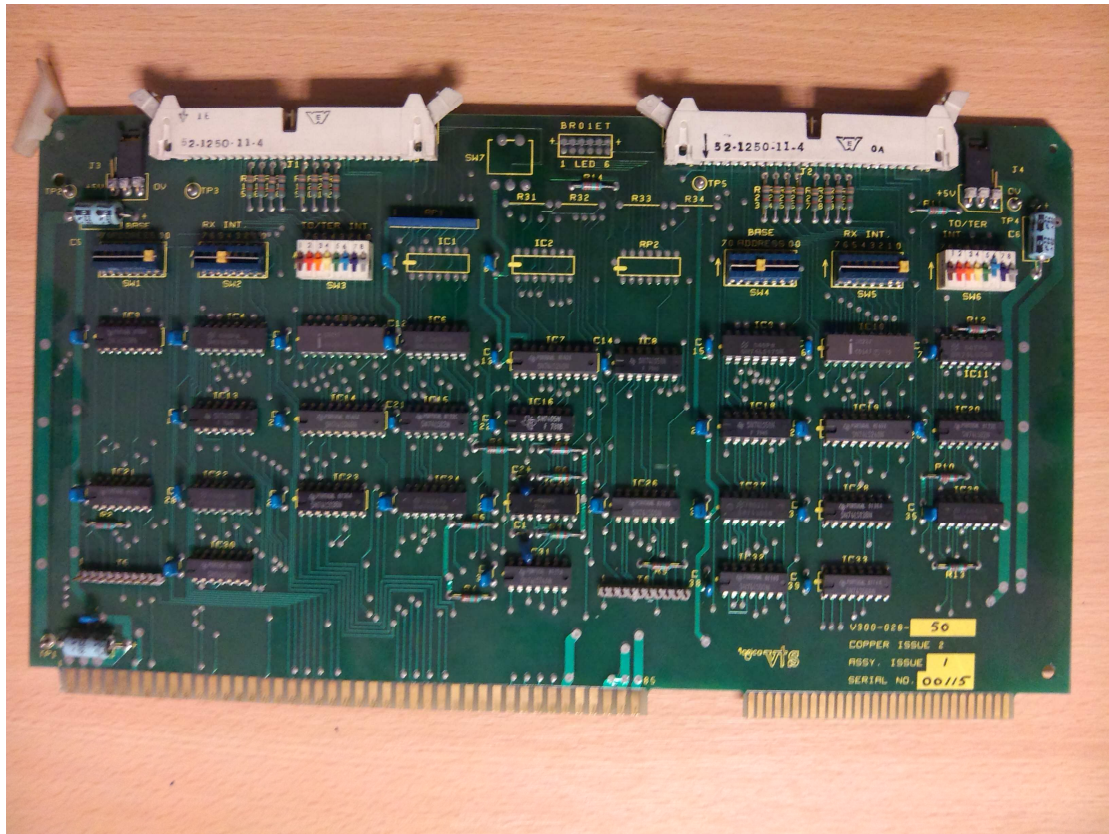


Figure 41: Logica VTS V300-028-50 Multibus I/O Board 2 front view
NB: numbered as per its board set

