AccessionIndex: TCD-SCSS-T.20250916.002
Accession Date: 16-Sep-2025
Accession By: Dmitry Grinberg and Dr.Brian Coghlan
Object name: Linux/4004 board
Vintage: 2025
Synopsis: A replica of the board that hosted the epic first successful boot of Linux on the 4004, the first commercially successful microprocessor.

Description:
This very ambitious project [1] to boot Linux on the Intel 4004 was undertaken by Dmitry Grinberg over an astonishingly short seven month period.

Of the first clutch of microprocessors, only two became standard commercially available products: the Intel 4004 and the Fairchild PPS-25. The Intel 4004 [2] was the world's first commercially successful microprocessor, designed by Federico Faggin, Masatoshi Shima, Ted Hoff and Stan Mazor. To Faggin must go much of the plaudits, for using the silicon gate technology (SGT) he had invented at Fairchild, and for inventing how to use buried contacts and bootstrap loads with SGT, halving chip size and increasing yields. On 15th November, 1971, Intel published the now-famous advertisement in Electronic News (Fig.1), for many beginning the microprocessor age [3][4]. The chipset, marketed as *MCS-4* (see [5] and Fig.2) consisted of:

4001	256 x 8 ROM plus 4-bit I/O port
4002	80 x 4 RAM plus 4-bit output port
4003	10-bit parallel output shift register
4004	4-bit microprocessor
4008	8-bit memory address latch plus I/O port
4009	memory and I/O converter

The MCS-4 design details are well known and will not be repeated here. Suffice to say that the 4-bit 4004 contained just 2300 transistors (Figs.3-4) and executed instructions in 10.7µS with a 750kHz two-phase clock. From Dmitry's website [1]:

> I booted Debian Linux on a 4-bit intel microprocessor from 1971 - the first microprocessor in the world - the 4004. It is not fast, but it is a real Linux kernel with a Debian rootfs on a real board whose only CPU is a real intel 4004 from the 1970s.
> …
> Of course, Linux cannot and will not boot on a 4004 directly. … So, same as before, I would have to resort to emulation. … After studying the options, it became clear that MIPS R3000 would be the winner here.
> …
> I have never before seen a CPU that lacked ability to do basic logical operations, until I saw the 4004 manual. The 4004 lacks ability to do any of them. There is no logical AND, no logical OR, and no XOR.
> …
> It was all worth it though! The boot time dropped to 4.81 days! … Avoiding checks for need to sign-extend and for size loops added a small additional speed benefit: 4.76 days to boot!

For the full flavour of this *tour de force*, this amazing feat, the reader is encouraged to delve into [1] and peruse the photos of this item shown in Figs.5-10.

Many thanks to Dmitry Grinberg and Brian Coghlan for donating this item.

The homepage for this catalog is at: https://www.scss.tcd.ie/SCSSTreasuresCatalog/
Click *'Accession Index'* (1st column listed) for related folder, or *'About'* for further guidance.
Some of the items below may be more properly part of other categories of this catalog,
but are listed here for convenience.

Accession Index	Object with Identification
TCD-SCSS-T.20250916.002	Linux/4004 board. A replica of the board that hosted the epic first successful boot of Linux on the 4004, the first commercially successful microprocessor, 2025.
TCD-SCSS-T.20250916.001	Intel 4004 and 4040 microprocessors and associated chips. The first commercially successful microprocessors. 1971.
TCD-SCSS-T.20251216.004	Arduino shield for Intel 4040. A board that enables execution of software by the 4040, 2025.
TCD-SCSS-X.20250916.001	Dr.Brian Coghlan's Collection of Early Microprocessors. An extensive and nearly complete set of unused 1970s microprocessor chips, most accompanied with documentation, some with demonstration boards. 1971.

References:

1. Dmitry Grinberg, *Linux/4004*, see:
   https://dmitry.gr/?r=05.Projects&proj=35.%20Linux4004
   Last browsed to on 16-Sep-2025.
   Also: https://www.scss.tcd.ie/SCSSTreasuresCatalog/hardware/TCD-SCSS-T.20250916.002/Linux-on-the-Intel-4004-DmitryGrinberg-16Sep2025-Word2025.pdf

2. Wikipedia, *Intel/4004*, see:
   https://en.wikipedia.org/wiki/Intel_4004
   Last browsed to on 16-Sep-2025.

3. Federico Faggin, *Silicon, From the Invention of the Microprocessor to the New Science of Consciousness*, pp.304, ISBN: 978-1949003413, Waterside Productions, USA, 8th February, 2021.

4. RobWalker, *Interview of Federico Faggin*, 9th June, 1998, see:
   https://www.scss.tcd.ie/SCSSTreasuresCatalog/hardware/TCD-SCSS-T.20250916.001/Interview-of-FedericoFaggin-byRobWalker-9Jun1998.pdf
   Last browsed to on 16-Sep-2025.

5. Intel, *Intel MCS-4 User's Manual*, see:
   https://www.scss.tcd.ie/SCSSTreasuresCatalog/hardware/TCD-SCSS-T.20250916.001/Intel-MCS4-UsersManual-OCR.pdf
   Last browsed to on 16-Sep-2025.

