

ECT 213 Digital Electronics

Lecture 1 / Chapter 1
Digital vs Analog Signals
Number Systems

Digital Signals / Analog Signals

- Digital -> On/Off
- Analog -> Light dimmer

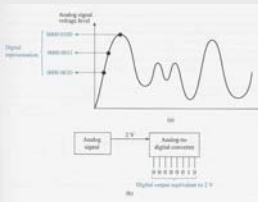
http://www.sposto.com/content/projects/faedra_demo/switch.swf

Analog vs Digital:

Analog: continuous waveform.
Analog represents most natural occurring physical quantities.

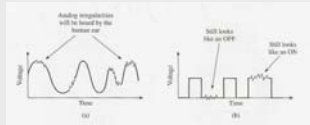
Digital: discrete levels in waveform.
High level represents **On / 5v / High**
Low level represents **Off / 0v / Low**

Analog Converted to Digital



Each analog point is represented by a series of digital bits.

Why Digital

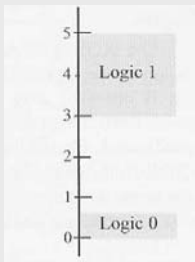


Effect of Noise can be minimized.

Signal Degradation can be reversed.

Signal degrades when transmitted over a wire because of Wire Resistance, Capacitance and Crosstalk due to EMF.

Analog vs Digital



- Logic 1 represents high
- Logic 0 represents low

Number Systems

Decimal – Base 10

- Decimal has digits 0 - 9.
- Number system we commonly use in our day to day lives.

Hundreds	Tens	Ones
10^2	10^1	10^0

Binary – Base 2

- Binary has digits 0 and 1.
- Commonly used in digital logic, computers and networking.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Example Decimal to Binary Conversion

(Subtraction Method)

- Convert 100 to binary using weighting factors.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Example Decimal to Binary Conversion

- Convert 200 to binary using weighting factors.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Convert 100 to binary

(division method)

Convert 100 to binary using division method.

Division	Quotient	Remainder

Example Binary to Decimal Conversion

(addition Method)

Convert 1010110_2 to decimal

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Example Binary to Decimal Conversion

(addition Method)

Convert 11010010_2 to decimal

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Octal – Base 8

- Octal has digits 0 through 7.
- Used to be used in computers (but rarely used today).
- Why base 8? Because 3 bits can be converted to decimal digits 0 -> 7.

4	2	1
2^2	2^1	2^0

Example Decimal to Octal Conversion

(Subtraction Method)

Convert 100 to Octal via Binary.

256	128	64	32	16	8	4	2	1
2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
4	2	1	4	2	1	4	2	1

Example Decimal to Octal Conversion

(Subtraction Method)

Convert 200 to Octal via Binary.

256	128	64	32	16	8	4	2	1
2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
4	2	1	4	2	1	4	2	1

Example Octal to Decimal Conversion

Convert 127 Octal to Decimal.

4	2	1	4	2	1	4	2	1
256	128	64	32	16	8	4	2	1

Example Octal to Decimal Conversion

Convert 476 Octal to Decimal.

4	2	1	4	2	1	4	2	1
256	128	64	32	16	8	4	2	1

Hex – Base 16

If Binary (base 2) uses digits 0 and 1 and Octal (base 8) uses digits 0 through 7.

What would Base 16 use?

Hex – Base 16

If Binary (base 2) uses digits 0 and 1 and Octal (base 8) uses digits 0 through 7.

What would Base 16 use?

But we represent 10 through 15 as "A" through "F"

Hex – Base 16

Base 10	Base2	Base 16	Base 10	Base2	Base 16
0	0000	0	8	1000	8
1	0001	1	9	1001	9
2	0010	2	10	1010	A
3	0011	3	11	1011	B
4	0100	4	12	1100	C
5	0101	5	13	1101	D
6	0110	6	14	1110	E
7	0111	7	15	1111	F

Hex – Base 16

- Most commonly used in computers and networking (error messages in windows and mac addressing)
- Why base 16? Because 4 bits can be converted to decimal digits 0 -> 15.

8	4	2	1
2^3	2^2	2^1	2^0

Example Decimal to Hex Conversion

(Subtraction Method)

Convert 100 to Hex via Binary.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
8	4	2	1	8	4	2	1

Example Decimal to Hex Conversion

(Subtraction Method)

Convert 200 to Hex via Binary.

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
8	4	2	1	8	4	2	1

Example Hex To Decimal Conversion

Convert A5 Hex To Decimal.

8	4	2	1	8	4	2	1
128	64	32	16	8	4	2	1

Example Hex To Decimal Conversion

Convert 7D Hex To Decimal.

8	4	2	1	8	4	2	1
128	64	32	16	8	4	2	1

Special Number Systems

Binary Coded Decimal (BCD)

- Used to store decimal numbers in binary form.
- Uses 4 bits to store digits 0 – 9.

Base 10	Base 2	BCD
0	0000 ₂	0000 _{BCD}
1	0001 ₂	0001 _{BCD}
2	0010 ₂	0010 _{BCD}
3	0011 ₂	0011 _{BCD}
4	0100 ₂	0100 _{BCD}
5	0101 ₂	0101 _{BCD}
6	0110 ₂	0110 _{BCD}
7	0111 ₂	0111 _{BCD}
8	1000 ₂	1000 _{BCD}
9	1001 ₂	1001 _{BCD}

Example Decimal To BCD Conversion

Example: Convert 97 to BCD

2 ³	2 ²	2 ¹	2 ⁰	2 ³	2 ²	2 ¹	2 ⁰
8	4	2	1	8	4	2	1

Example Decimal To BCD Conversion

Example: Convert 38 to BCD

2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
8	4	2	1	8	4	2	1

Example BCD To Decimal Conversion

Example: Convert 10011001_{BCD} to Decimal

2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
8	4	2	1	8	4	2	1

Example BCD To Decimal Conversion

Example: Convert 00100101_{BCD} to Decimal

2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
8	4	2	1	8	4	2	1

ASCII

- ASCII (pronounced “askee”) Code
- **American Standard Code for Information Interchange**
- Used to store characters in computer memory.
- <http://www.asciitable.com/>
