AccessionIndex: TCD-SCSS-T.20250918.007
Accession Date: 18-Sep-2025
Accession By: Dr.Brian Coghlan
Object name: Zilog Z80 microprocessor and associated chips
Vintage: 1976
Synopsis: Zilog's superset of the Intel 8080 microprocessor.

Description:
The Zilog Z80 [1] was designed by Masatoshi Shima and Federico Faggin (who designed Intel's 4004 chips and led their 8008 and 8080 teams).

The design history of the Z80 is well known and undisputed [2]. Essentially when the 8080 was in design, Faggin, who was Intel's lead designer for silicon-gate technology (SGT, which he invented), became frustrated when Intel did not realise the potential of microprocessors, and did not respond to his suggested enhancements. So he and Intel's lead custom integrated circuit designer, Ralph Ungermann, resigned at the end of October, 1974, and set up Zilog as a pure microprocessor manufacturer, funded by Exxon Ltd. By the end of 1974 they had focussed on what became the Z80. Then Masatoshi Shima, who was an outstanding designer of random logic chips, joined them in February, 1975. The Z80 is almost entirely a random logic chip design, something that became anathema in the 1980s once computer-aided chip design tools began to perform well (Zilog's next-generation Z8000, designed by Shima, was probably the last CPU with random logic design). After two iterations the Z80 chip design was ready by November, 1975. First samples were fabricated by Mostek in March, 1976, and the Z80 was launched in July, 1976. Mostek was licensed to make their second source Z80, the MK3880.

The Z80 was designed to be binary compatible with Intel's 8080, which was a descendant of the 8008 (not binary compatible, but all 8008 instructions had matching 8080 instructions); the 8008 was a chip implementation of an architecture proposed by Datapoint (which they implemented in TTL as the Datapoint 2200). But the Z80 had an alternate register set for faster interrupt handling, two 16-bit index registers like Motorola's 6800, more register orthogonality, and also additional/enhanced instructions (e.g. shifts/rotates on memory and registers, subtraction of BCD numbers, rotates for packed BCD, relative branches, block copy, block I/O, etc). See [1] for a full list of additions/enhancements. Because Intel claimed copyright on their 8080 assembly mnemonics, Zilog developed a new more systematic syntax for the Z80. Zilog defined 158 "instruction types", 78 of which were as per the Intel 8080, and encoded 252 instructions as one byte opcodes, with the remaining 4 encodings as prefixes that allowed numerous permutations. There were several undocumented instructions, again see [1] for details.

The Z80 was designed for the then new nMOS process (but subsequently redesigned for CMOS), hence had just one 5V power supply and was TTL compatible. Internally it had a 4-bit ALU, so operations were done in two steps. It had a single-phase 5V 2.5MHz clock (gradually increasing to 50MHz in later versions). Instructions took between three and six clock periods. It had built-in DRAM refresh, non-multiplexed busses, plus non-maskable and vectored interrupts (that could be configured simply in a daisy-chain), so its expanded register set included a DRAM refresh counter register and an interrupt vector base register.

The Z80 had 16-bit (64kB) memory addressing, and 8-bit (256 ports) input/output-addressing, although for the latter the entire 16-bit address bus was activated, which could be exploited. Like the 8080, the Z80 had a separate control signal to select input/output. The Z80 input/output chips include:

Number	Type	Function
Z8410	DMA	direct memory access
Z8420	PIO	parallel input/output
Z8430	CTC	counter/timer channel
Z8440	SIO	serial input/output (synchronous or asynchronous)
Z8470	DART	dual asynchronous receiver/transmitter

All supported the Z80's interrupt handling mechanisms and I/O address space.

All of the above features were attractive. It was an extremely successful product, and it and its support chips were made by Zilog and numerous second sources, although it included layout traps (transistors that behaved differently than expected) to deter unlicensed copying. The Z80 continued to be made by Zilog for nearly 50 years.

