AccessionIndex: TCD-SCSS-T. 20250916.001
Accession Date: 16-Sep-2025
Accession By: Dr.Brian Coghlan and Erturk Kocalar
Object name: Intel 4004 and 4040 microprocessors and associated chips
Vintage: 1971
Synopsis: The first commercially successful microprocessors.

Description:
Over the years there was debate over who invented the first microprocessor in the face of two patents from Intel and Texas Instruments, eventually leading to a court case that resolved that these patents be invalidated and Lee Boysel be recognised as the inventor, a decision that is now widely accepted, see Fig.4 of the History of the Early Ideas of Computers. Nevertheless it is undeniable that Intel's 4004 [1] was the first commercially successful microprocessor.

From [2]:

Starting in 1968 a young engineer at Busicom, Masatoshi Shima, worked on the design of Busicom's first calculator with printed output, the Busicom 141-PF. Due to the pressure for rapid development, Shima's supervisor, Tadashi Tanba, using his experience while working at the advanced computer manufacturer Control Data Corporation, had started a design based on a programmed approach using computer software technology with desktop calculator hardware. This would allow easy changes to be applied to alter the specification of the calculator or control other products in their business product line.

Shima, who had some programming experience, took this "computer system" approach further and produced a design for the 141-PF incorporating arithmetic units (adders), multiplier units, registers, read-only memory, and he even defined the macro-instruction set to control this decimal computer system.

Tadashi Sasaki was an executive for Sharp Corporation, a major manufacturer of electronic calculators, and had had a good working relationship with Bob Noyce of Fairchild Semiconductor Corporation, the U.S. integrated circuit manufacturer. In 1968 Noyce left Fairchild to start up Intel Corporation with Gordon Moore, and shortly afterwards visited Sasaki at Sharp in Japan to try to sell Intel's integrated circuits. Unfortunately, Sharp was contracted to Rockwell for the exclusive supply of calculator integrated circuits so no business with Intel was possible.

However, Sasaki had graduated from the same university department as Yoshio Kojima, the president of the up and coming Busicom Corporation, and so felt empathy for Kojima and his company, which was struggling financially. This resulted in Sasaki, as an executive of the large Sharp Corporation, offering some technical assistance to the much smaller Busicom, a business situation that was allowed in Japan. However, working behind the scenes, Sasaki went a step further and offered finance to Busicom on the condition that it contracted Intel Corporation to develop the integrated circuits for Masatoshi Shima's "computer system" design for the 141-PF calculator.

In 1969 Masatoshi Shima was one of three Busicom employees who traveled from Japan to Intel in the U.S.A. with details of the proposal for the integrated circuits for the 141-PF and other advanced calculators, which would differ just by the contents of the instructions in the ROM (Read-Only Memory) chips.

Intel put Marcian E. "Ted" Hoff in charge of the project with the assistance of Stanley Mazor, another engineer.

There was little progress in the first year of the project. Intel knew little about calculator electronics and how to use the proposed line printer, and was not very enthusiastic about developing the proposed integrated circuits. Also it considered that for its small development staff there were too many chips required, the designs were too complicated and required non-standard packaging with large numbers of pins, and they had enough to do working on the RAM (Random-Access Memory) chips that were Intel's principal product and were starting to sell well.

Hoff had been working with a DEC PDP-8 computer and appreciated its RISC (Reduced Instruction Set Computer) architecture which simplified the electronics at the expense of a bigger memory for the larger program required. And, happily, Intel was a memory chip manufacturer.

Hoff proposed a much simplified system using a few standardised chips employing a limited instruction set so that different combinations of the simple instructions could be used for different actions such as reading the keyboard and driving the printer. Use of a small chipset to produce a computing system was actually something that had been foreseen by many in the computing and semiconductor industries for some time, but Intel had the manufacturing capability and here was a specific proposal.

Intel was in two minds. On the positive side there would be much less chip development required for Hoff's proposal than Busicom's proposal, but it still did not really have the development staff available, and would it make any money after the development costs for a small production run of specialised chips for one company?

For some months Shima and Hoff continued to work on their different designs at Intel. However, in October 1969, Busicom executives visited Intel and they were given presentations on the two proposals. The Busicom executives decided to go with Hoff's proposal, perhaps somewhat surprisingly since they would have been expected to favour their in-house proposal.