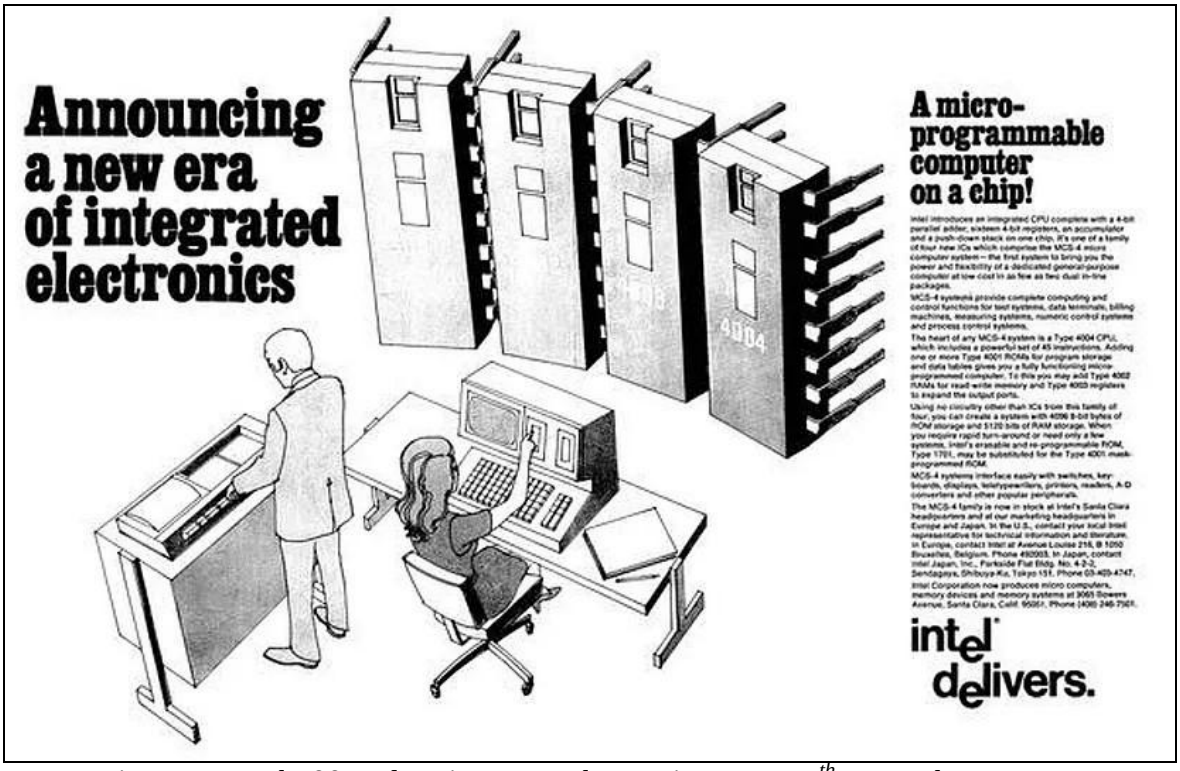

Figure 1: Intel 4004 advertisement, Electronic News, 15th November, 1971.

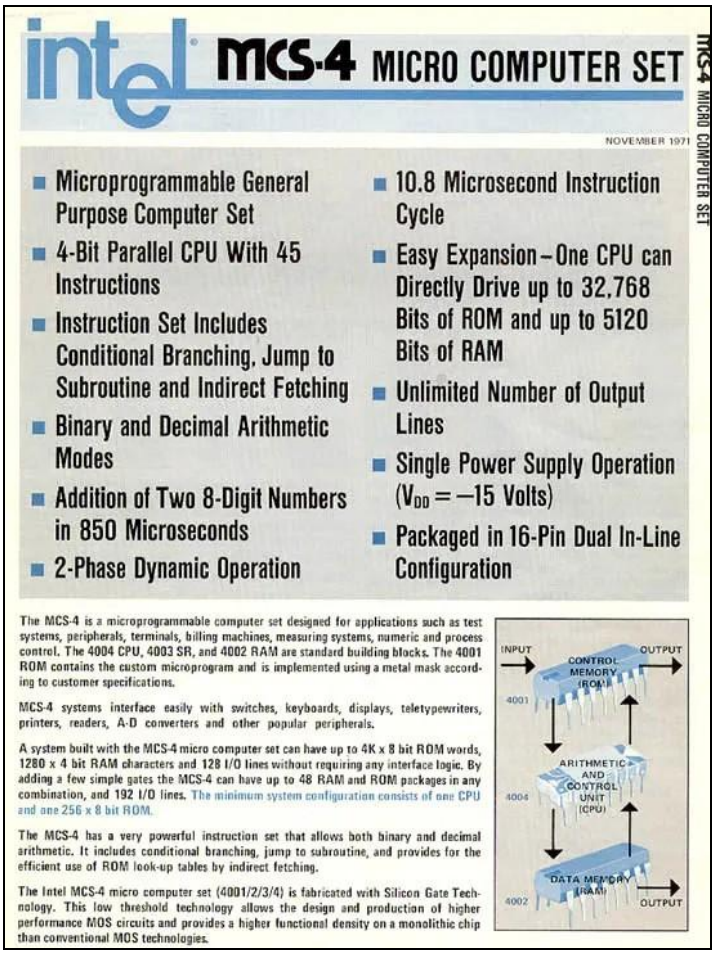

Figure 2: Intel MCS4 specification, November 1971.

