

Introduction to Digital Electronics

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Key concepts, building blocks, and practical considerations

1. What Is Digital Electronics?

- **Definition:** Branch of electronics that deals with signals having discrete (binary) values, typically **0** and **1**.
 - **Contrast with Analog:**
 - *Analog:* Continuous range of values (e.g., voltage varies smoothly).
 - *Digital:* Only a finite set of levels; most common is two-level (binary) logic.
 - **Why It Matters**
 - Enables reliable data storage, processing, and transmission.
 - Forms the foundation of computers, microcontrollers, communication systems, and many modern devices.
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2. Binary Number System

Decimal Binary Hexadecimal

0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
...	...	...
15	1111	F
16	10000	10

- **Bit** – a single binary digit (0 or 1).
 - **Nibble** – 4 bits (one hexadecimal digit).
 - **Byte** – 8 bits (common data unit).
 - **Word** – processor-dependent group of bits (e.g., 16?, 32?, 64?bit).
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3. Basic Digital Logic Levels

Symbol Voltage Range (Typical, 5V TTL) Logic State

0	0V–0.8V	LOW (Logic 0)
1	2V–5V	HIGH (Logic 1)

Note: CMOS families use a wider range (0V– V_{DD}) and have lower static power consumption.

4. Fundamental Logic Gates

Gate	Symbol	Boolean Expression	Truth Table
AND	AND	$Y = A \cdot B$	$0 \cdot 0 = 0, 0 \cdot 1 = 0, 1 \cdot 0 = 0, 1 \cdot 1 = 1$
OR	OR	$Y = A + B$	$0 + 0 = 0, 0 + 1 = 1, 1 + 0 = 1, 1 + 1 = 1$
NOT (Inverter)	NOT	$Y = \neg A$	$0 \rightarrow 1, 1 \rightarrow 0$
NAND	NAND	$Y = \neg(A \cdot B)$	Complement of AND
NOR	NOR	$Y = \neg(A + B)$	Complement of OR
XOR	XOR	$Y = A \oplus B$	