Since Hoff's design was to go ahead Shima dropped the work he had been doing and started to work on Hoff's design, and then went back to Japan at the end of 1969 to finish the programming and produce the documentation. When Shima returned to Intel in April 1970 to check on how the development was progressing he was aghast to find that nothing further had been done. Hoff had been moved from this job to the development of another central processing unit for an intelligent terminal for Computer Terminal Corporation. This cpu would become the very successful Intel 8008.

In March 1970 Intel poached Frederico Faggin from Fairchild to design the chips by December. When two days later Shima returned to Intel to check on progress he was appalled. Faggin began the heroic effort, with assistance from Shima, to complete the design. To Faggin must go much of the plaudits, for using the silicon gate technology (SGT) he’d invented at Fairchild, and for inventing how to use buried contacts and bootstrap loads with SGT, halving chip size and increasing yields. The first faulty samples were corrected by January 1971, and delivery to Busicom began in March 1971.

Busicom then found its 4004-based 141-PF calculator progressively less competitive against designs using medium-scale (e.g. TTL) chips, which were falling in price. This was overcome by negotiating a reduced price per chipset in exchange for allowing Intel to sell the chipset to the general market. Thus on the 15th November, 1971, Intel published the now-famous advertisement in the Electronic News, see Fig.2, for many the accepted beginning of the microprocessor age [3][4].

The chipset, marketed as *MCS-4* (see [5] and Fig.3) 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	microprocessor
4008	8-bit memory address latch plus I/O port
4009	memory and I/O converter

Federico Faggin, to overcome Intel’s preference for small/cheap dual-inline packages (DIP), which had constrained the 4004 to a 16-pin DIP, proposed an expansion of the 4004 to a modest 24-pins, formulated the architecture (see Fig.4) and led the design, supervising the detailed design by Tom Innes of what became the 4040 [6]. The extra pins enabled a doubling of the ROM space, interrupts (absent on the 4004), and halt/stop/single-step. The register set was roughly doubled and, the instruction set expanded from 46 to 60. The 4040 was introduced in 1974, with a more expansive chipset, and marketed as *MCS-40* [7], consisting of:

4040	microprocessor
3216	4-bit parallel bus driver
3226	4-bit parallel bus driver
4101	256 × 4-bit Static RAM
4201	Clock generator
4207	general purpose 8-bit output port
4209	general purpose 8-bit input port
4211	general purpose 8-bit I/O port
4265	programmable general-purpose I/O
4269	keyboard/display interface
4289	memory interface (merged 4008 + 4009)
4308	1K × 8-bit ROM
4316	2K × 8-bit ROM
4702	256 × 8-bit EPROM

Many thanks to Brian Coghlan and Erturk Kocala for donating these items.

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.20250916.001	Intel 4004 and 4040 microprocessors and associated chips. The first commercially successful microprocessors. 1971.
TCD-SCSS-T.20250916.001.01	Intel 4004 microprocessor. [Erturk Kocala]
TCD-SCSS-T.20250916.001.02	2 x Intel 4003 I/O interface.
TCD-SCSS-T.20250916.001.03	2 x Intel D4265 programmable general-purpose I/O.
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, S/N: ???, 2025.
TCD-SCSS-T.20250918.001	Intel 8008 microprocessor and associated chips. Intel's first and very early 8-bit microprocessor.
TCD-SCSS-T.20250918.003	Intel 8080 microprocessor and associated chips. Intel's second and very successful early 8-bit microprocessor. 1972.
TCD-SCSS-T.20250918.004	Intel 8086 microprocessor and associated chips. Intel's very successful early 16-bit microprocessor. 1978.
TCD-SCSS-T.20250918.005	Intel MCS-48 microcontrollers and associated chips. Intel's 8048, 8035 and 8748 microcontroller series. 1976.
TCD-SCSS-T.20250918.006	Intel MCS-48 microcontrollers and associated chips. Intel's 8051, 8052, 8751, 8752, 8031 and 8032 and 8044 microcontroller series. 1980.
TCD-SCSS-T.20250918.007	Zilog Z80 microprocessor and associated chips. Zilog's Z80 superset of the Intel 8080 microprocessor. 1976.
TCD-SCSS-T.20250919.001	Motorola MC14500 microprocessor and associated chips. A very interesting 1-bit microprocessor designed for industrial control applications. 1977.
TCD-SCSS-T.20250919.003	MOS Technology 6500 microprocessor and associated chips. A highly successful early 8-bit microprocessor family. 1975.
TCD-SCSS-T.20250919.005	Motorola 6800 microprocessor and associated chips. An early big-endian 8-bit microprocessor. 1974.
TCD-SCSS-T.20250919.007	Motorola 68000 microprocessor and associated chips. A complex instruction set big-endian 32-bit microprocessor. 1979.
TCD-SCSS-T.20250921.001	Signetics 2650 microprocessor. An early 8-bit microprocessor designed by John Kessler modelled on the IBM 1130. 1975.
TCD-SCSS-T.20250921.003	Signetics 8X300. An early 8-bit microprocessor designed by SMS for signal processing. 1975.
TCD-SCSS-T.20250922.001	Intel C3000 bit-slice chipset. Intel's bipolar microcoded bit-slice processor. 1973.
TCD-SCSS-T.20250922.002	AMD 2900 bit-slice chipset. AMD's very successful bipolar microcoded bit-slice processor. 1975.
TCD-SCSS-T.20250922.003	Monolithic Memories 6700 bit-slice chipset. A bipolar microcoded bit-slice processor. 1974.
TCD-SCSS-T.20251001.001	InMOS Transputers and associated chips. Very interesting