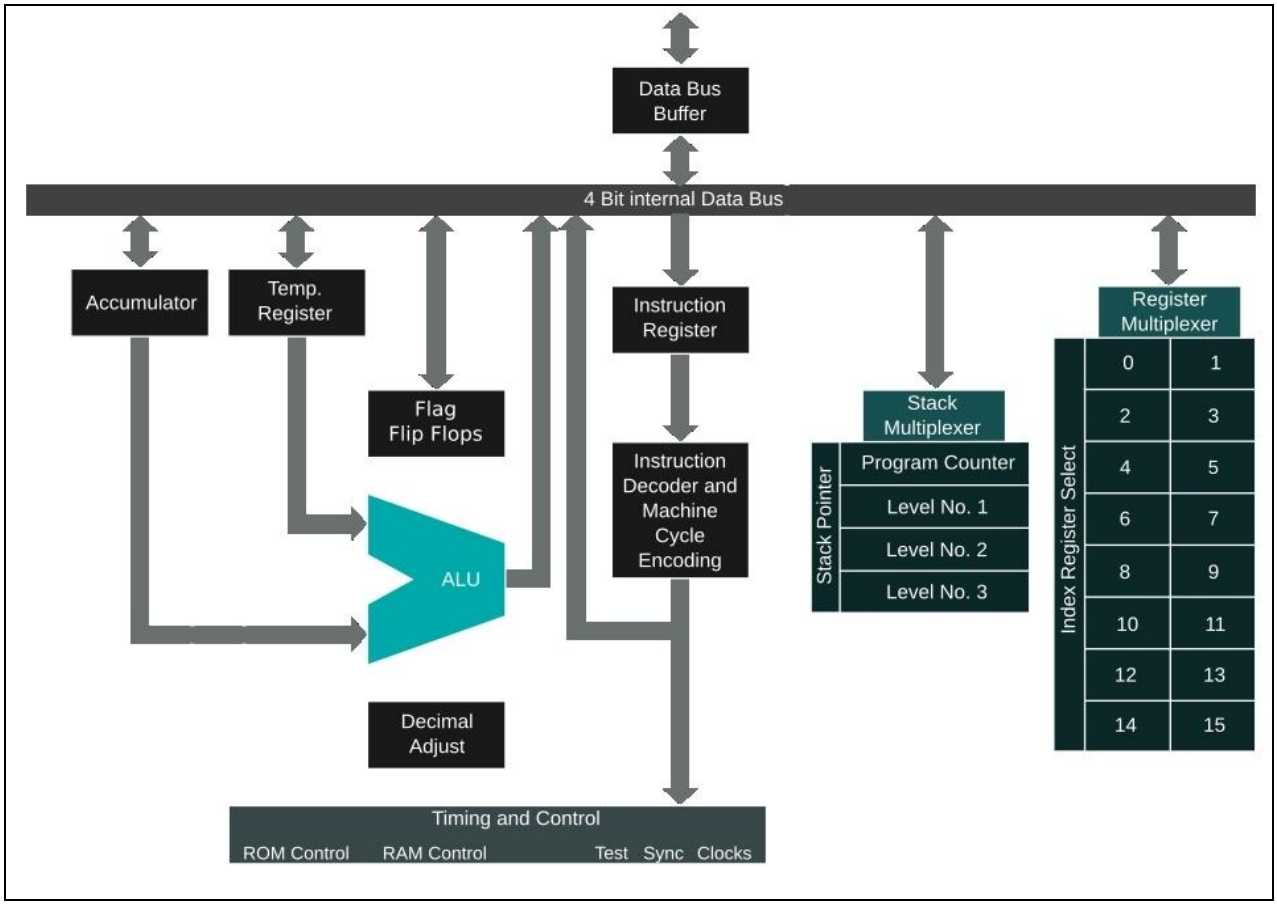

Figure 3: Intel 4004 architecture (from Wikipedia).