Many thanks to Brian Coghlan for donating these items.

The homepage for this catalog is at: https://www.scss.tcd.ie/SCSSTreasuresCatalog/
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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.20250918.007	Zilog Z80 microprocessor and associated chips. Zilog's superset of the Intel 8080 microprocessor. 1976.
TCD-SCSS-T.20250918.007.01	2 x Zilog Z084C0010PEC Z80 microprocessor.
TCD-SCSS-T.20250918.007.02	1 x National Semiconductor NSC800N-4 Z80-compatible CPU.
TCD-SCSS-T.20250918.007.03	1 x Zilog Z0841004PSC DMA controller.
TCD-SCSS-T.20250918.007.04	2 x Zilog Z84C3006PEC CTC timer.
TCD-SCSS-T.20250918.007.05	2 x Zilog Z0844104PSC SIO/1 serial I/O.
TCD-SCSS-T.20250918.007.06	2 x Zilog Z8530 serial communications controller (SCC).
TCD-SCSS-T.20250918.007.07	2 x Toshiba TMPZ84C20AP-6 CMOS parallel input/output (PIO).
TCD-SCSS-T.20251216.007	Arduino shield for Zilog Z80. A board that enables execution of software by the Z80, Zilog's superset of the Intel 8080 microprocessor, 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. Wikipedia, *Zilog Z80*, see:
   https://en.wikipedia.org/wiki/Zilog_Z80
   Last browsed to on 18-Sep-2025.

2. Federico Faggin, *Silicon*, pp.304, ISBN: 978-1949003413, Waterside Productions, 2021, see:
   https://www.amazon.com.au/Silicon-Invention-Microprocessor-Science-Consciousness/dp/1949003418
   Last browsed to on 18-Sep-2025.