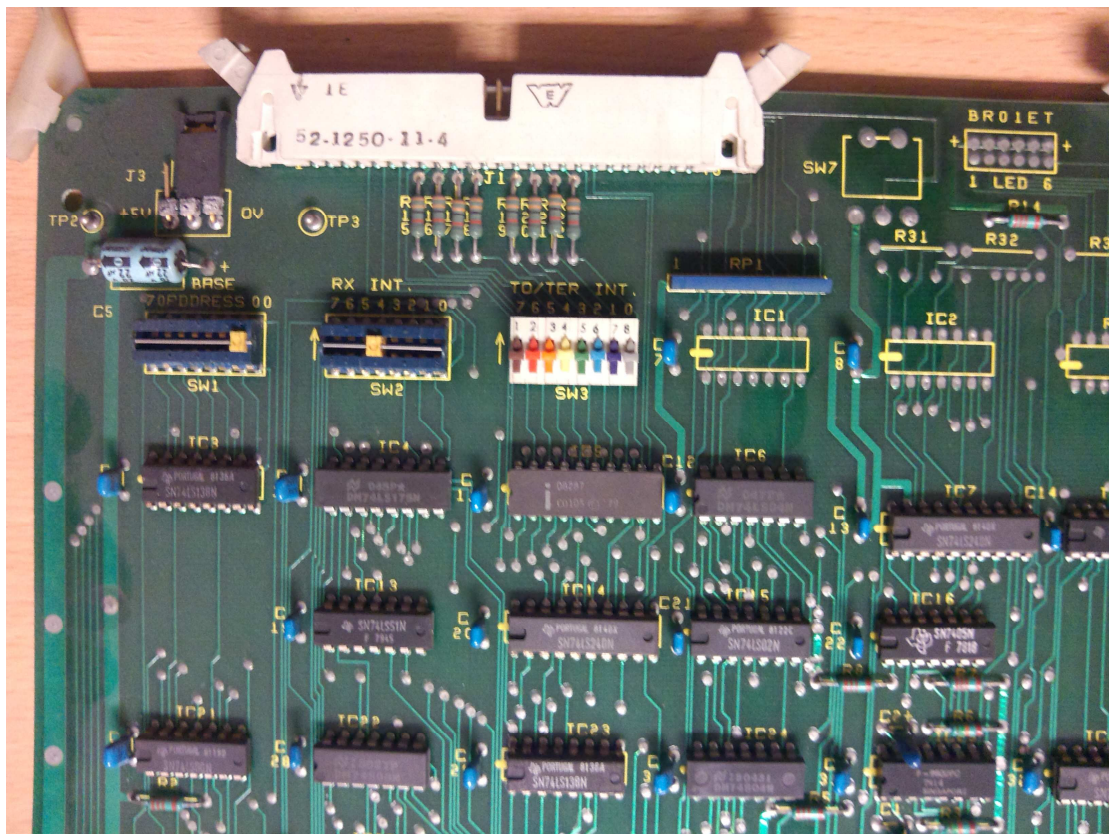


Figure 42: Logica VTS V300-028-50 Multibus I/O Board 2 closeup

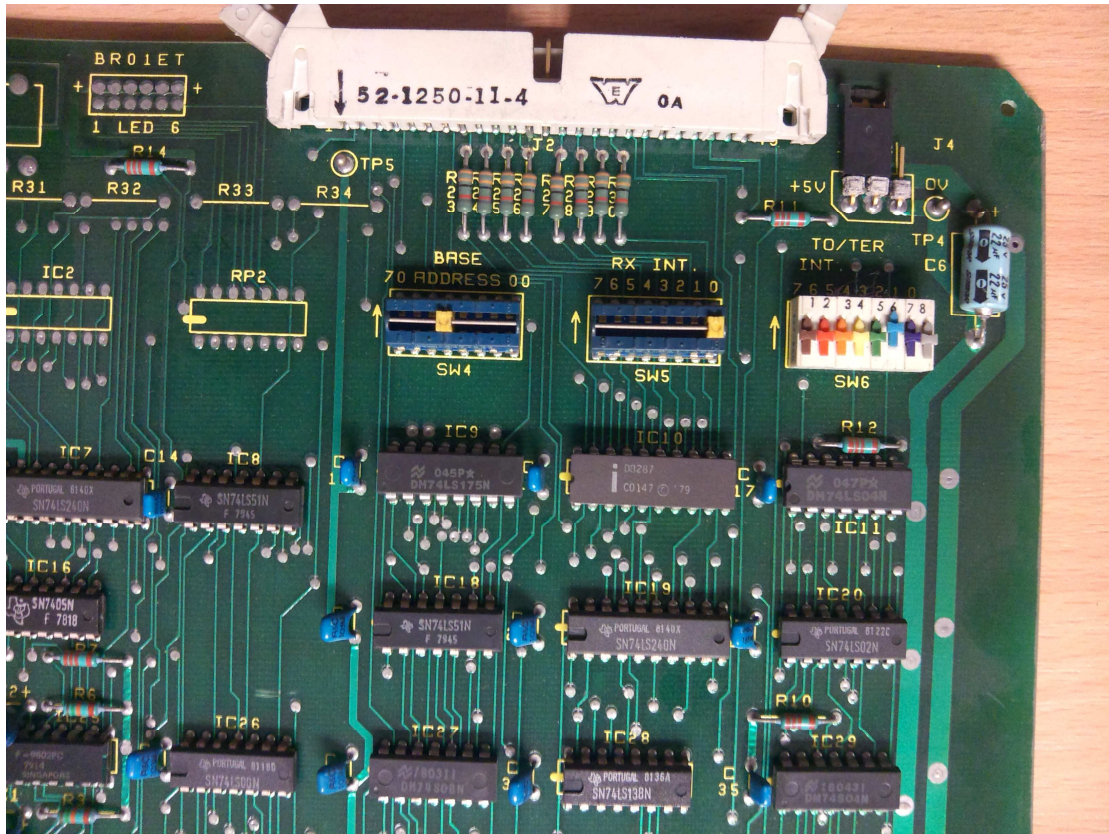


Figure 43: Logica VTS V300-028-50 Multibus I/O Board 2 closeup

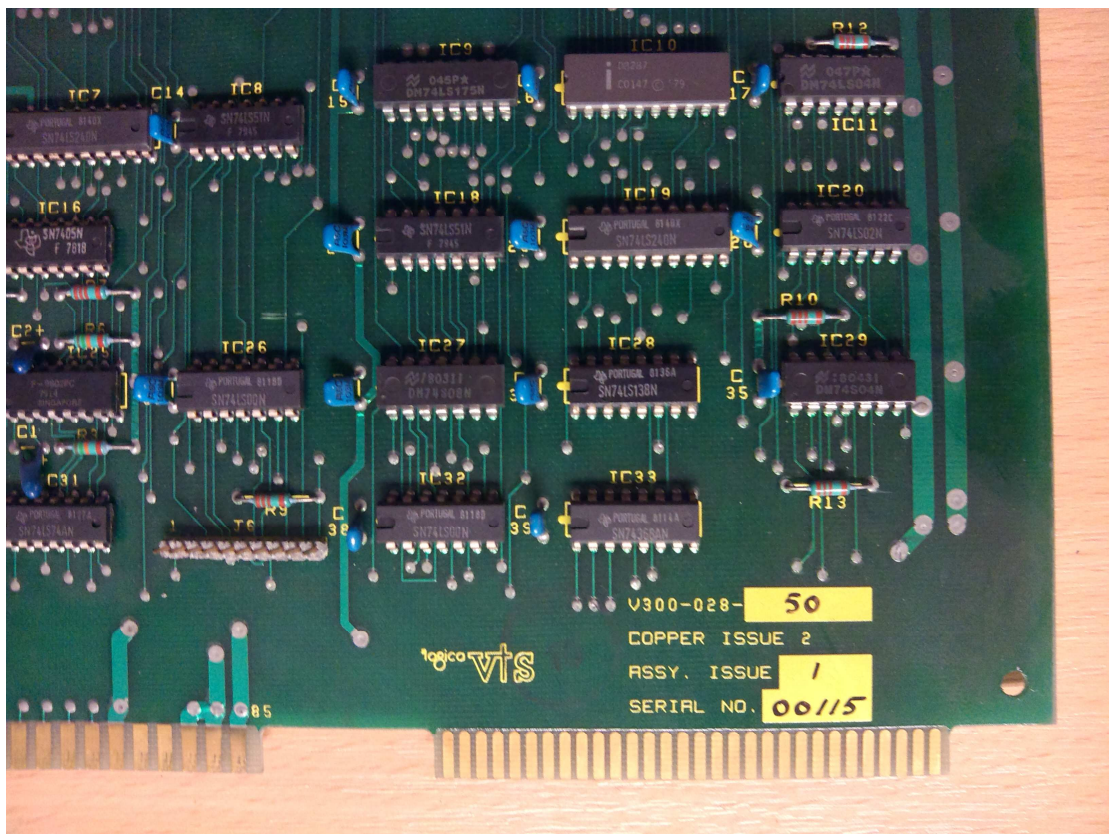


Figure 44: Logica VTS V300-028-50 Multibus I/O Board 2 closeup

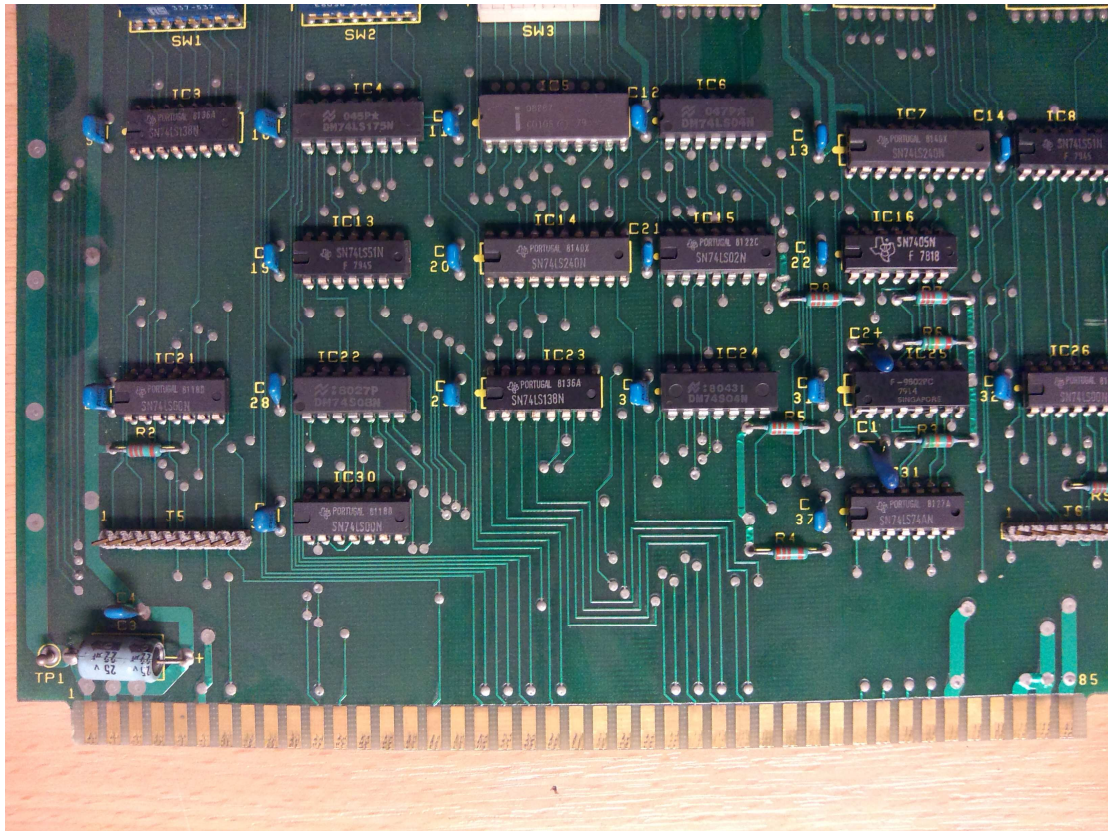


Figure 45: Logica VTS V300-028-50 Multibus I/O Board 2 closeup

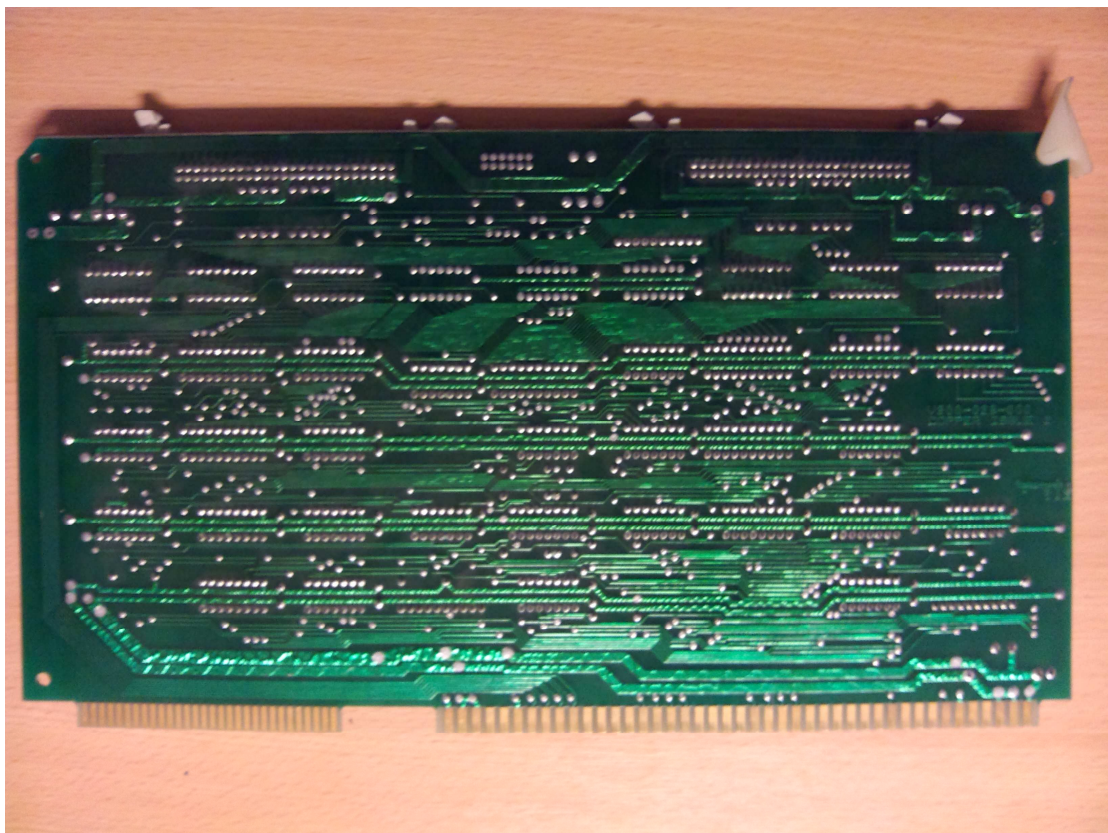