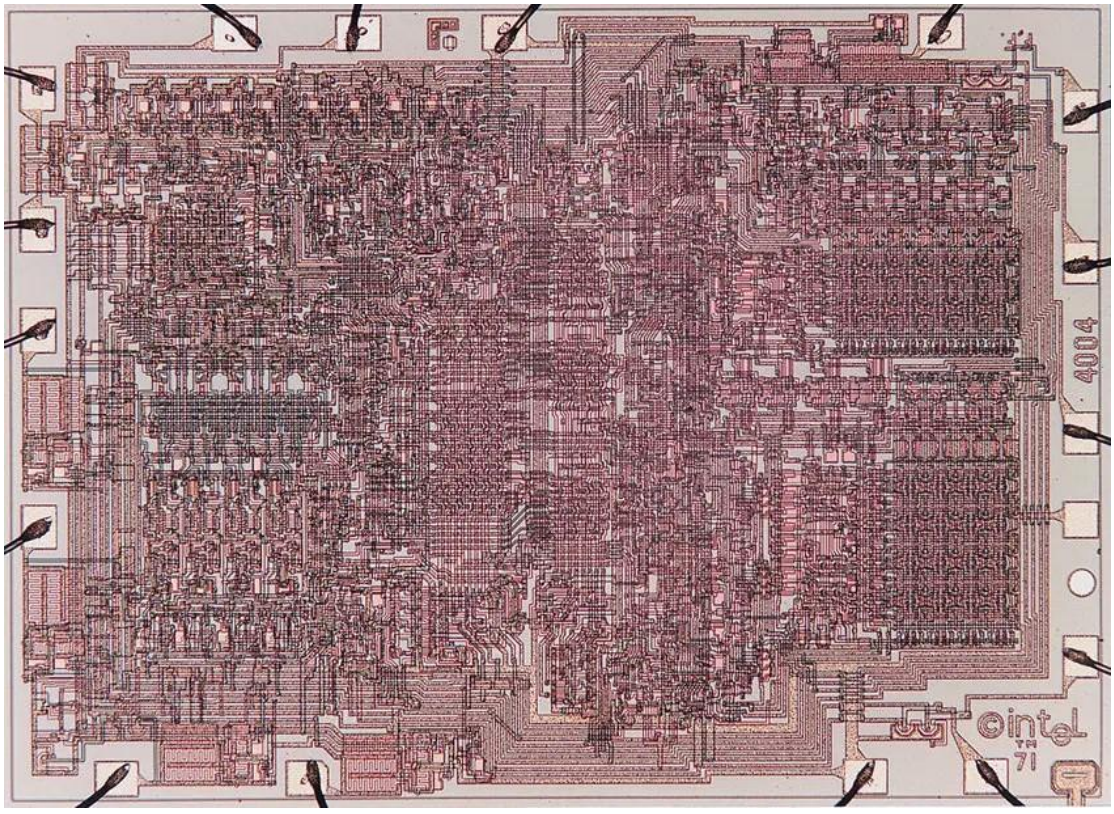

Figure 4: Intel 4004 chip die micrograph.

