ECT 213 Digital Electronics

Lecture 1 / Chapter 1

Digital vs Analog Signals

Number Systems

Digital Signals / Analog Signals

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

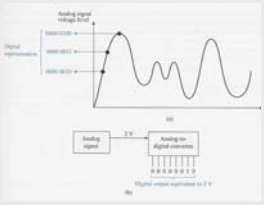
http://www.sposto.com/content/projects/faedra_demo/switch.swf

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.

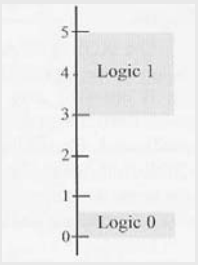
Why Digital

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 though 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 though 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 though 7.

What would Base 16 use?

But we represent 10 though 15 as “A” though “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
- **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange
- Used to store characters in computer memory.
- http://www.asciitable.com/