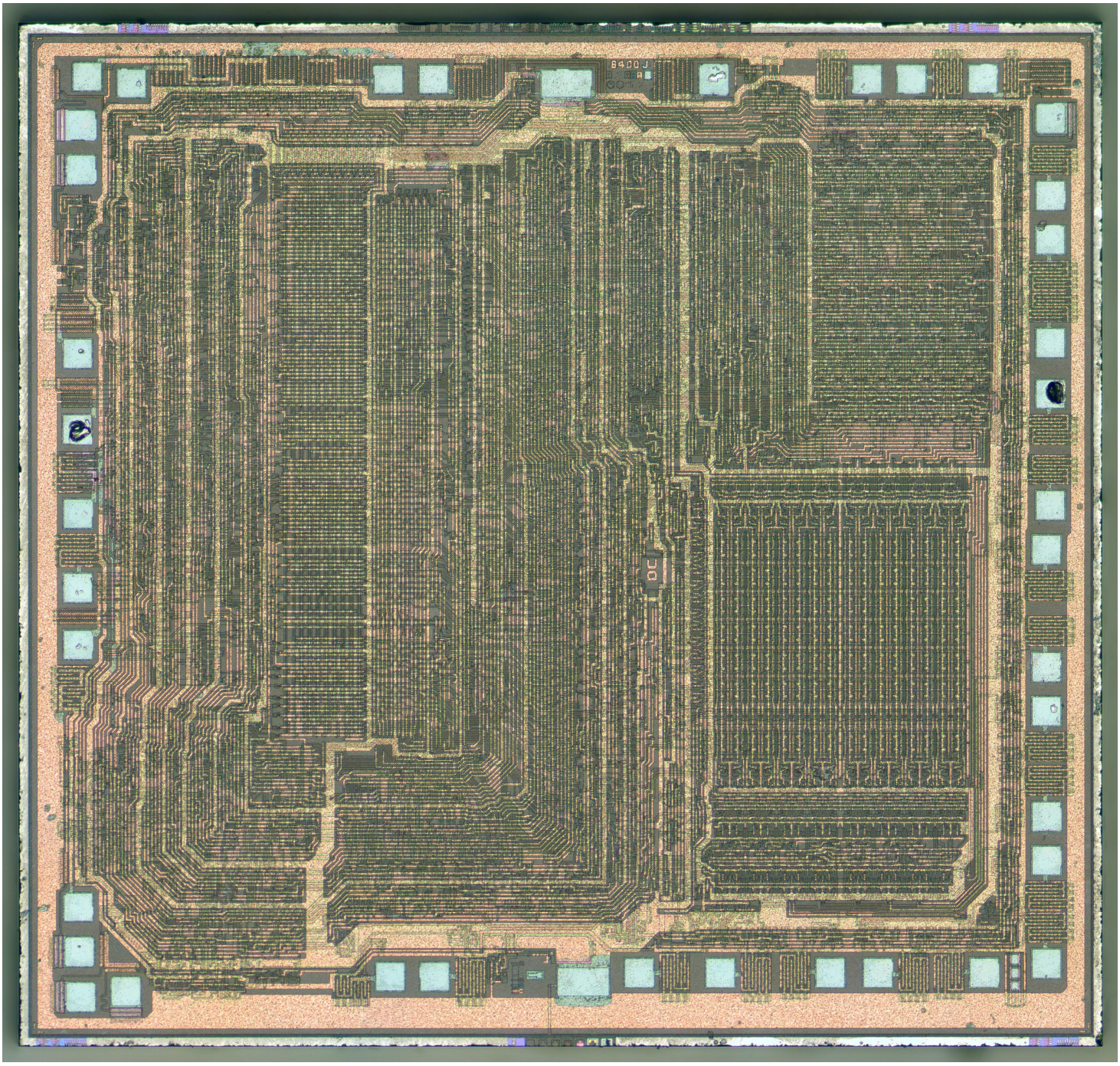

Figure 1: Zilog Z80 chip die micrograph (from Wikipedia).

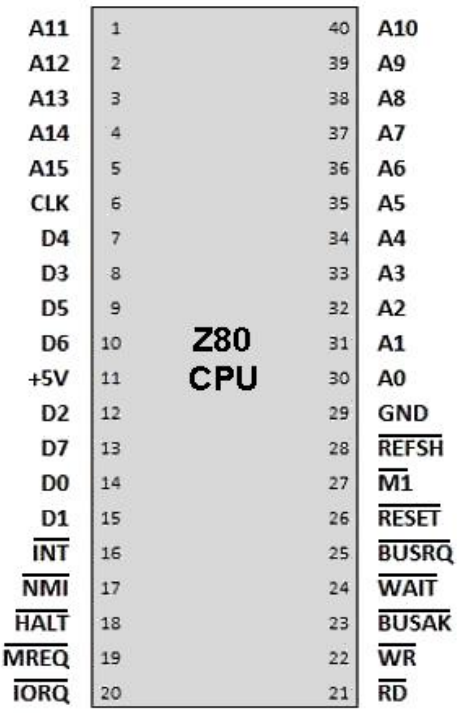

Figure 2: Zilog Z80 pinout.