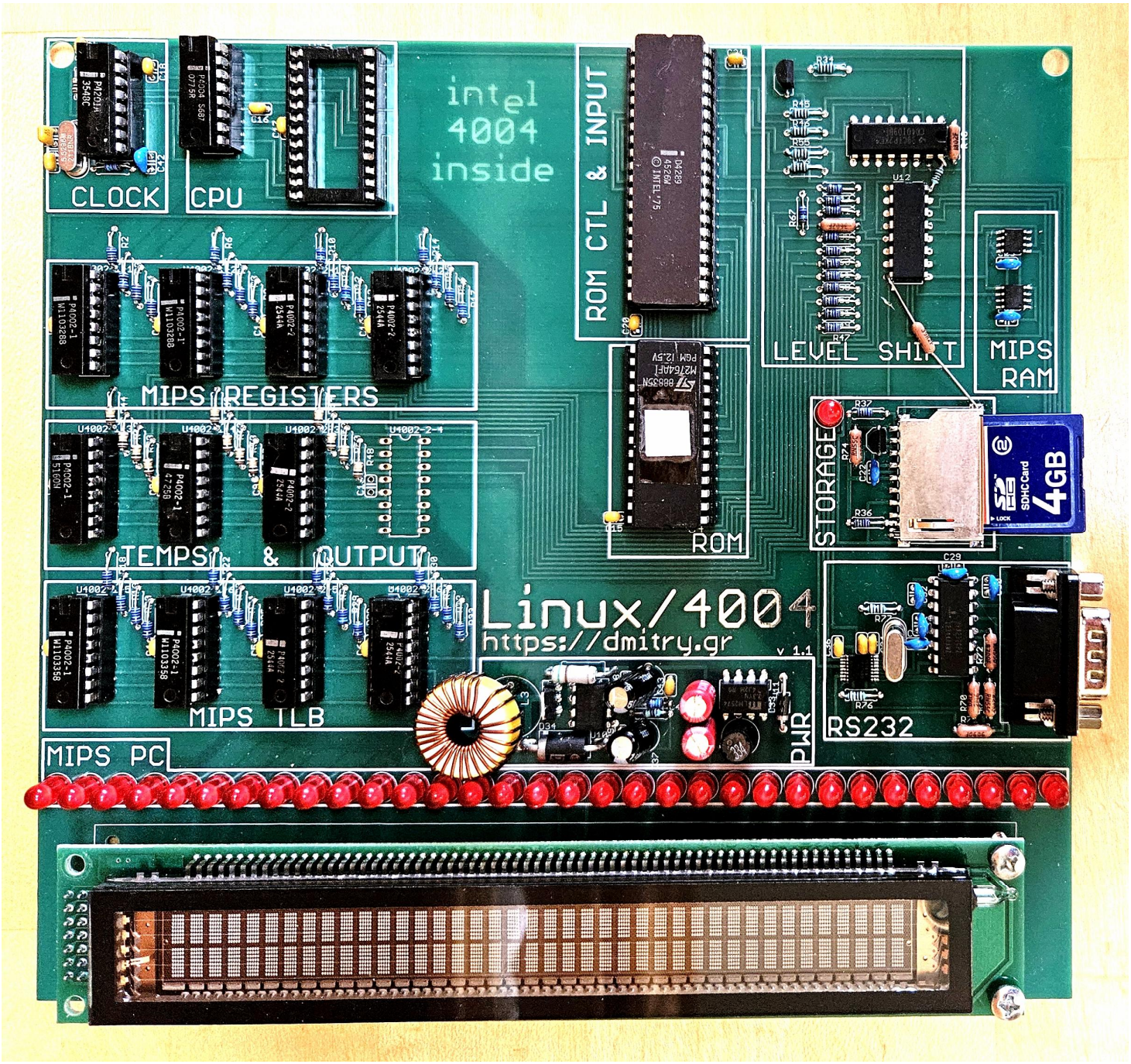

Figure 5: Linux/4004 front view.

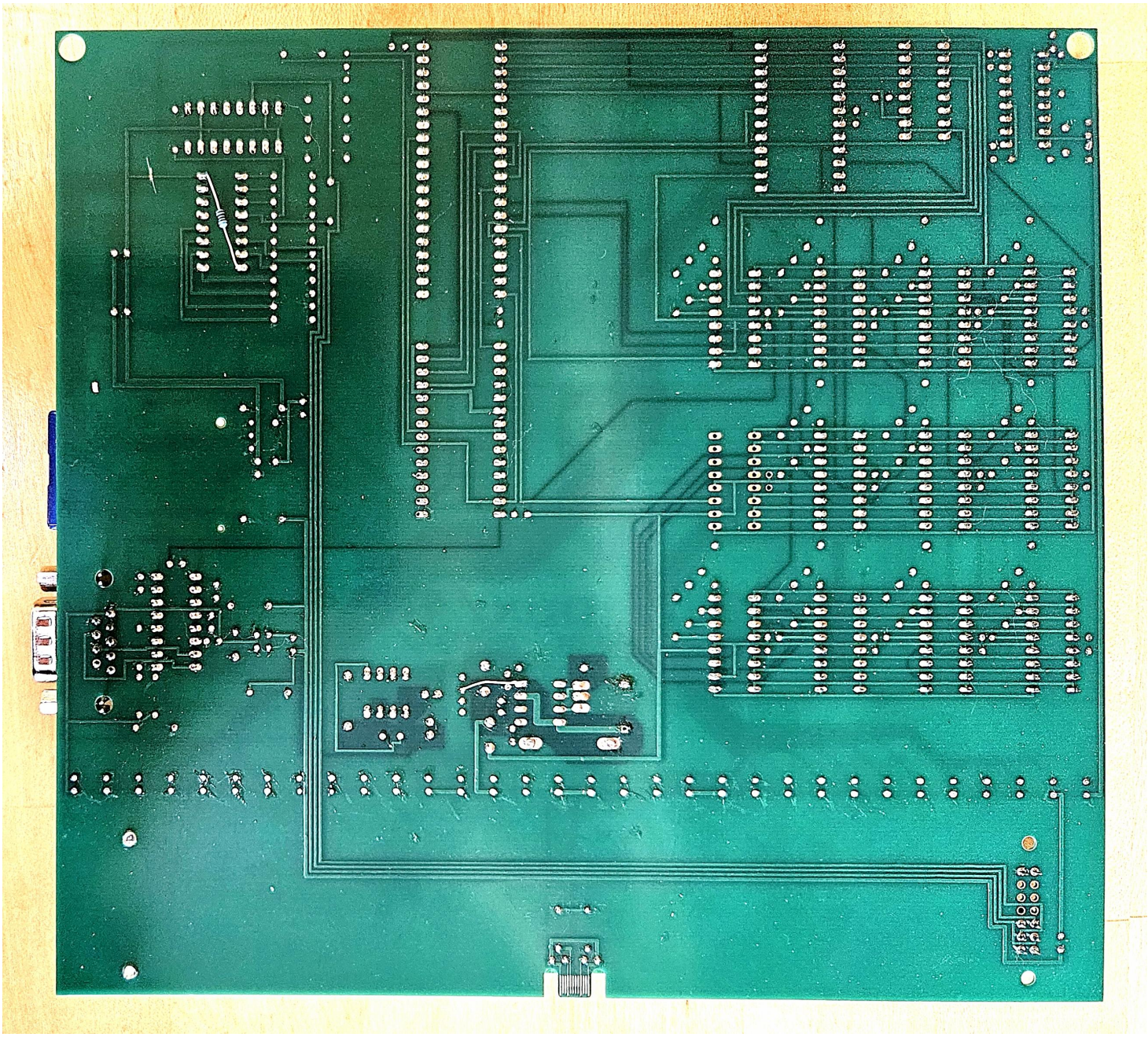

Figure 6: Linux/4004 rear view.

