4-bit

In computer architecture, **4-bit** integers, memory addresses, or other data units are those that are 4 bits wide. Also, 4-bit CPU and ALU architectures are those that are based on registers, address buses, or data buses of that size. A group of four bits is also called a nibble and has $2^4 = 16$ possible values.

Some of the first microprocessors had a **4-bit** word length and were developed around 1970. The TMS 1000, the world's first single-chip microprocessor, was a 4-bit CPU; it had a Harvard architecture, with an on-chip instruction ROM, 8-bit-wide instructions and an on-chip data RAM with 4-bit words.[1] The first commercial microprocessor was the binary-coded decimal (BCD-based) Intel 4004,[2][3] developed for calculator applications in 1971; it had a 4-bit word length, but had 8-bit instructions and 12-bit addresses.

The HP Saturn processors, used in many Hewlett-Packard calculators between 1984 and 2003 (including the HP 48 series of scientific calculators) are "4-bit" (or hybrid 64-/4-bit) machines; as the Intel 4004 did, they string multiple 4-bit words together, e.g. to form a 20-bit memory address, and most of the registers are 64 bits wide, storing 16 4-bit digits.[4][5][6]

The 4-bit processors were programmed in assembly language or Forth, e.g. "MARC4 Family of 4 bit Forth CPU"[7] because of the extreme size constraint on programs and because common programming languages (for microcontrollers, 8-bit and larger), such as the C programming language, do not support 4-bit data types (C requires that the size of the `char` data type be at least 8 bits,[8] and that all data types other than bitfields have a size that is a multiple of the character size[9][10][11]). While larger than 4-bit values can be used by combining more than one manually, the language has to support the smaller values used in the combining. If not, assembly is the only option.

The 1970s saw the emergence of 4-bit software applications for mass markets like pocket calculators. During the 1980s 4-bit microprocessor were used in handheld electronic games to keep costs low.

In the 1970s and 1980s, a number of research and commercial computers used bit slicing, in which the CPU's arithmetic logic unit (ALU) was built from multiple 4-bit-wide sections, each section including a chip such as an Am2901 or 74181 chip.

The Zilog Z80, although it is an 8-bit microprocessor, has a 4-bit ALU.[12][13]

Contents

Modern uses

While 32- and 64-bit processors are more prominent in modern consumer electronics, 4-bit CPUs continue to be used (usually as part of a microcontroller) in cost-sensitive applications that require minimal computing power. For example, one bicycle computer specifies that it uses a "4-bit 1-chip microcomputer".[14] Other typical uses include coffee makers, infrared remote controls,[15] and security alarms.[16]

Use of 4-bit processors has declined relative to 8-bit or even 32-bit processors, as they are hard to find cheaper in general computer suppliers' stores. The simplest kinds are not available in any of them, and others are "non-stock" and more expensive.[17] (A few expensive ones can be found, as of 2014, on eBay.)[18][19][20]

Electronics stores still carry as of 2014, non-CPU/non-MCU 4-bit chips, such as counters.

As of 2015, most PC motherboards, especially laptop motherboards, use a 4-bit LPC bus (introduced in 1998) to connect the southbridge to the motherboard firmware flash ROM (UEFI or BIOS) and the Super I/O chip.[21][22]

Details

With 4 bits, it is possible to create 16 different values. All single-digit hexadecimal numbers can be written with four bits. Binary-coded decimal is a digital encoding method for numbers using decimal notation, with each decimal digit represented by four bits.

Binary	Octal	Decimal	Hexadecimal
0000	0	0	0
0001	1	1	1
0010	2	2	2
0011	3	3	3
0100	4	4	4
0101	5	5	5
0110	6	6	6
0111	7	7	7
1000	10	8	8
1001	11	9	9
1010	12	10	A
1011	13	11	B
1100	14	12	C
1101	15	13	D
1110	16	14	E
1111	17	15	F

List of 4-bit processors

- TMS 1000
- Intel 4004
- Intel 4040
- 10NES
- Atmel MARC4 core[23][24] – (discontinued: "Last ship date: March 7, 2015"[25])
- Samsung S3C7 (KS57 Series) 4-bit microcontrollers (RAM: 512 to 5264 nibbles, 6 MHz clock)
- Toshiba TLCS-47 series
- HP Saturn
- NEC µPD75X
- NEC µCOM-4
- NEC (now Renesas) µPD612xA (discontinued), µPD613x, µPD6x[15][26] and µPD1724x[27] infrared remote control transmitter microcontrollers[28][29]

Intel C4004

- EM Microelectronic-MarinEM6600 family,[30] EM6580,[31][32] EM6682,[33] etc.
- Epson S1C63 family
- National Semiconductor MAPS MM570X

See also

- GMC-4
- Low Pin Count

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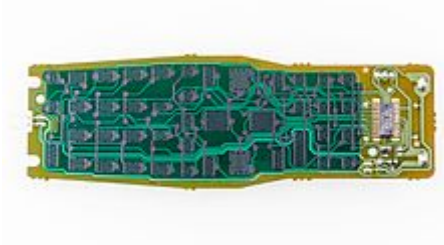

an infrared remote controltransmitter controlled by a NEC D63GS 4-bit microcontroller

NEC D63GS: a 4-bit microcontroller for infrared remote control transmission

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External links

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- "Products: High Performance 4-bit Microcontrollers [S1C63 family]". *Epson*. Archived from the original on 2013-07-29.
- Considerations for 4-bit processing

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