Figure 46: Logica VTS V300-028-50 Multibus I/O Board 2 rear view

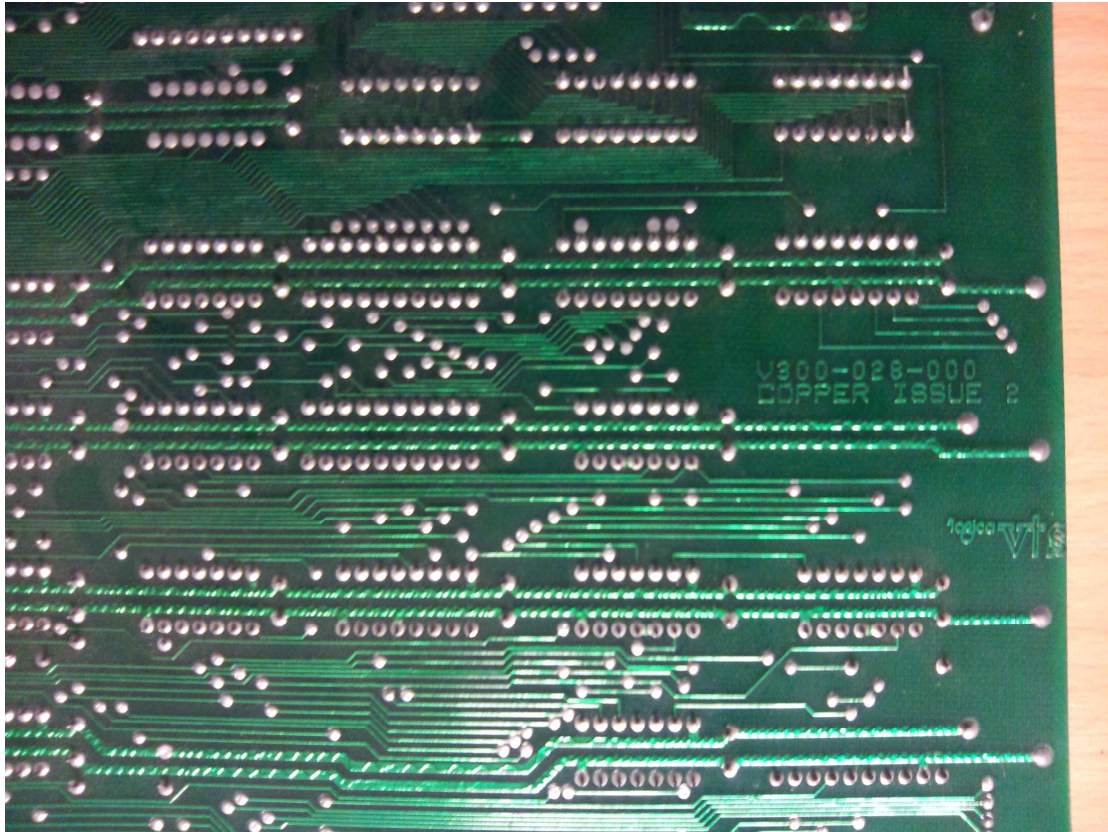


Figure 47: Logica VTS V300-028-50 Multibus I/O Board 2 manufacturing label

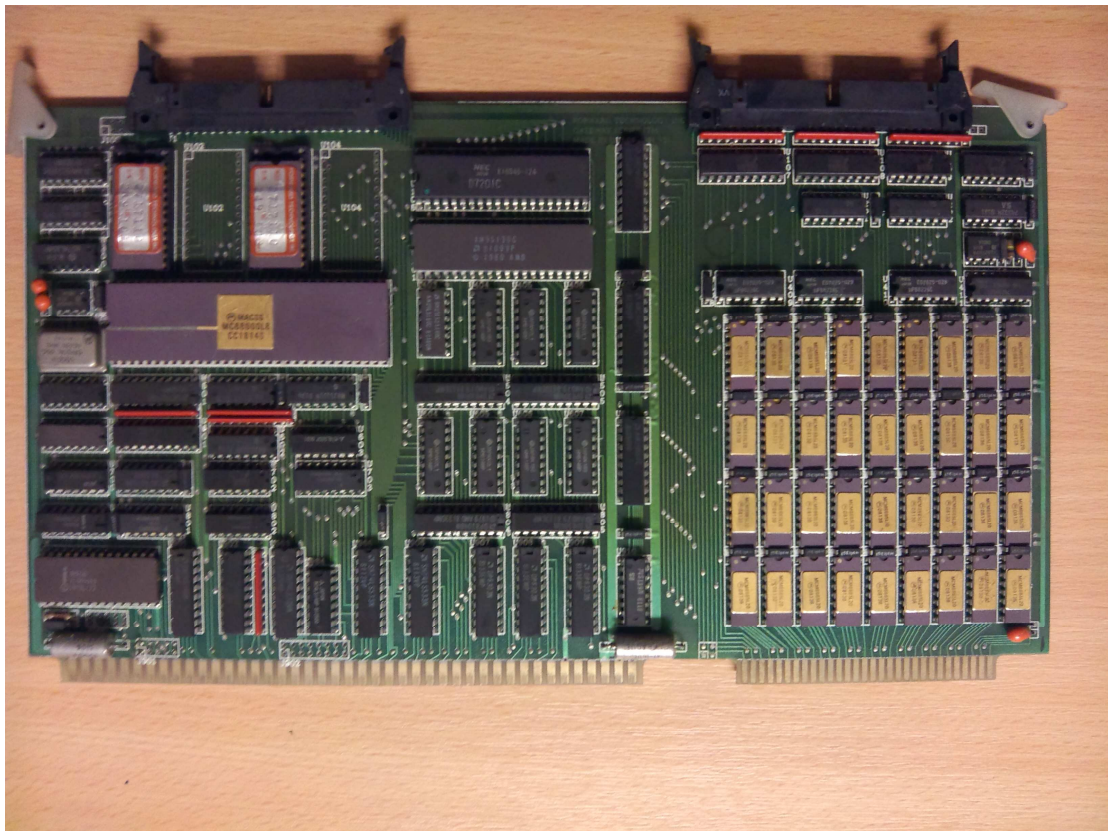


Figure 48: Pre-production SUN-1 Workstation CPU board 3 front view

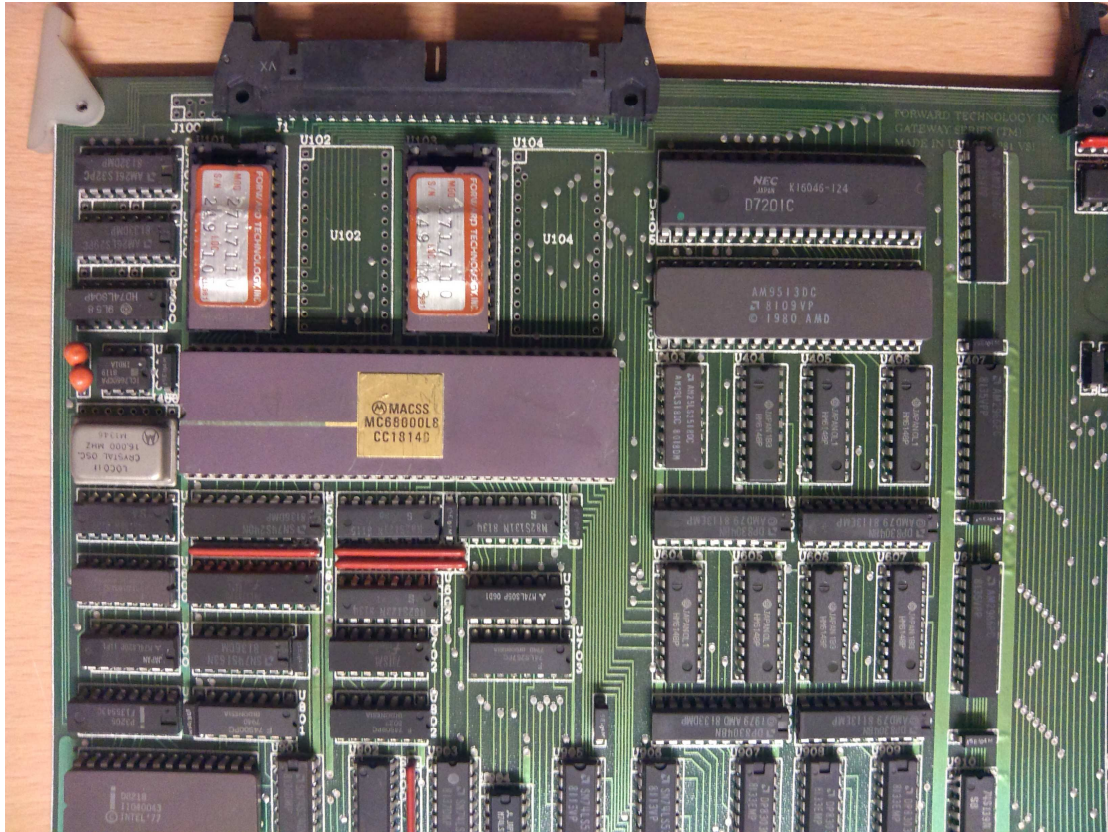


Figure 49: Pre-production SUN-1 Workstation CPU board 3 closeup

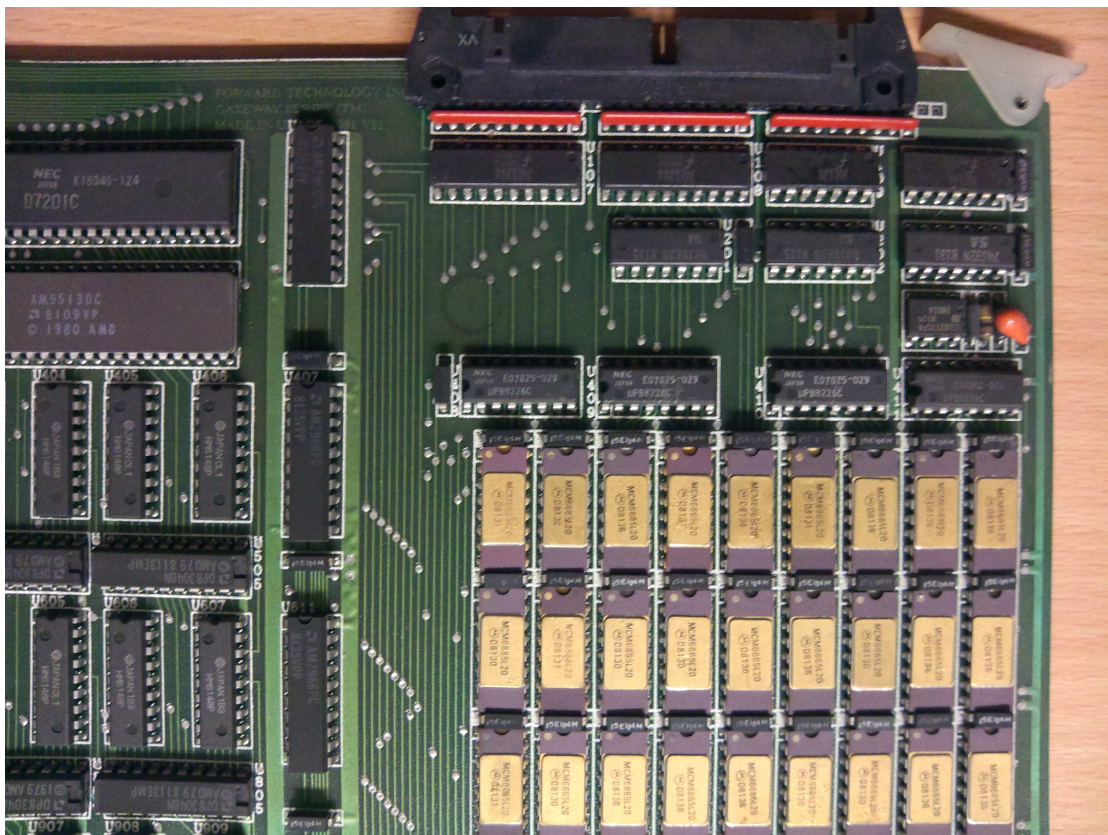


Figure 50: Pre-production SUN-1 Workstation CPU board 3 closeup