	parallel processing chips comprising RISC-style stack-oriented CPU, memory, 20Mbps serial links and a realtime embedded kernel based on CSP process calculus. 1984.
TCD-SCSS-T.20251002.001	Fairchild resistor-transistor (RTL) chips. First digital logic family to be produced as monolithic integrated circuits.
TCD-SCSS-T.20251002.002	Motorola diode-transistor (DTL) chips. Second generation of monolithic digital logic integrated circuits. 1962.
TCD-SCSS-T.20251002.003	Texas Instruments 7400 series transistor-transistor (TTL) chips. Medium-scale-integration (MSI) logic. 1963.
TCD-SCSS-T.20251002.004	UV-erasable programmable read-only memory (EPROM) chips. Non-volatile memory for software and data storage. 1971.
TCD-SCSS-T.20251002.005	Static random-access memory (SRAM) chips. Memory that does not require regular refresh.
TCD-SCSS-T.20251002.006	Dynamic random-access memory (DRAM) chips. Memory that requires regular refresh. 1970.
TCD-SCSS-T.20251002.007	Miscellaneous digital computer and logic chips. Sundry monolithic digital integrated circuits that are not members of the other chip families in this catalog. 197x.
TCD-SCSS-T.20251002.008	Miscellaneous analog chips. Sundry monolithic and hybrid analog integrated circuits. 197x.
TCD-SCSS-T.20251002.009	Programmable logic chips. PAL, GAL, etc, integrated circuits that provide programmable logic. 1978.
TCD-SCSS-T.20251003.001	Early calculator chips. Integrated circuits for early desktop and hand-held calculators. 1971.
TCD-SCSS-T.20251005.001	Fairchild PPS25 microprocessor and associated chips. Fairchild's first and very early 4-bit microprocessor. 1971.
TCD-SCSS-T.20251005.002	Fairchild F8 microprocessor and associated chips. Fairchild's earliest 8-bit microprocessor. 1975.
TCD-SCSS-T.20251006.001	National Semiconductor's COP microprocessors and associated chips. NatSemi's earliest microprocessors. 197x.
TCD-SCSS-T.20251006.002	National Semiconductor's SC/MP microprocessors and associated chips. NatSemi's earliest 8-bit microprocessors. 1976.
TCD-SCSS-T.20251006.003	National Semiconductor's 32000 series microprocessors and associated chips. NatSemi's 32-bit microprocessors, the first with virtual memory. 1981.

References:

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   https://en.wikipedia.org/wiki/Intel_4004
   Last browsed to on 16-Sep-2025.

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3. Frederico 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 Frederico Faggin*, 9th June, 1998, see:
   https://www.scss.tcd.ie/SCSSTreasuresCatalog/hardware/TCD-SCSS-T.20250916.001/Interview-of-FredericoFaggin-byRobWalker-9Jun1998.pdf
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   https://www.scss.tcd.ie/SCSSTreasuresCatalog/hardware/TCD-SCSS-T.20250916.001/Intel-MCS4-UsersManual-OCR.pdf
   Last browsed to on 16-Sep-2025.

6. Wikipedia, *Intel 4040*, see:
   https://en.wikipedia.org/wiki/Intel_4040
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7. Intel, *Intel MCS-40 User's Manual*, see:
   https://www.scss.tcd.ie/SCSSTreasuresCatalog/hardware/TCD-SCSS-T.20250916.001/MCS-40-Users-Manual-Nov74.pdf
   Last browsed to on 16-Sep-2025.