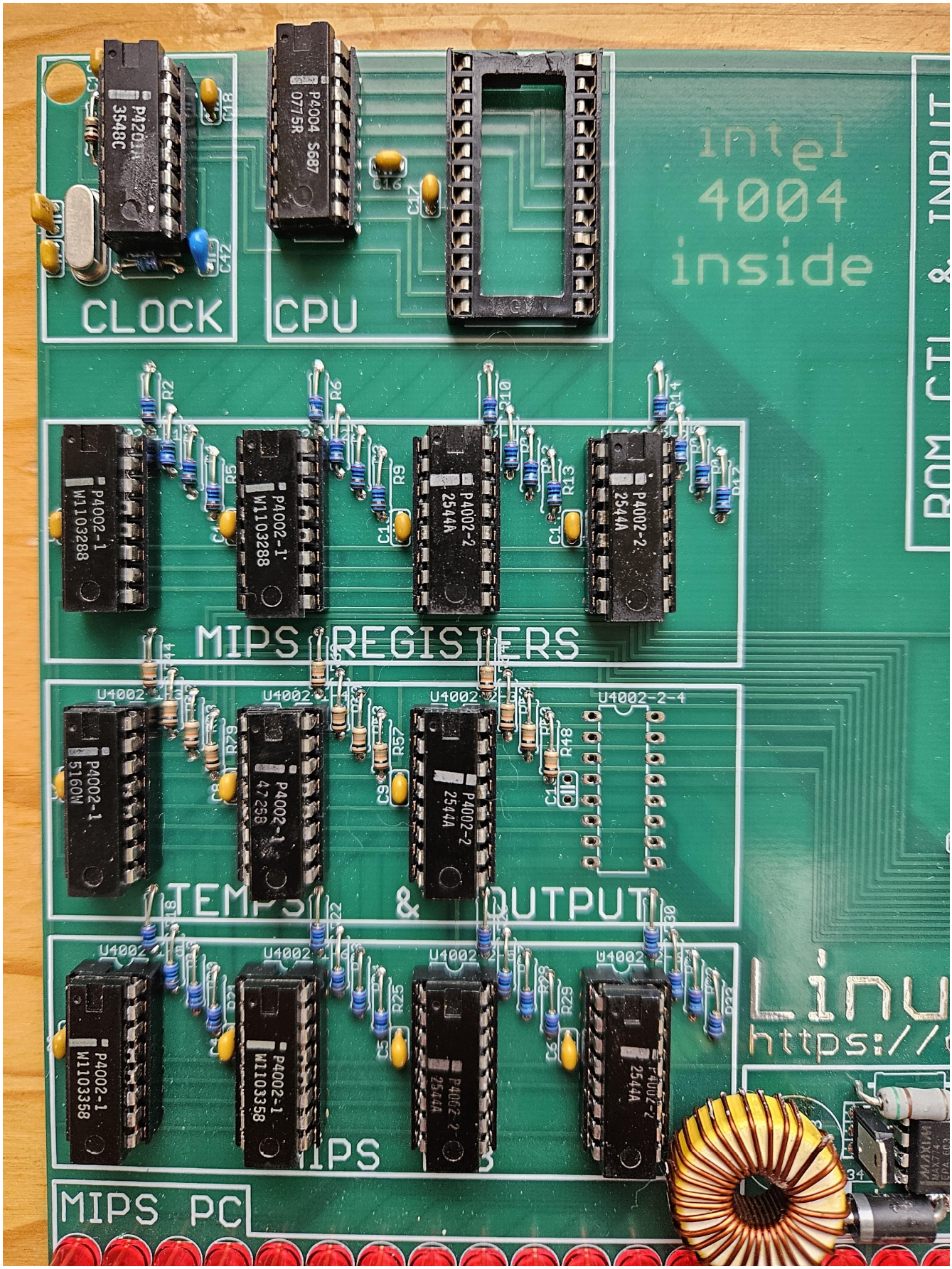

Figure 7: Linux/4004 front top-left closeup view.