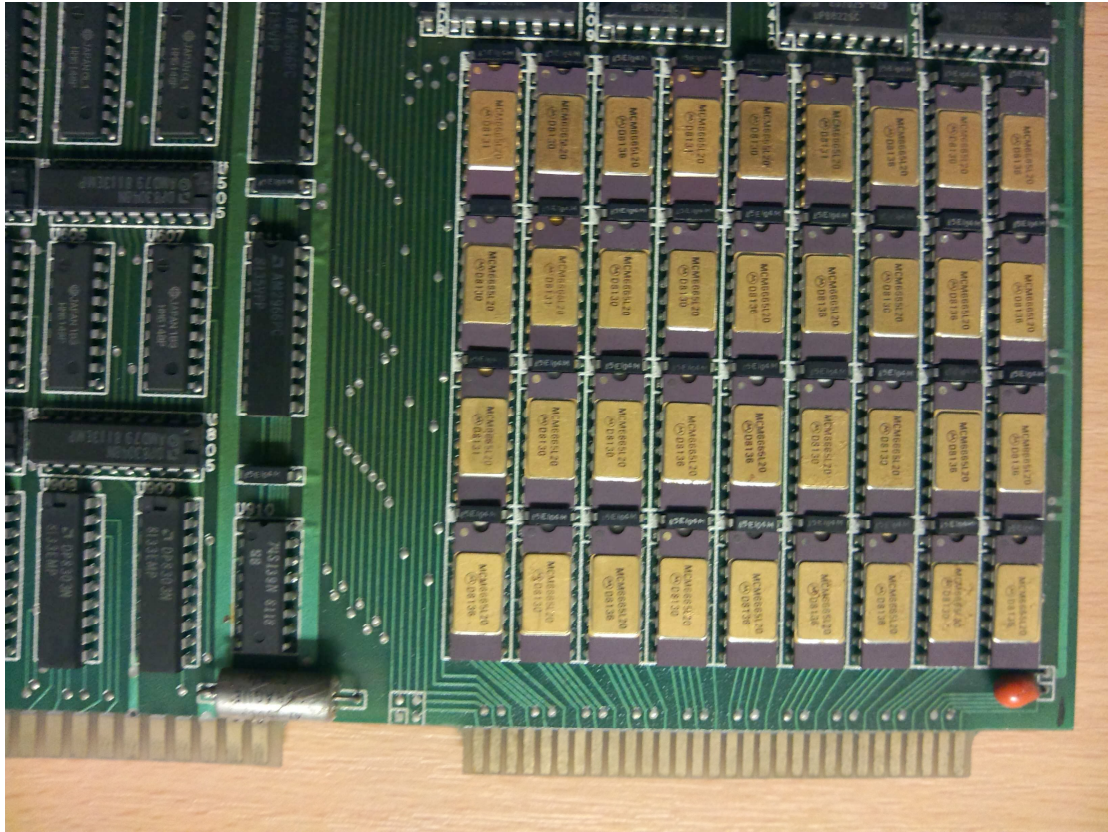


Figure 51: Pre-production SUN-1 Workstation CPU board 3 closeup

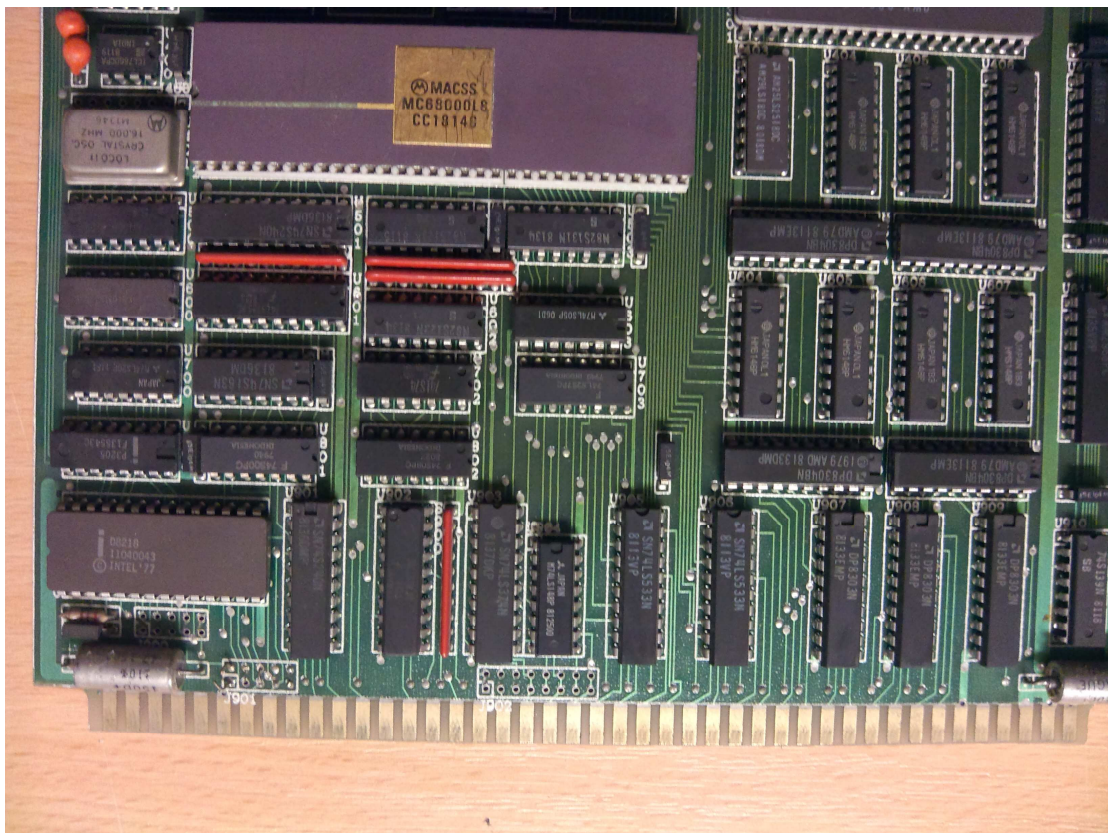


Figure 52: Pre-production SUN-1 Workstation CPU board 3 closeup

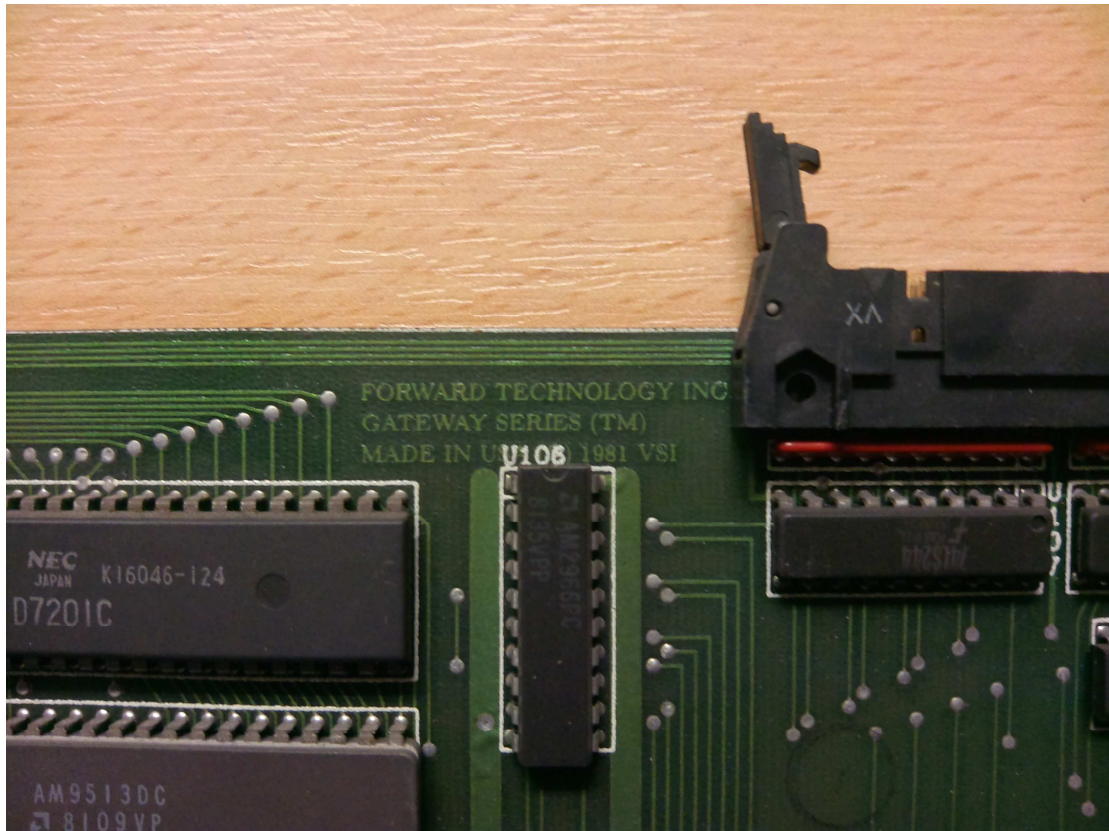


Figure 53: Pre-production SUN-1 Workstation CPU board 3 manufacturing label

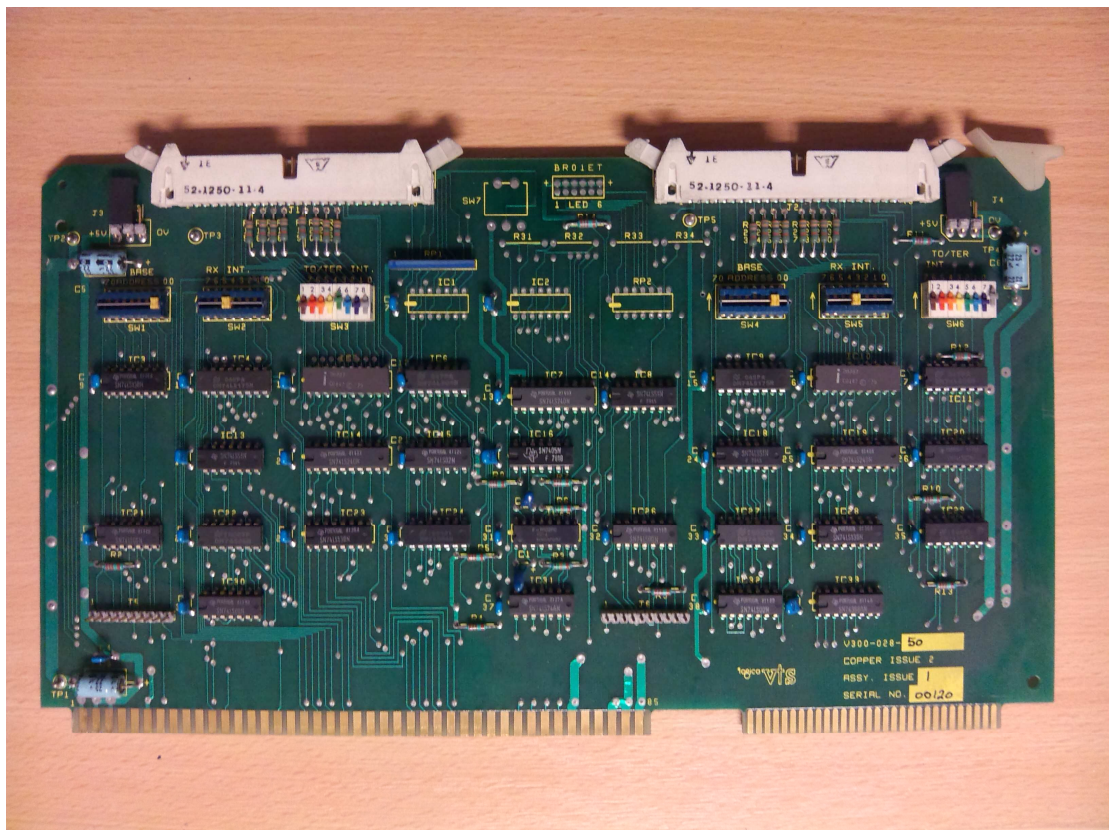


Figure 54: Logica VTS V300-028-50 Multibus I/O Board 3 front view
NB: numbered as per its board set

