Lecture 2

September 29, 2013

1 Data Representation (Cntd)

1.1 Floating Point Representation

- IEEE 754 floating-point standard (1985)
- Floating-point numbers have
  - a sign,
  - mantissa (M),
  - exponent (E).
- 32 bit representation:1 sign bit, 8 exponent bits, and 23 mantissa bits.
- E.g. $228_{10} = 11100100_2 = 1.11001_2 * 2^7$

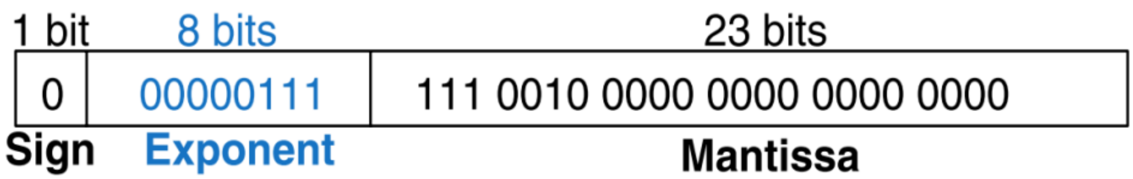


Figure 1: Floating Point Representation

- **Implicit leading one:** the first bit of the mantissa is always 1 and is not stored for efficiency.
- **Biased exponent:** original exponent plus a constant bias to represent both positive and negative exponents
  - Single precision (32-bit floating-point) uses a bias of 127.

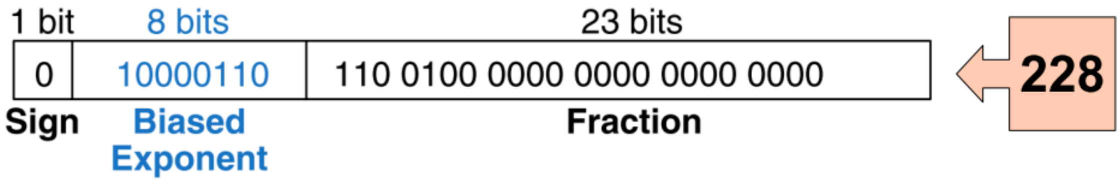


Figure 2: Floating Point Representation

- The FF_{16} exponent is reserved to represent special numbers
  - ∞ is a special case where the exponent = FFH, mantissa = 0 and S = 0
  - -∞ is a special case where the exponent = FFH, mantissa = 0 and S = 1
- 0 is a special case where both exponent and mantissa = 0
- Max floating number is $2^{128} = 3.4 * 10^{38}$ and the minimum value is $2^{-126} = 1.2 * 10^{-38}$

1.1.1 Examples

- $0.25 = +0.01_2 = 1.00 * 2^{-2}$
  S = 0, E=$-2 + 127 = 01111101_2$ and M=0
- $-1.75 = -1.11_2 = -1.11 * 2^0$
  S = 1, Exponent = 0 + 127 = 01111111_2 and Significand = $11000000000000000000000_2$

1.2 Other Common Data Representations

1.2.1 ASCII code

The American Standard Code for Information Interchange (ASCII) is a character-encoding scheme originally based on the English alphabet. ASCII codes represent text in computers, communications equipment, and other devices that use text. Most modern character-encoding schemes are based on ASCII, though they support many additional characters.

Standard ASCII code size is 7-bits [written in one byte (8-bits)] is used to represent differen charcters as shown in Table 1.