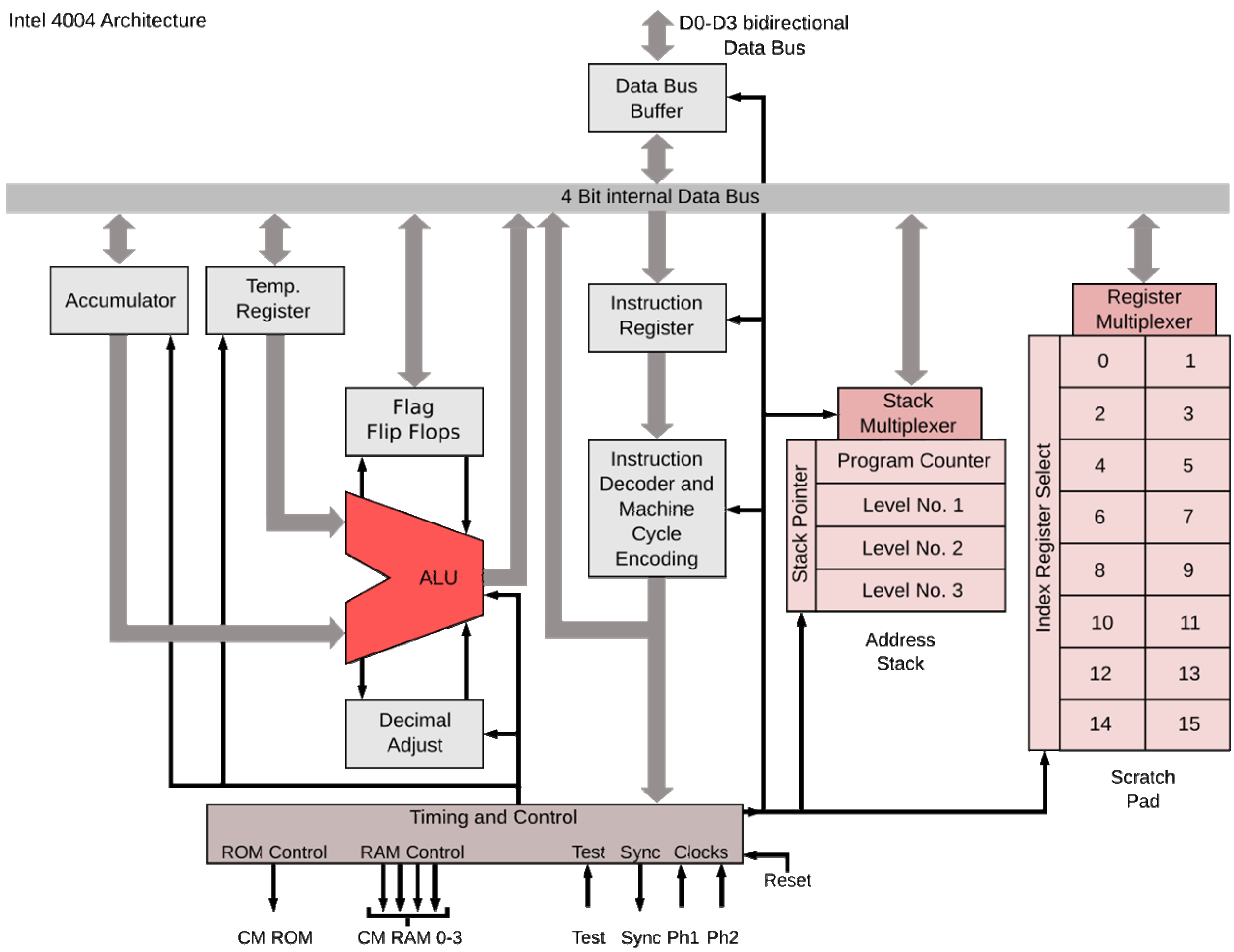

Figure 1: Intel 4004 architecture (from Wikipedia)