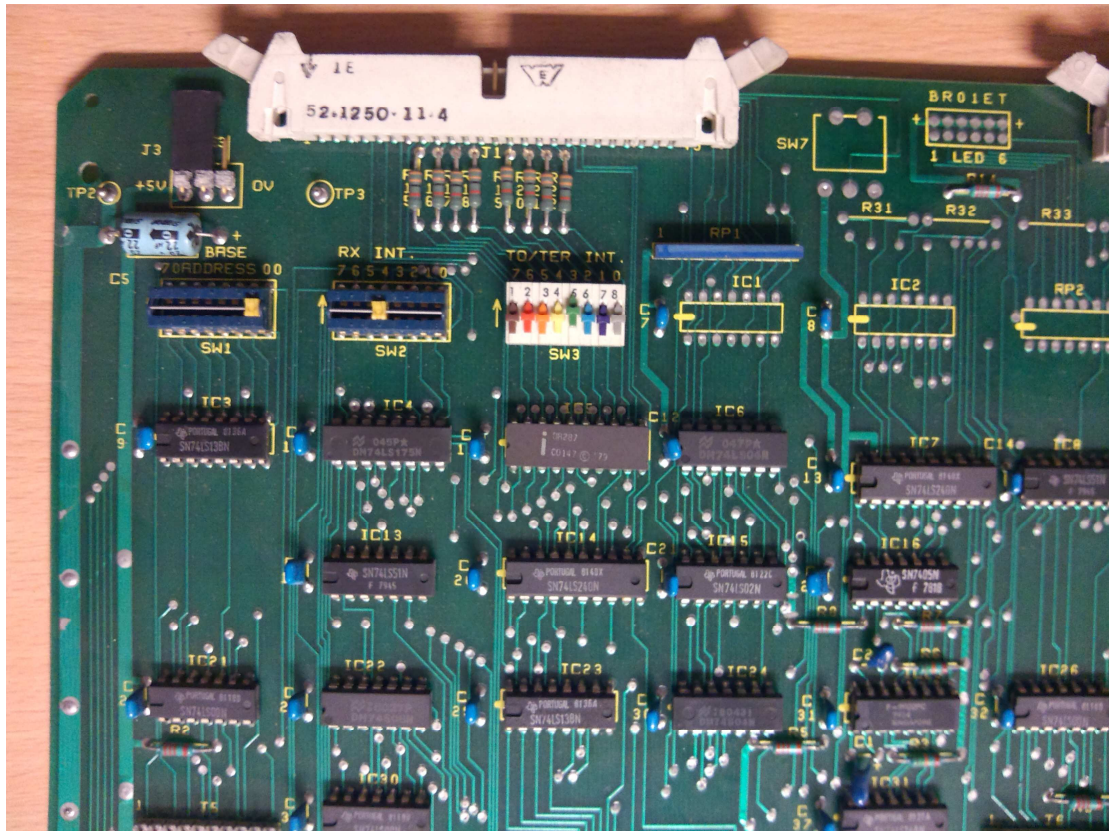


Figure 55: Logica VTS V300-028-50 Multibus I/O Board 3 closeup

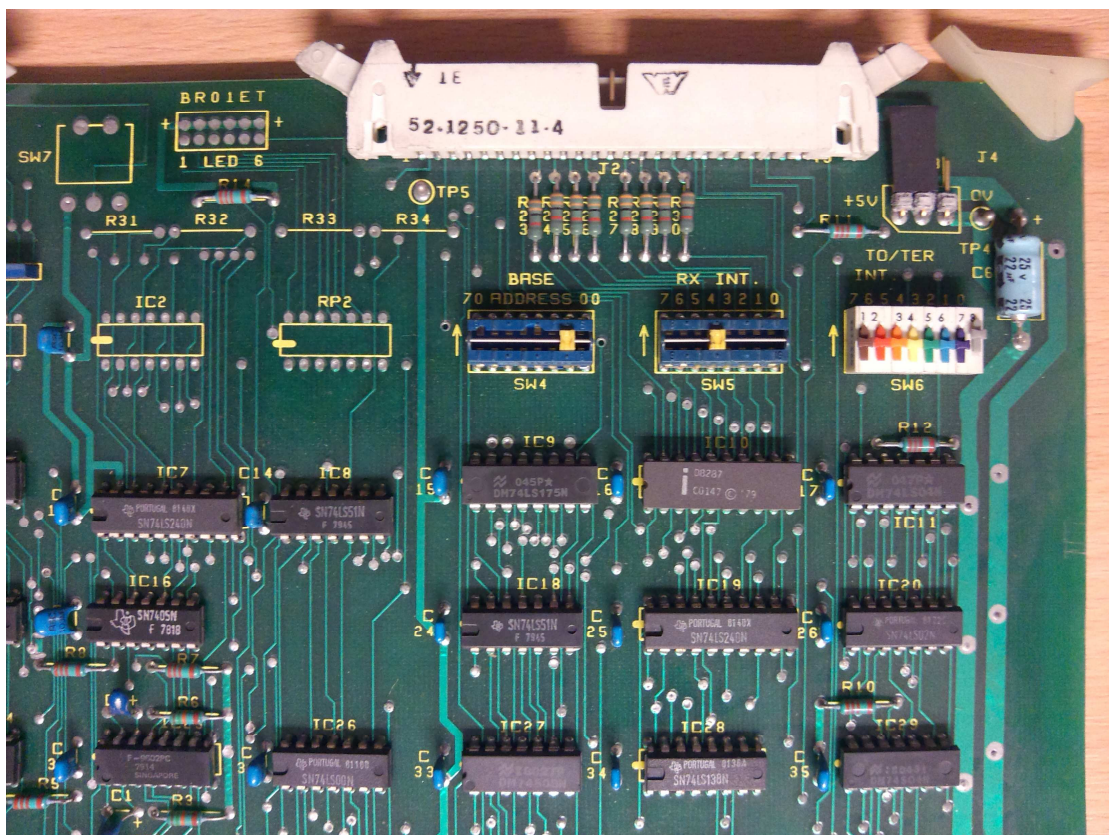


Figure 56: Logica VTS V300-028-50 Multibus I/O Board 3 closeup

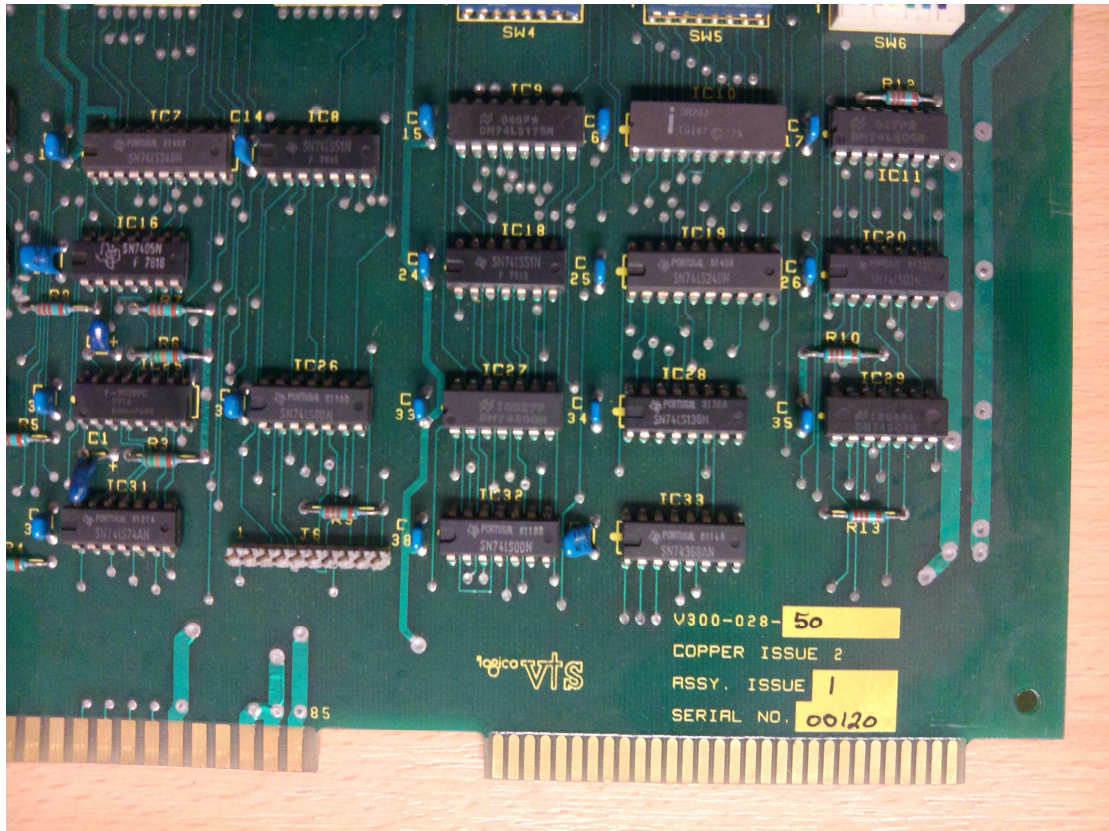


Figure 57: Logica VTS V300-028-50 Multibus I/O Board 3 closeup

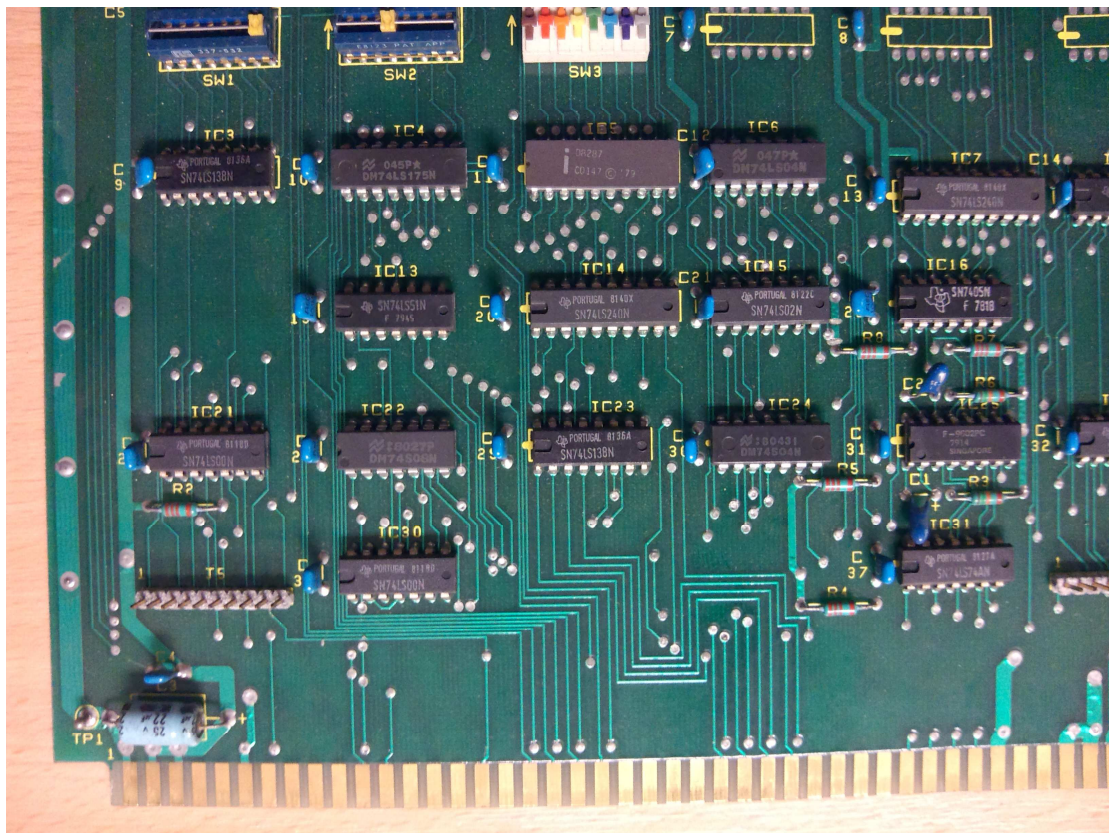


Figure 58: Logica VTS V300-028-50 Multibus I/O Board 3 closeup

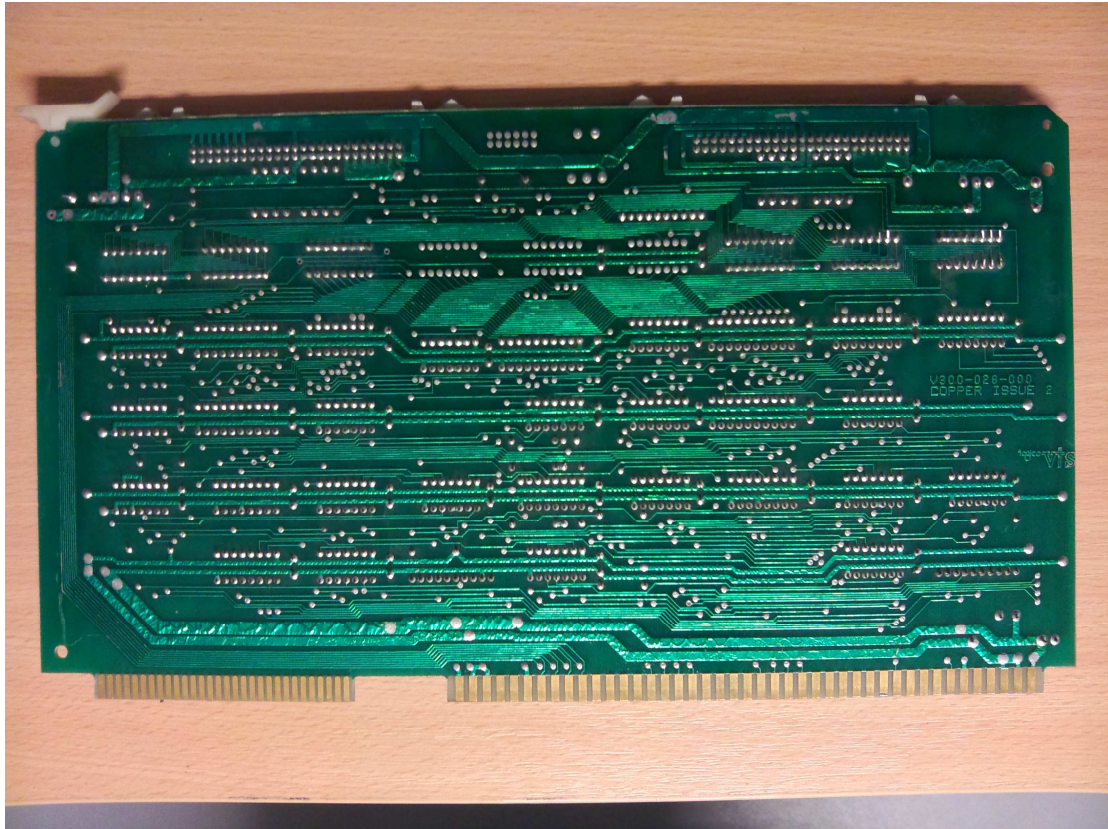


Figure 59: Logica VTS V300-028-50 Multibus I/O Board 3 rear view

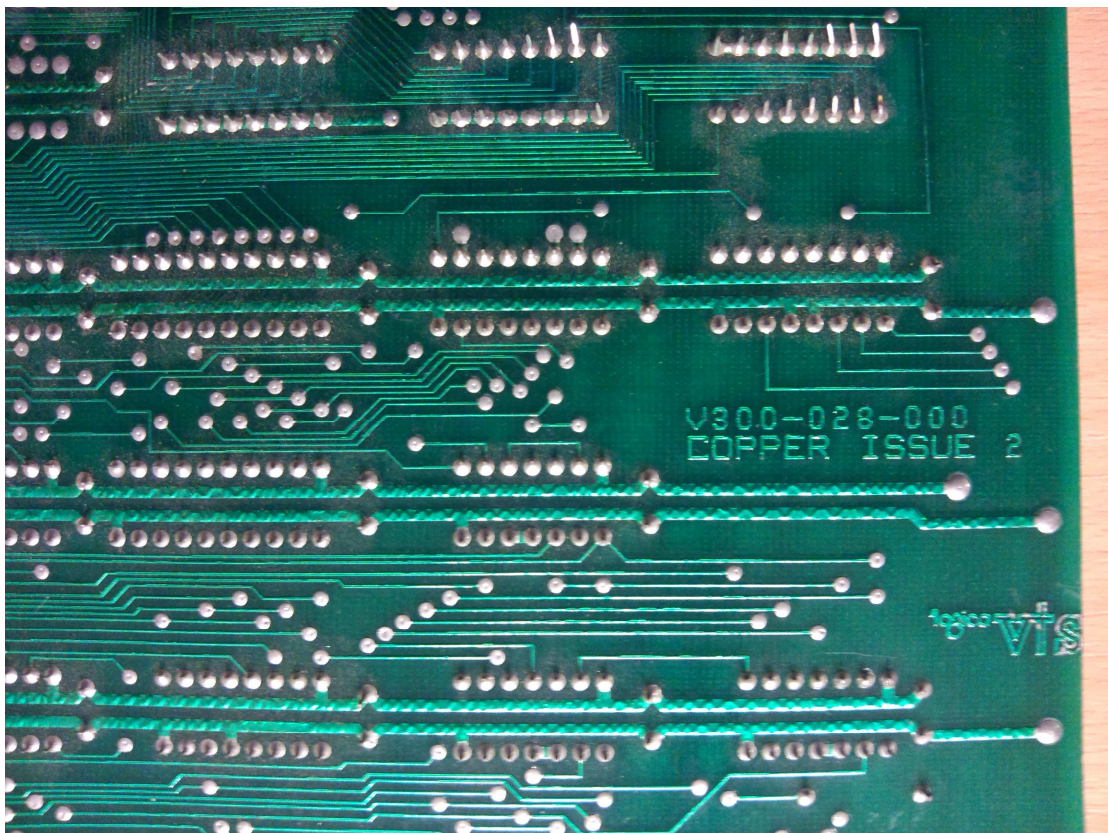


Figure 60: Logica VTS V300-028-50 Multibus I/O Board 3 manufacturing label