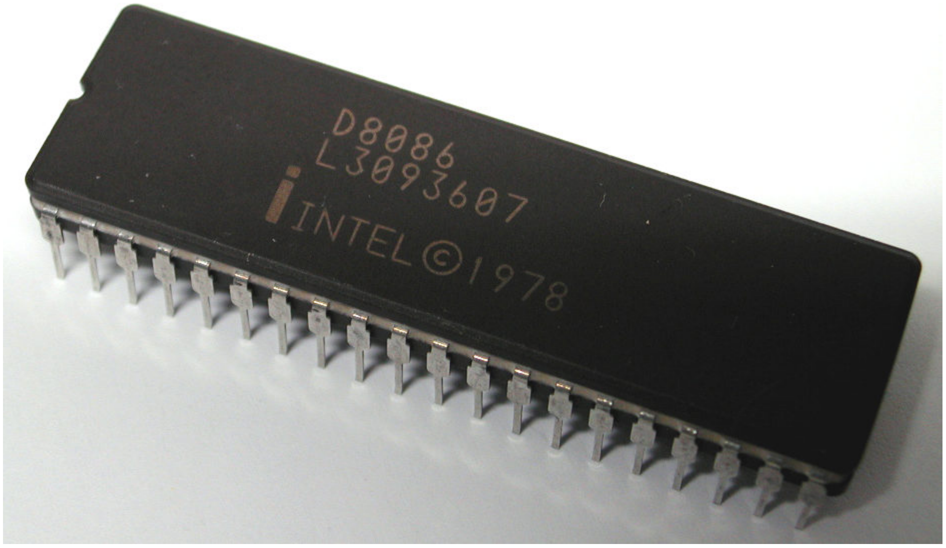
Table 1: Ascii Code Table

	0	1	2	3	4	5	6	7
0	NUL	DLE	space	0	@	P	`	p
1	SOH	DC1 XON	!	1	A	Q	a	q
2	STX	DC2	"	2	B	R	b	r
3	ETX	DC3 XOFF	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	+	;	K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	CR	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	_	o	del

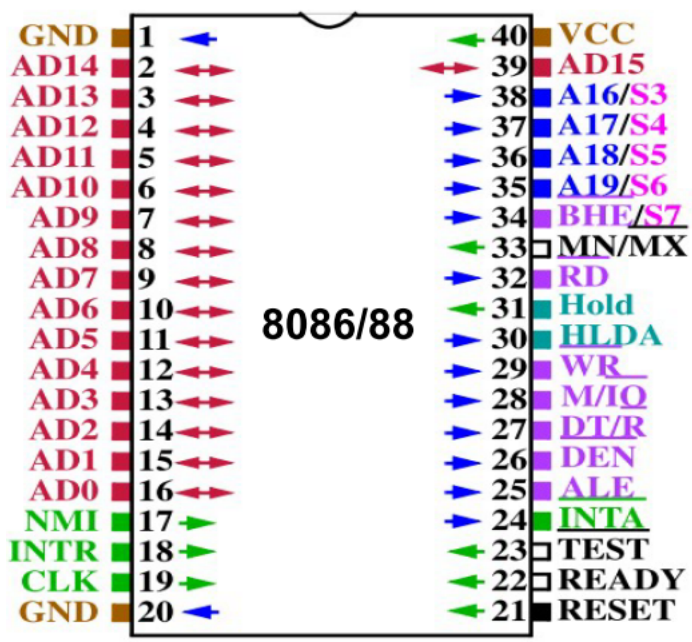
1.2.2 BCD Code

- binary-coded decimal (BCD) is a digital encoding method for numbers using decimal notation, with each decimal digit represented by its own binary sequence.
- In BCD, a numeral is usually represented by four bits (nibble), which represent the decimal range 0 through 9.
- The BCD code may be
  - Packed: one byte contains two BCD digits
    [e.g.: $12 = 00010010_2$]
  - Unpacked: one byte contains one BCD digit
    only [$12 = 0000000100000010_2$]

2 8086 Micro Architecture



- Intel 8086 is a 16 bit integer processor.
- It has 16-bit data bus and 20-bit address bus.
- The lower 16-bit address lines and 16-bit data lines are multiplexed (AD0-AD15).
- Since 20-bit address lines are available, 8086 can access up to 2^{20} or 1 mega-byte of physical memory.
- Programs written for the 8086 can be run on the 8088 without any changes. The main difference between 8088 and 8086 is the word size.