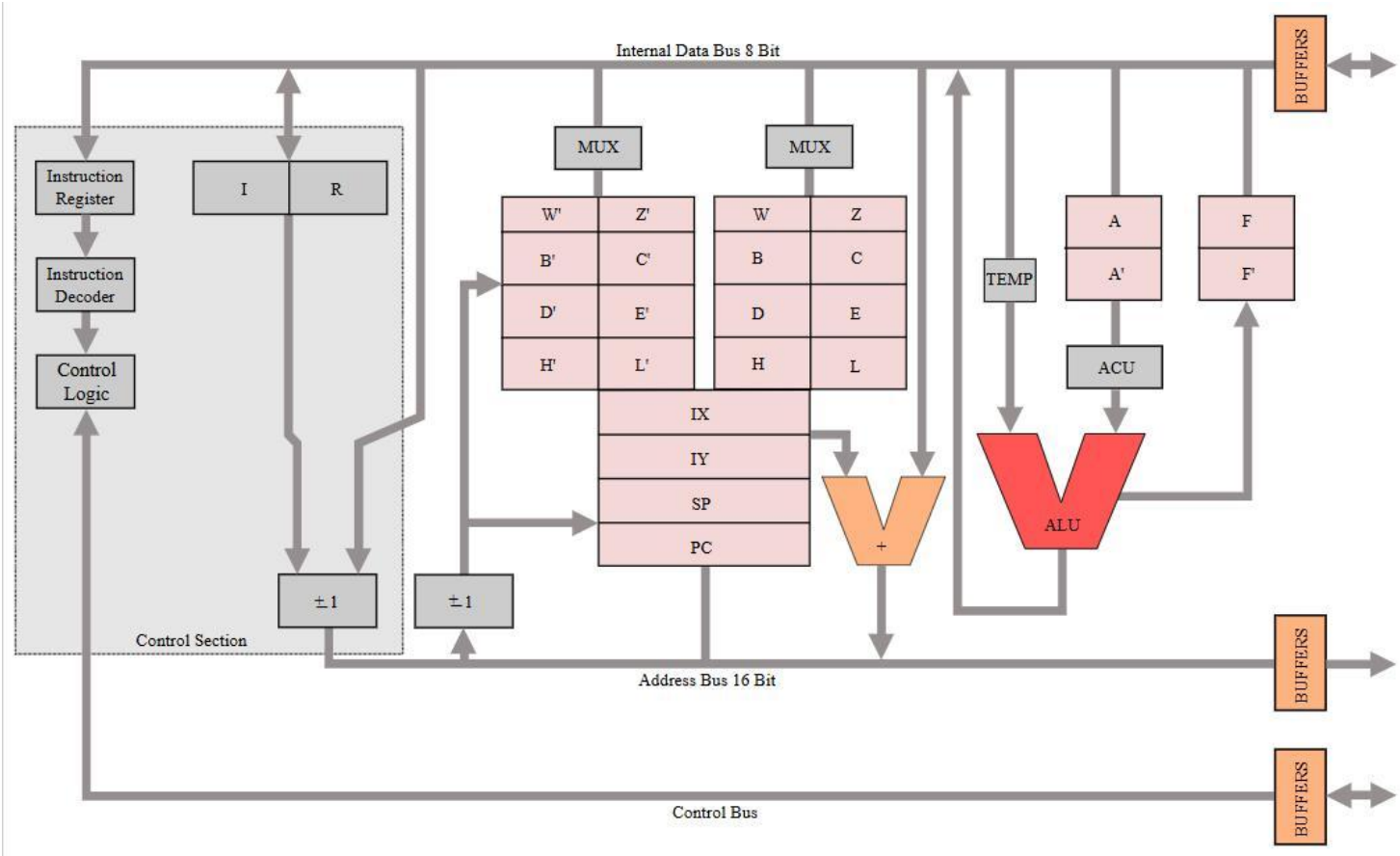

Figure 3: Zilog Z80 architecture (from Wikipedia).

Zilog Z80 registers

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	*(bit position)*

Main registers

Accumulator (A)	Flags (F)	**AF**
B	C	**BC**
D	E	**DE**
H	L	**HL**

Alternate (shadow) registers

Accumulator' (A')	Flags' (F')	**AF'**
B'	C'	**BC'**
D'	E'	**DE'**
H'	L'	**HL'**

Index registers

Index X	**IX**
Index Y	**IY**
Stack Pointer	**SP**

Other registers

Interrupt vector	Refresh counter	**I/R**

Program counter

Program Counter	**PC**

Status

S	Z	-	H	-	P/V	N	C	Flags
			IM		IFF1	IFF2		Interrupt

Figure 4: Zilog Z80 registers (from Wikipedia).