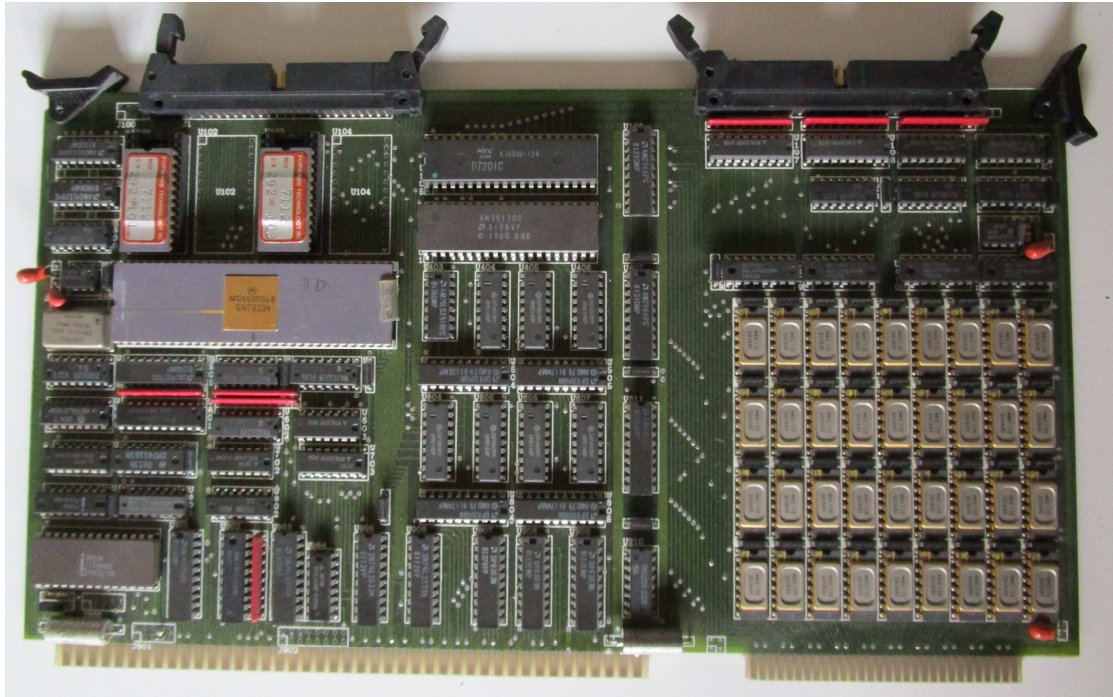


Figure 61: Pre-production SUN-1 Workstation CPU board 4 front view

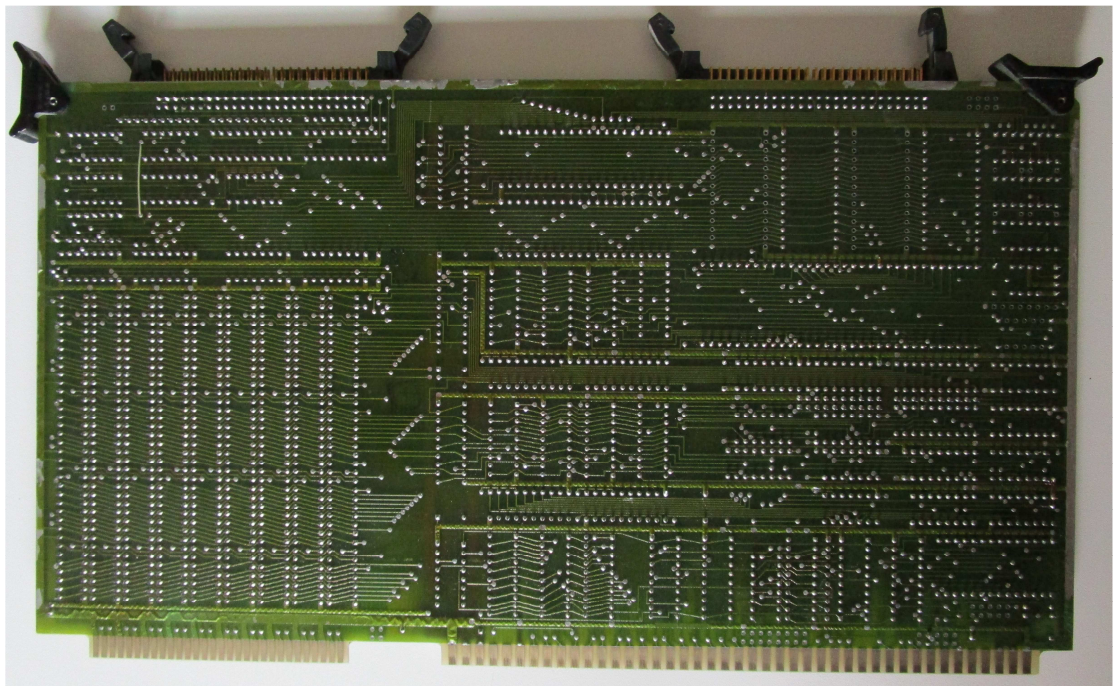
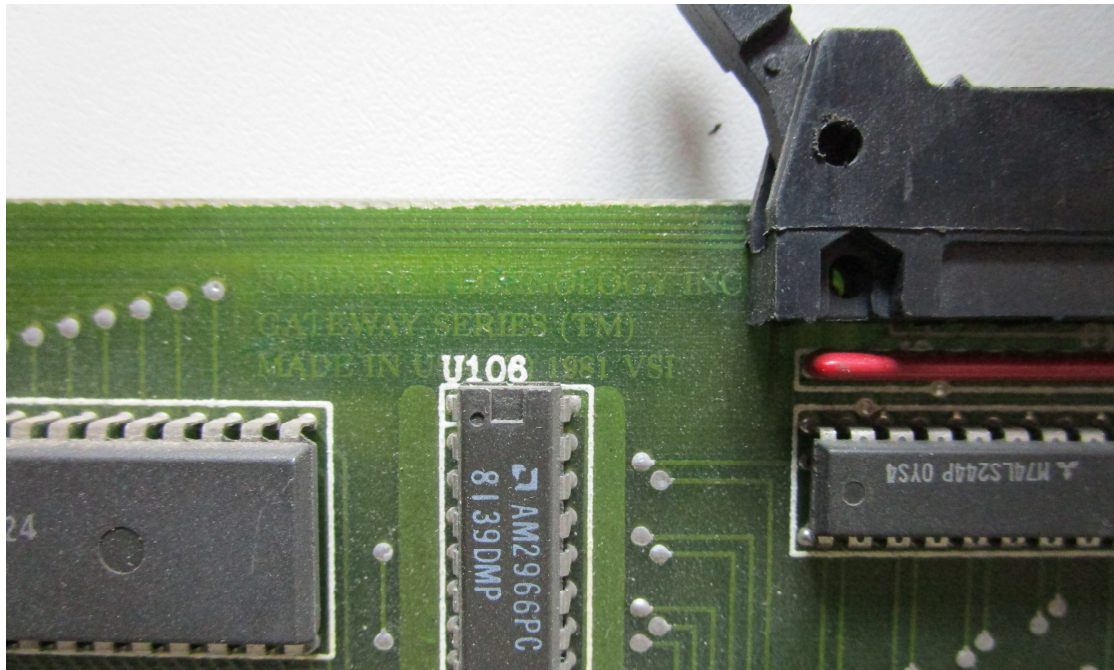


Figure 62: Pre-production SUN-1 Workstation CPU board 4 rear view



*Figure 63: Pre-production SUN-1 Workstation CPU board 4 manufacturing label
“Forward Technology Inc
Gateway Series™
Made in USA 1981 VSI”*

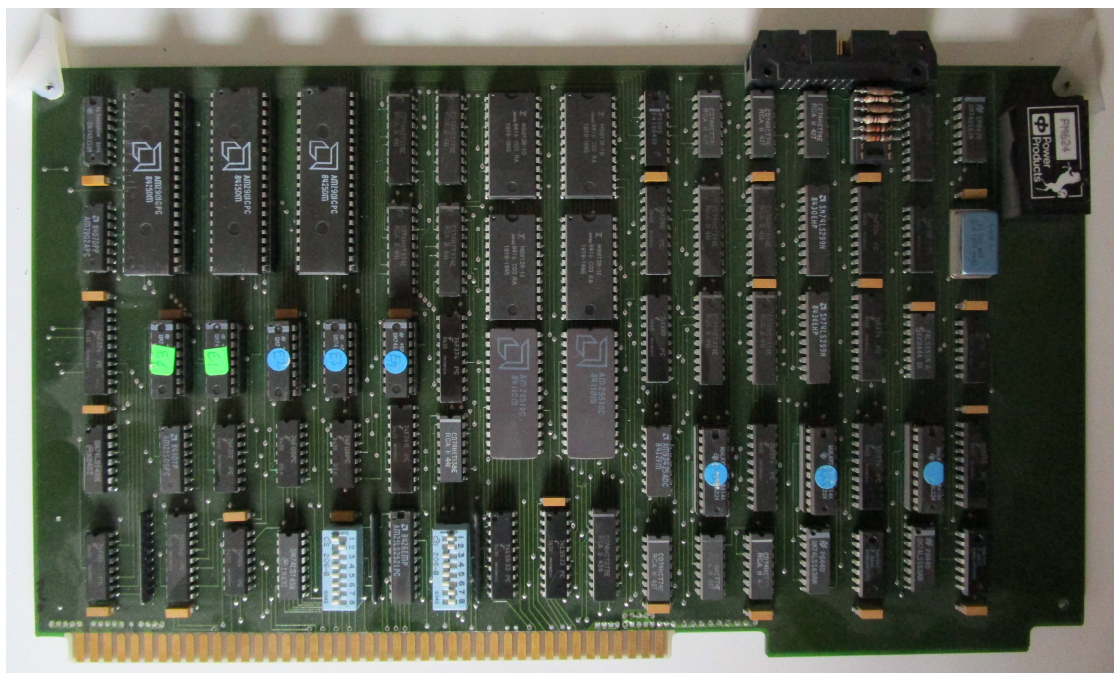


Figure 64: Pre-production SUN-1 Workstation 3Mbps Ethernet board 4 front view

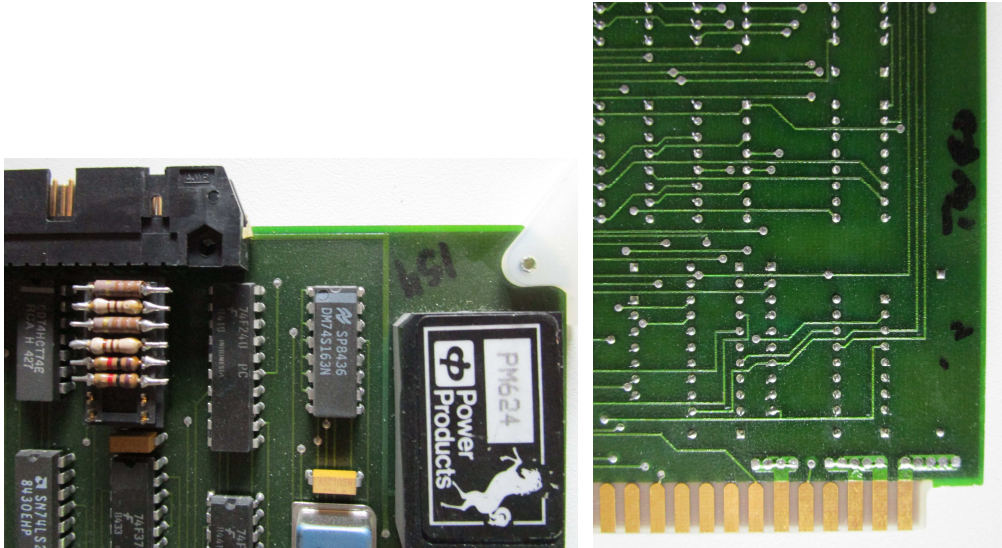


Figure 65: Pre-production SUN-1 Workstation 3Mbps Ethernet board 4 manufacturing labels
Markings: "154", "TW 40"