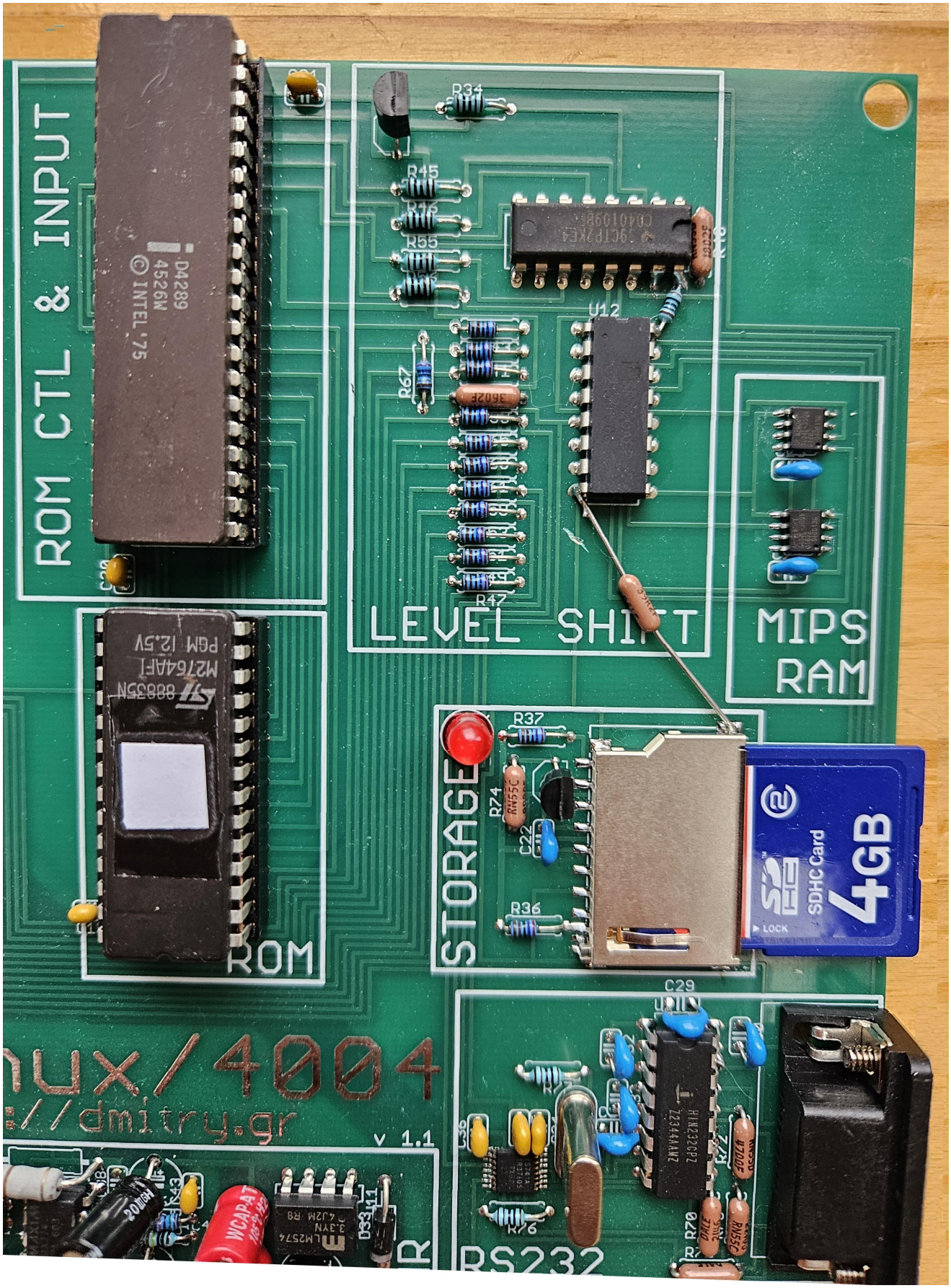

Figure 8: Linux/4004 front top-right closeup view.