3 8086 Internal Architecture

3.1 Main Units

- The 8086 CPU has two main units

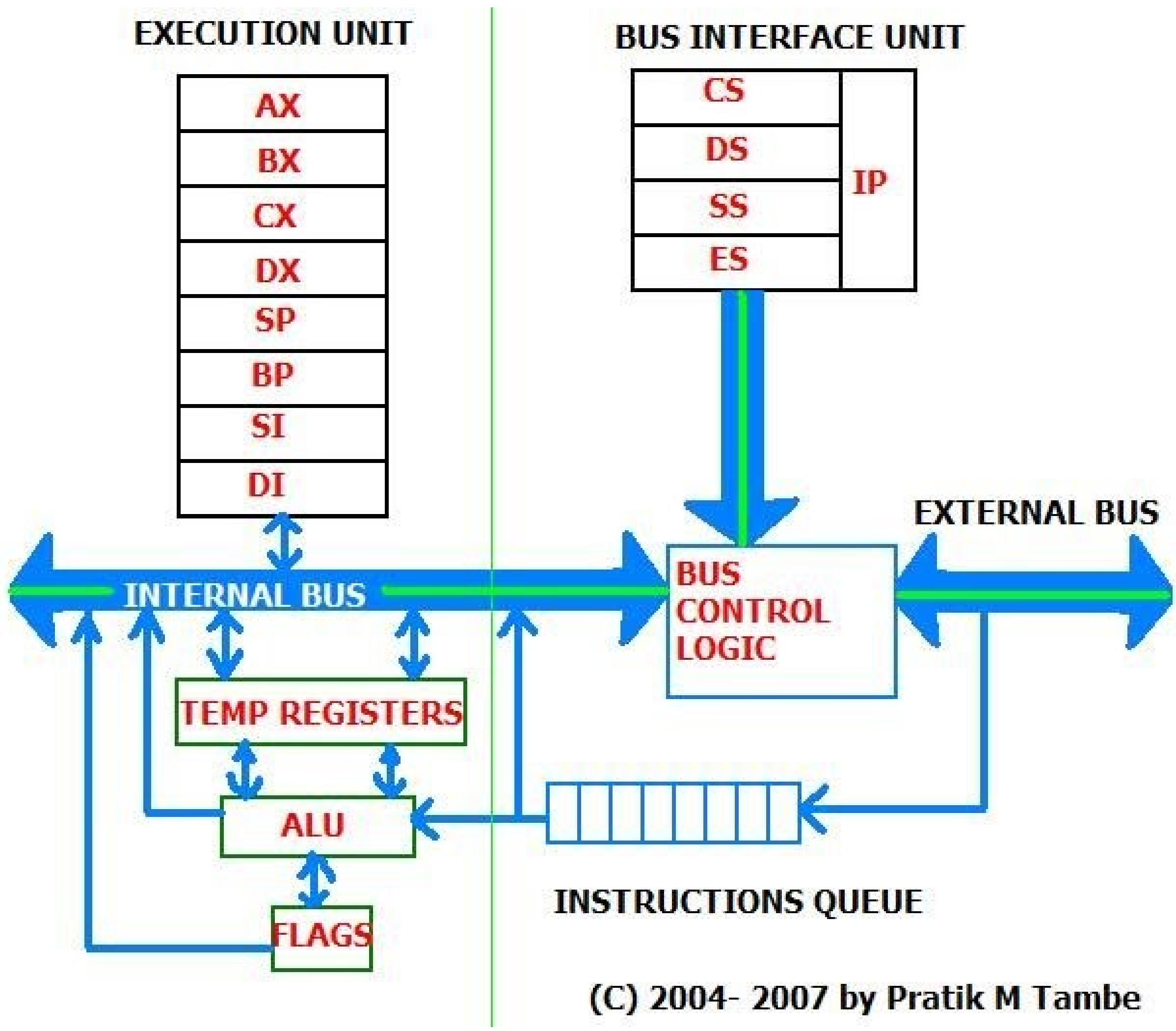


Figure 3: Intel 8086 Architecture

- Bus Interface Unit (BIU):
  * The BIU provides H/W functions, including generation of the memory and I/O addresses for the transfer of data between the outside world outside the CPU
  * BIU reads (fetches) instructions, reads operands, and writes results.
- Execution Unit (EU):
  * The EU receives program instruction codes and data from the BIU, executes these instructions, and store the results in the general registers.
  * By passing the data back to the BIU, data can also be stored in a memory location or written to an output device.
  * Note that the EU has no connection to the system buses. It receives and outputs all its data thru the BIU
  * executes instructions already fetched by the BIU

References

M. RAFIQUZZAMAN, "Fundamentals of Digital Logic and Microcomputer Design," Fifth Edition.