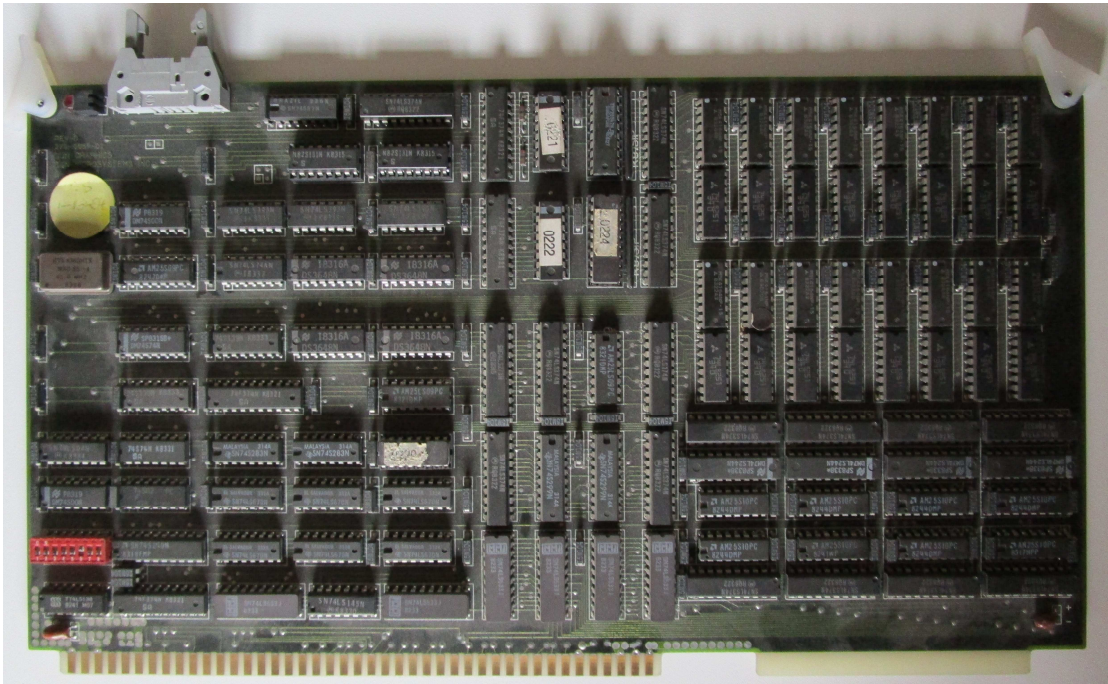


Figure 66: Pre-production SUN-1 Workstation Graphics board 4 front view

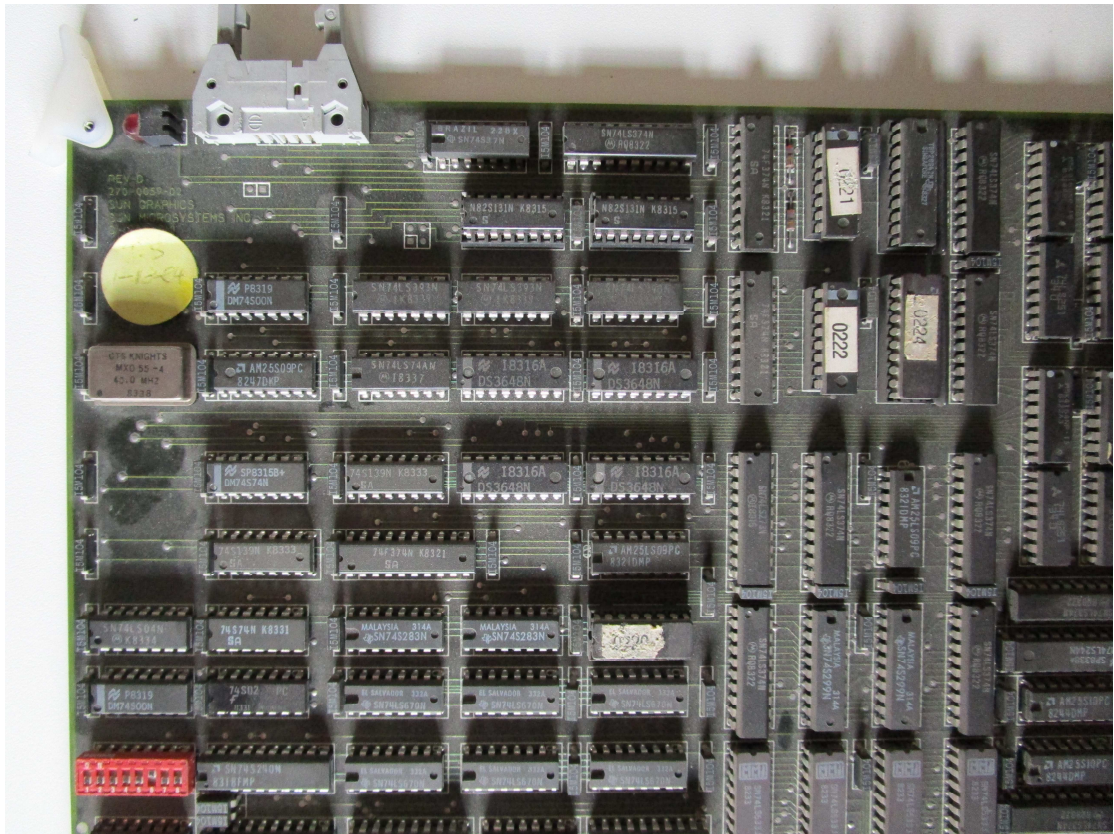


Figure 67: Pre-production SUN-1 Workstation Graphics board 4 front upper left closeup

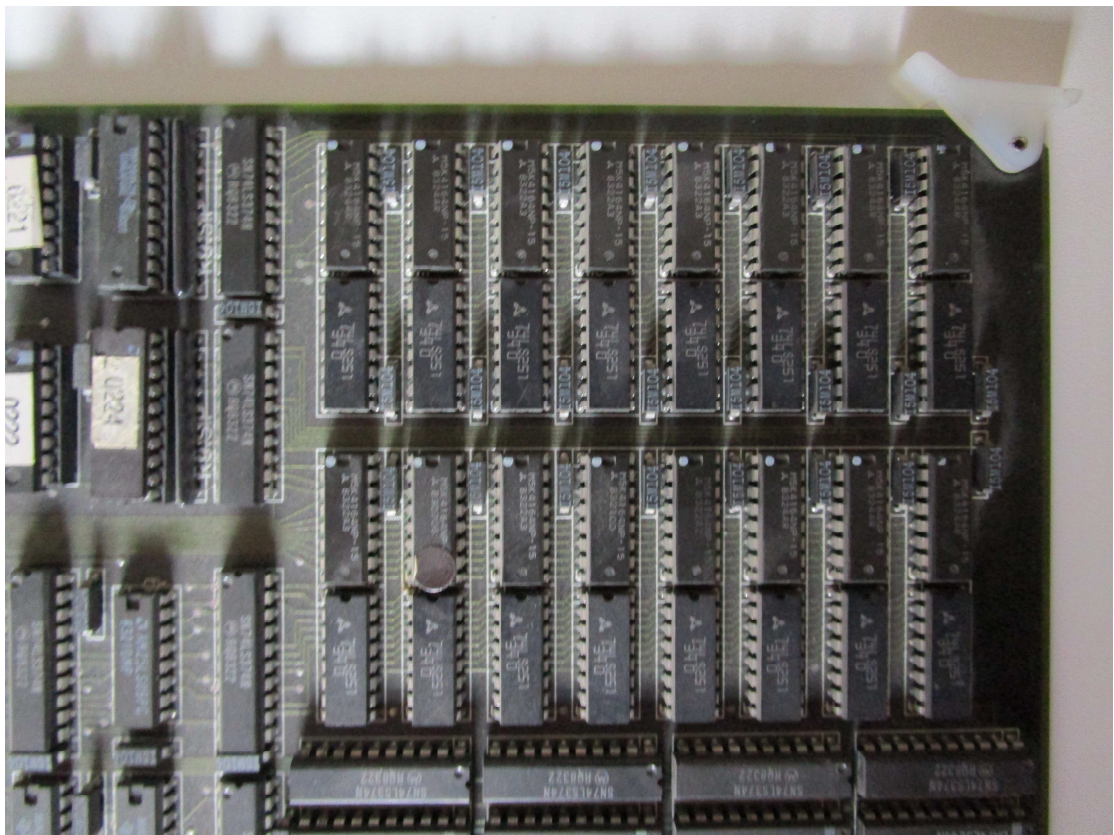


Figure 68: Pre-production SUN-1 Workstation Graphics board 4 front upper right closeup

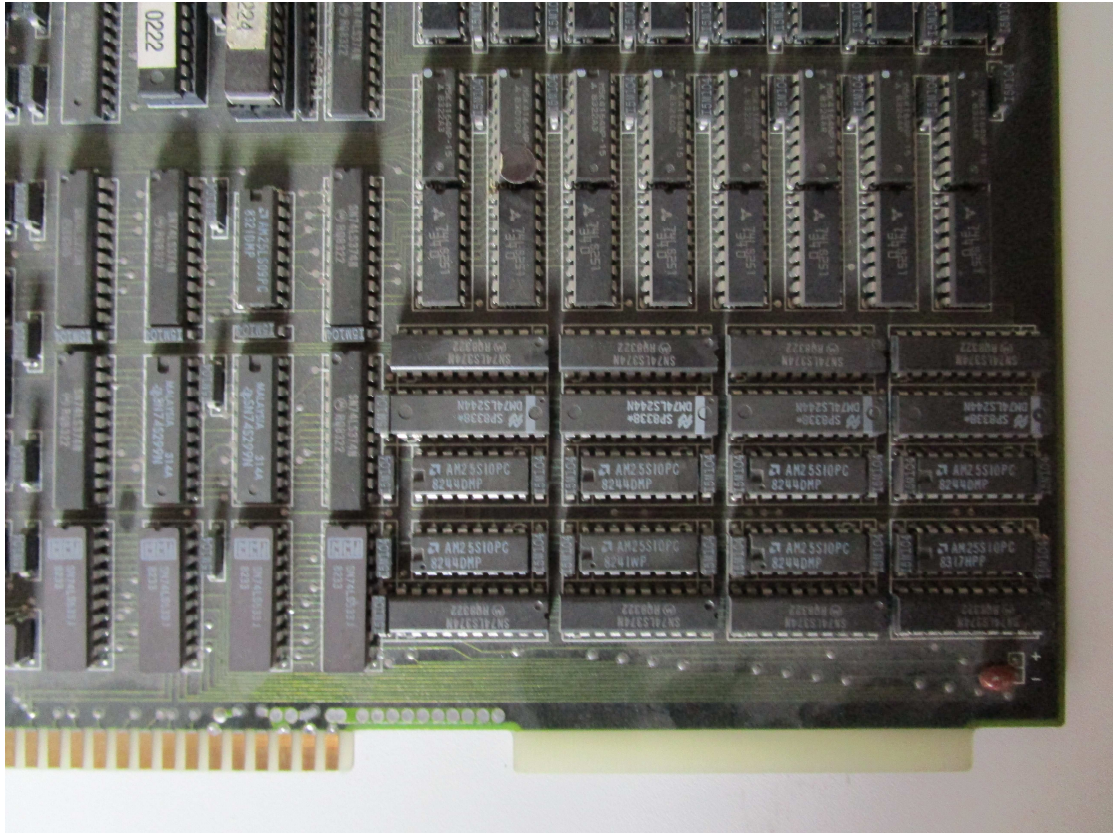


Figure 69: Pre-production SUN-1 Workstation Graphics board 4 front lower right closeup

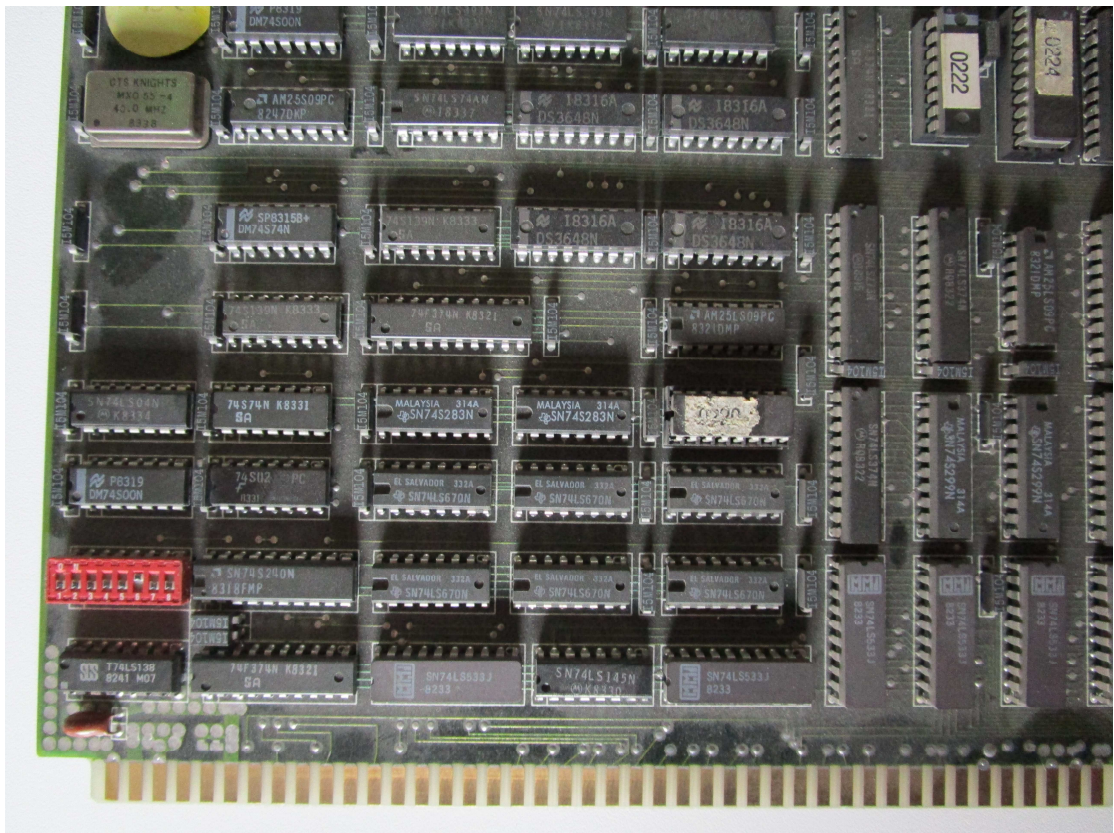


Figure 70: Pre-production SUN-1 Workstation Graphics board 4 front lower left closeup