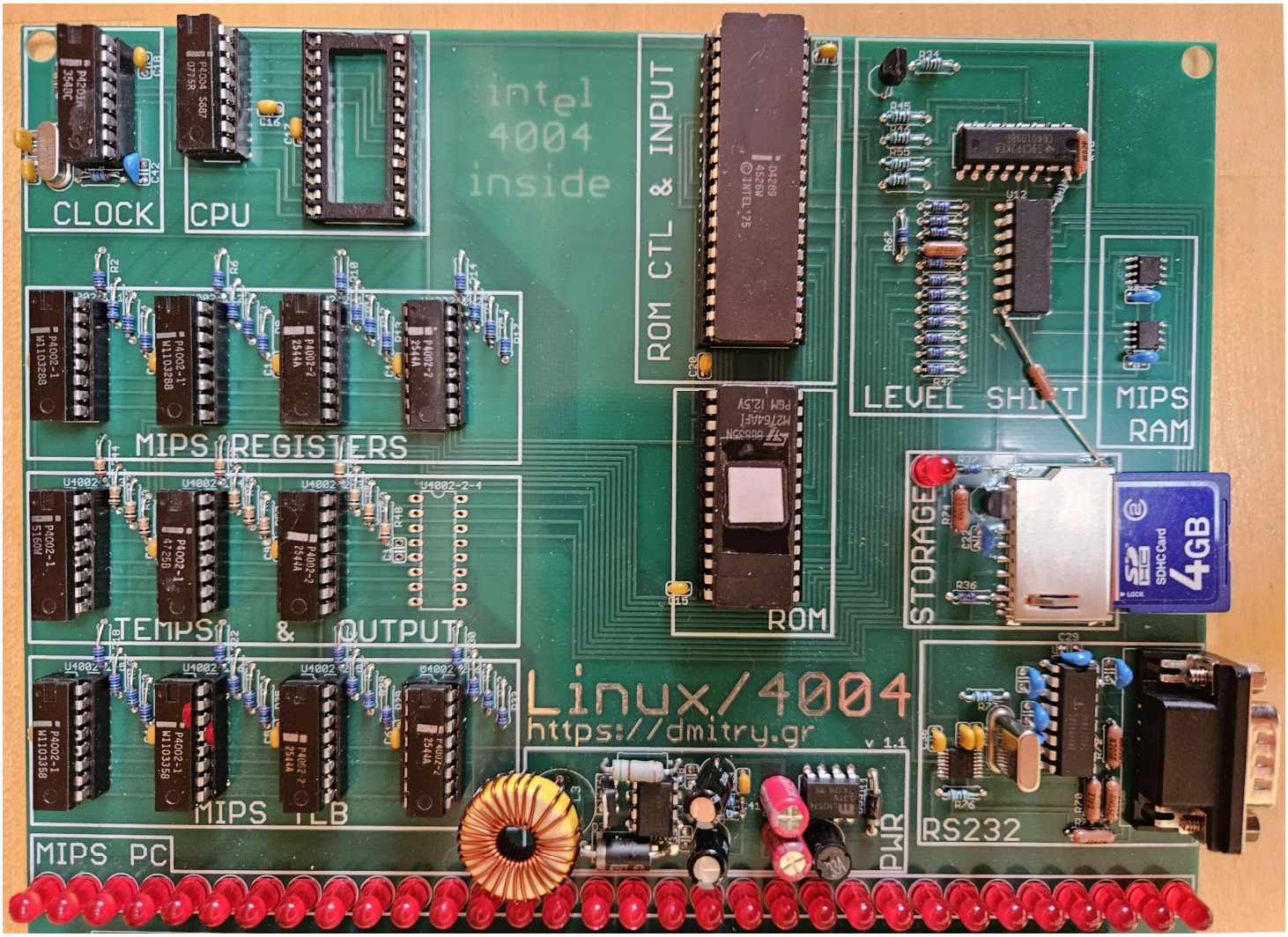

Figure 9: Linux/4004 upper front closeup view.

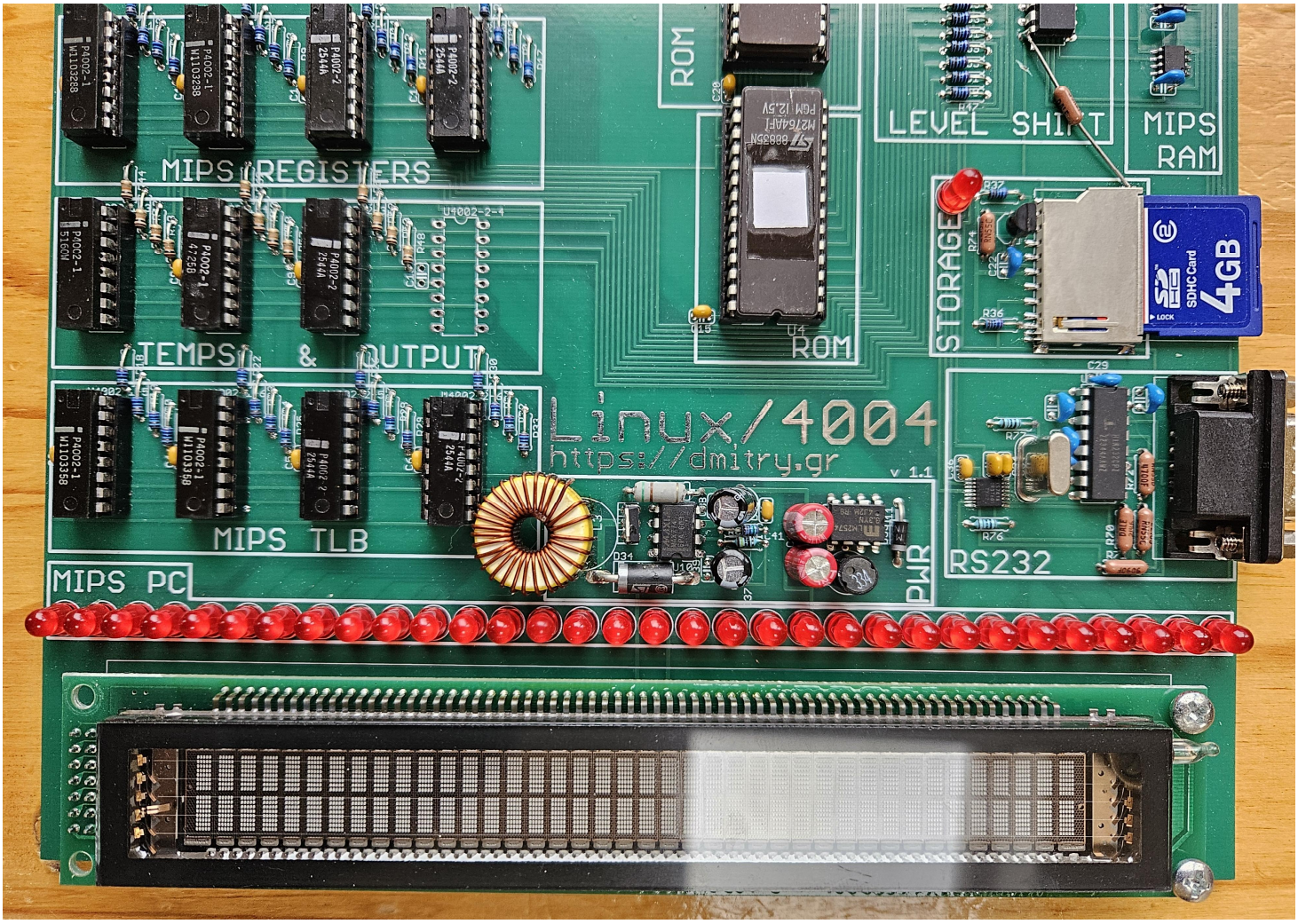

Figure 10: Linux/4004 lower front closeup view.