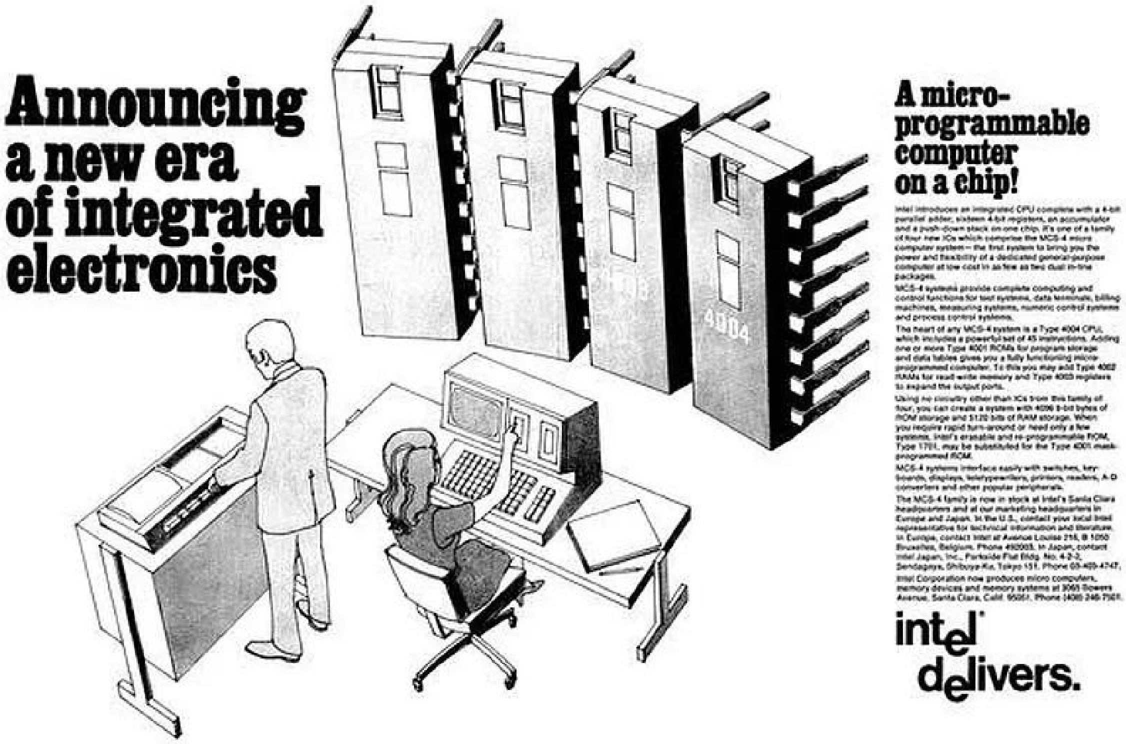

Figure 2: Intel 4004 advertisement, Electronic News 15-Nov-1971

intel MCS-4 MICRO COMPUTER SET

MCS-4 MICRO COMPUTER SET

NOVEMBER 1971

- Microprogrammable General Purpose Computer Set
- 4-Bit Parallel CPU With 45 Instructions
- Instruction Set Includes Conditional Branching, Jump to Subroutine and Indirect Fetching
- Binary and Decimal Arithmetic Modes
- Addition of Two 8-Digit Numbers in 850 Microseconds
- 2-Phase Dynamic Operation
- 10.8 Microsecond Instruction Cycle
- Easy Expansion – One CPU can Directly Drive up to 32,768 Bits of ROM and up to 5120 Bits of RAM
- Unlimited Number of Output Lines
- Single Power Supply Operation (V_{DD} = –15 Volts)
- Packaged in 16-Pin Dual In-Line Configuration

The MCS-4 is a microprogrammable computer set designed for applications such as test systems, peripherals, terminals, billing machines, measuring systems, numeric and process control. The 4004 CPU, 4003 SR, and 4002 RAM are standard building blocks. The 4001 ROM contains the custom microprogram and is implemented using a metal mask according to customer specifications.

MCS-4 systems interface easily with switches, keyboards, displays, teletypewriters, printers, readers, A-D converters and other popular peripherals.

A system built with the MCS-4 micro computer set can have up to 4K x 8 bit ROM words, 1280 x 4 bit RAM characters and 128 I/O lines without requiring any interface logic. By adding a few simple gates the MCS-4 can have up to 48 RAM and ROM packages in any combination, and 192 I/O lines. The minimum system configuration consists of one CPU and one 256 x 8 bit ROM.

The MCS-4 has a very powerful instruction set that allows both binary and decimal arithmetic. It includes conditional branching, jump to subroutine, and provides for the efficient use of ROM look-up tables by indirect fetching.

The Intel MCS-4 micro computer set (4001/2/3/4) is fabricated with Silicon Gate Technology. This low threshold technology allows the design and production of higher performance MOS circuits and provides a higher functional density on a monolithic chip than conventional MOS technologies.