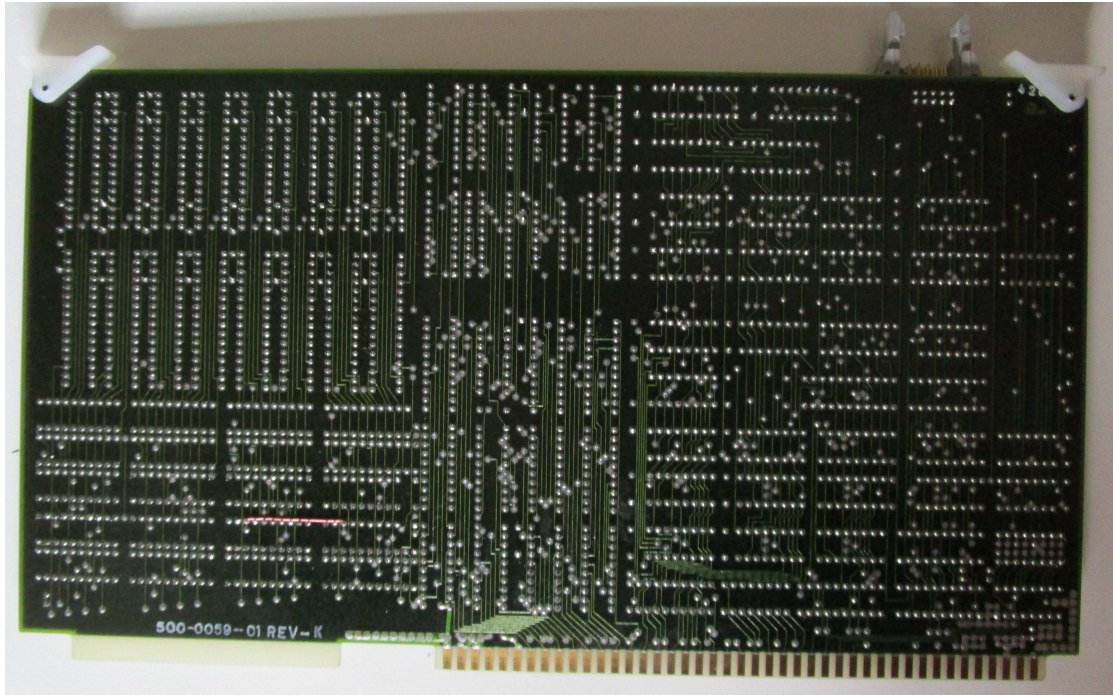


Figure 71: Pre-production SUN-1 Workstation Graphics board 4 rear view

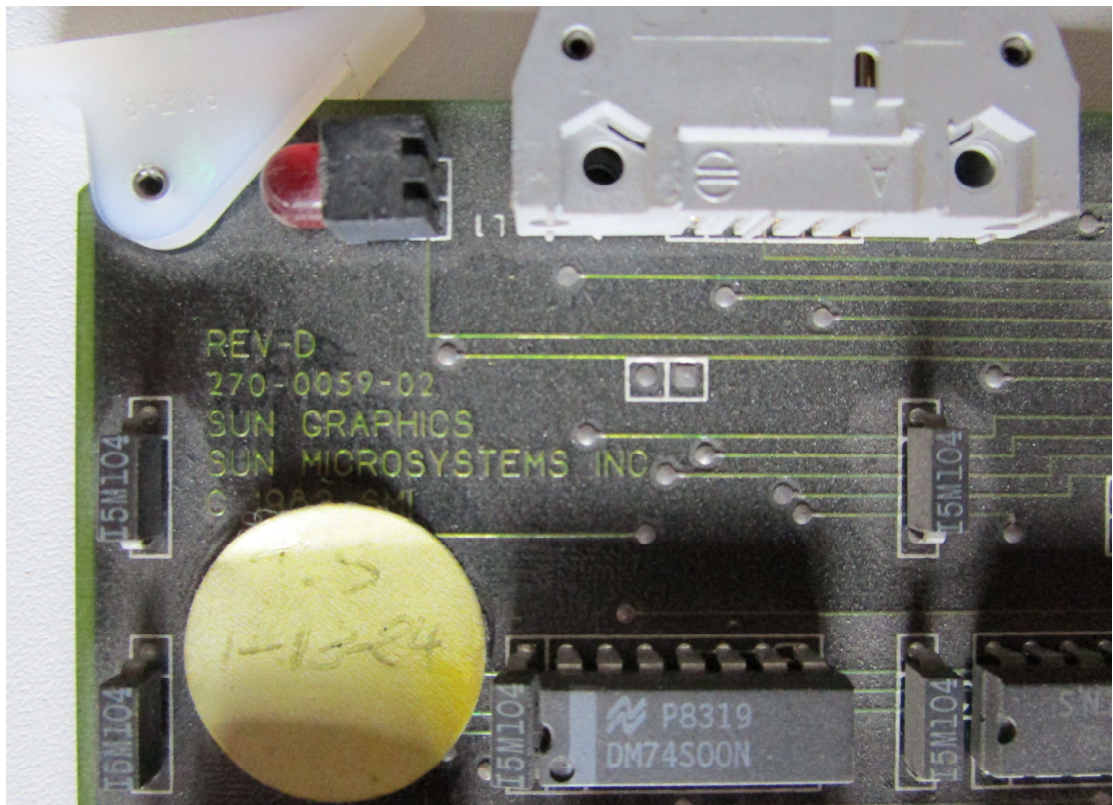
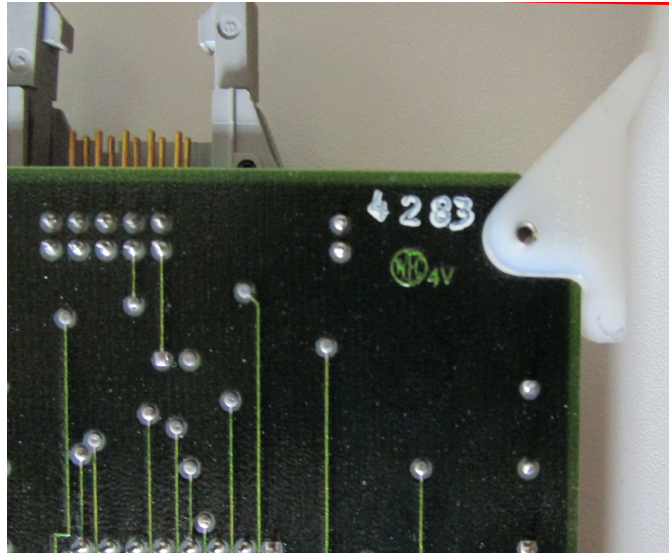
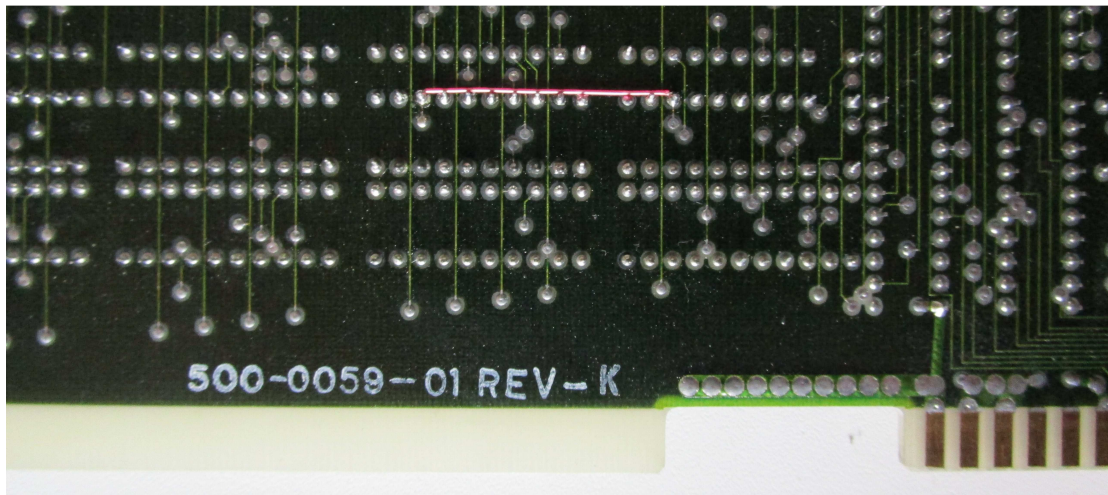


Figure 72: Pre-production SUN-1 Workstation Graphics board 4 manufacturing label
"Rev-D 270-0059-02
SUN Graphics
SUN Microsystems Inc
C 1982 SMI
, T-S 1-12-24"



*Figure 73: Pre-production SUN-1 Workstation Graphics board 4 manufacturing label
Marking: "283"*



*Figure 74: Pre-production SUN-1 Workstation Graphics board 4 manufacturing label
Marking: "500-0059-01 Rev-K"*

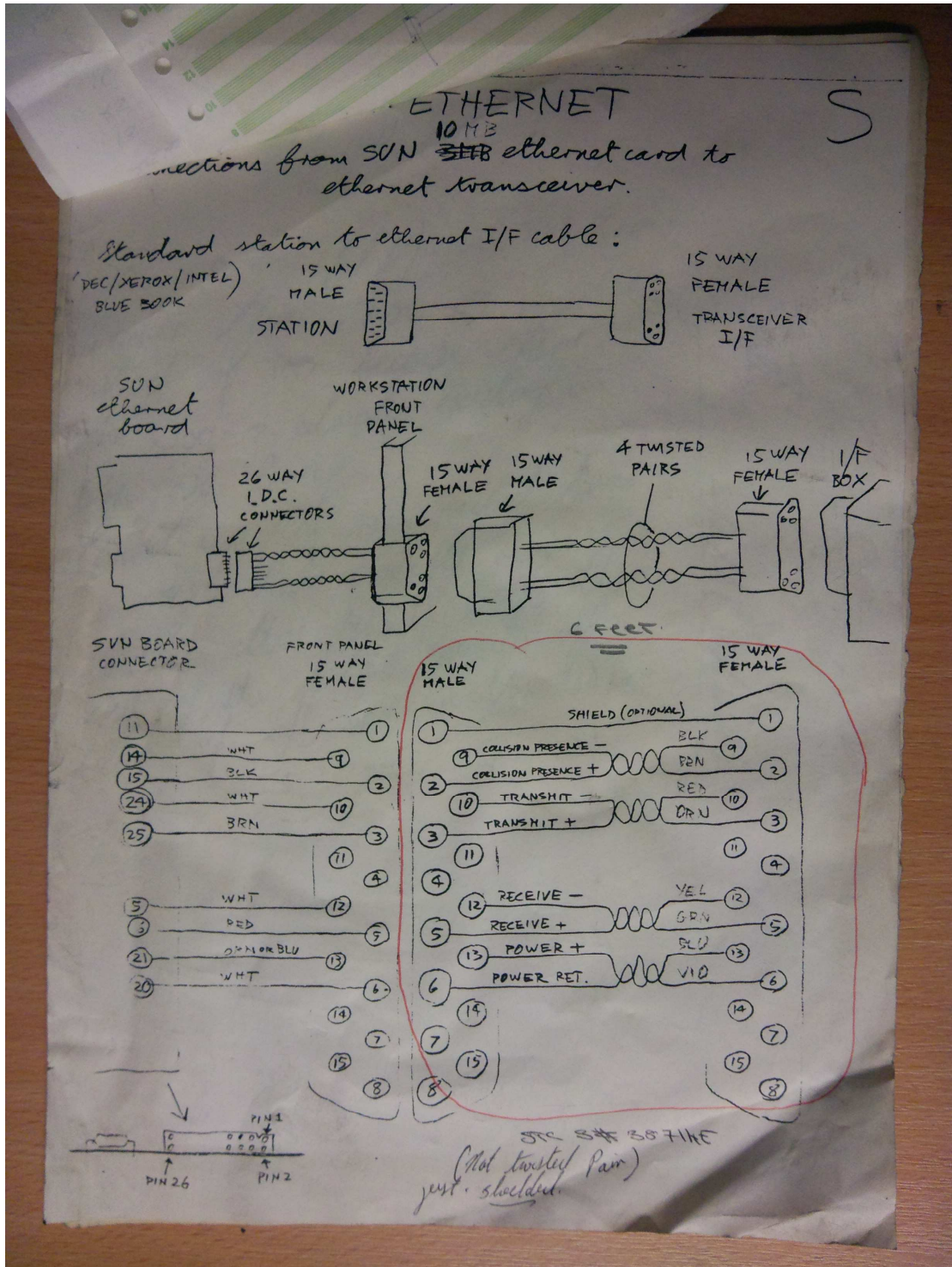


Figure 75: Pre-production SUN-1 Workstation 3Mbps Ethernet wiring at TCD
 Note update from 3Mbps to 10Mbps Ethernet
 (handwriting appears to be that of Dr.Neville Harris)



*Figure 76: 3Mbps Ethernet cabling at Dept. Computer Science, TCD
Photo courtesy Mike Nowlan*