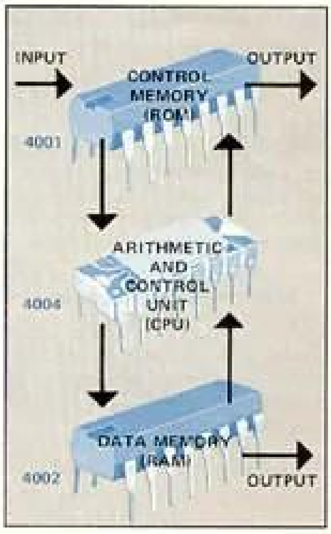

Figure 3: Intel MCS-4

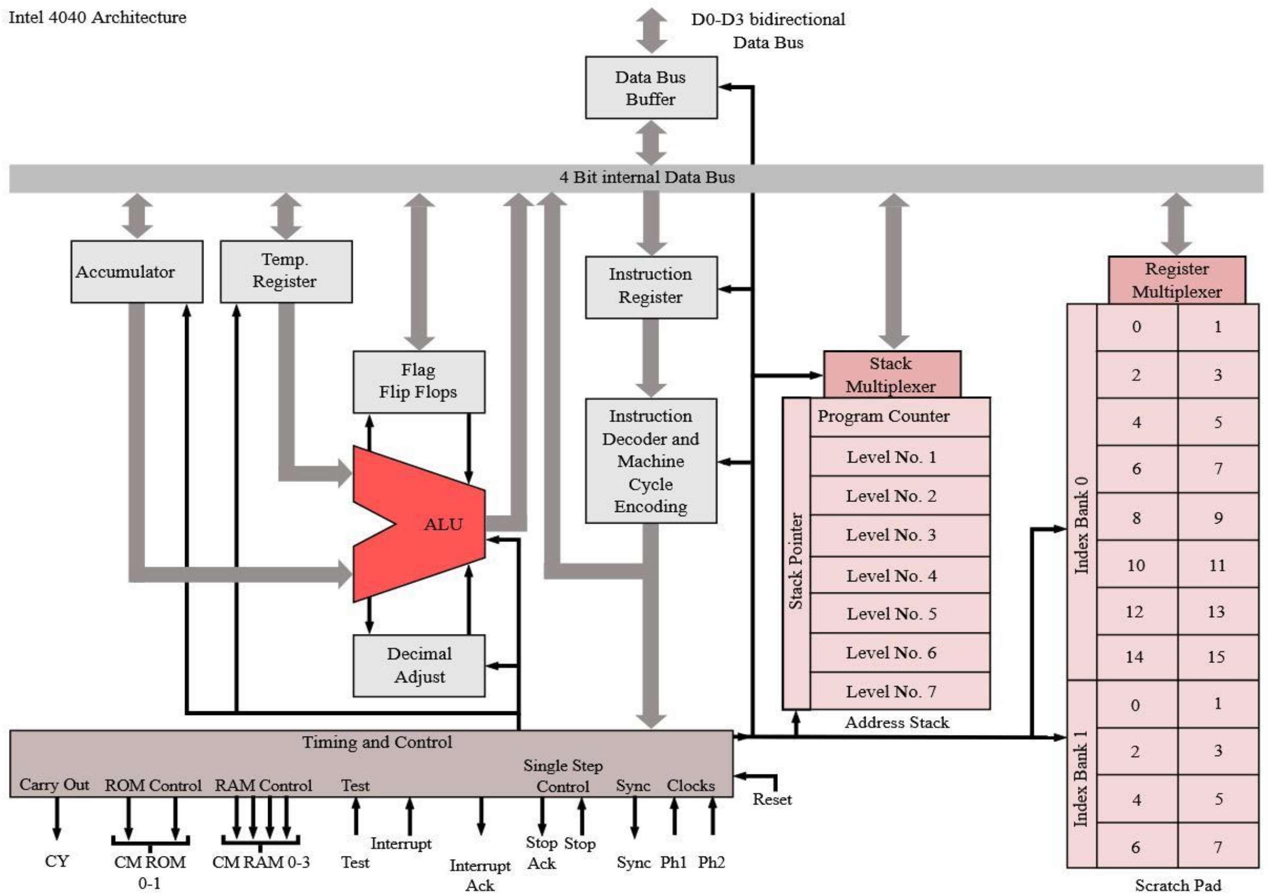

Figure 4: Intel 4040 architecture (from Wikipedia)

Figure 5: Intel 4004 and 2x 4003