



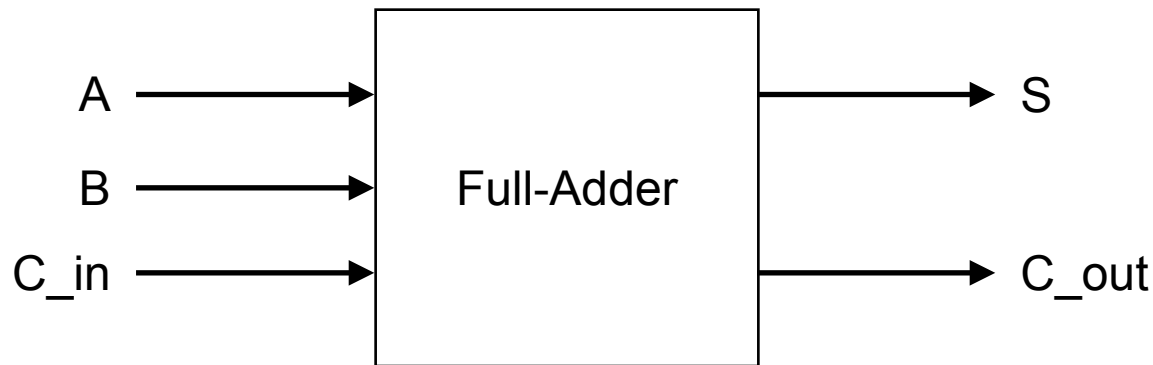
University of San Carlos | Department of
COMPUTER ENGINEERING

CpE 2303L
CpE Drafting and Design

Schematic Diagram

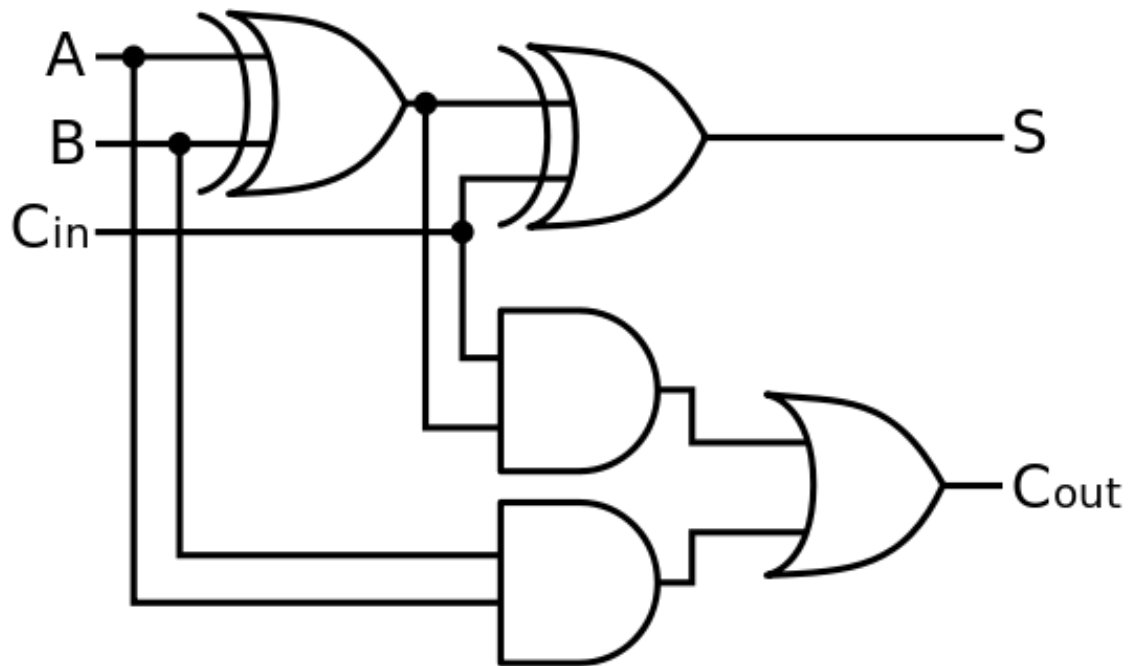
Block Diagram

- A block is only a ‘black box’ with certain inputs and outputs, but performing a definite function.



Block diagram of a Full-Adder

Schematic Diagram



Schematic diagram of a Full-Adder

Schematic Diagram

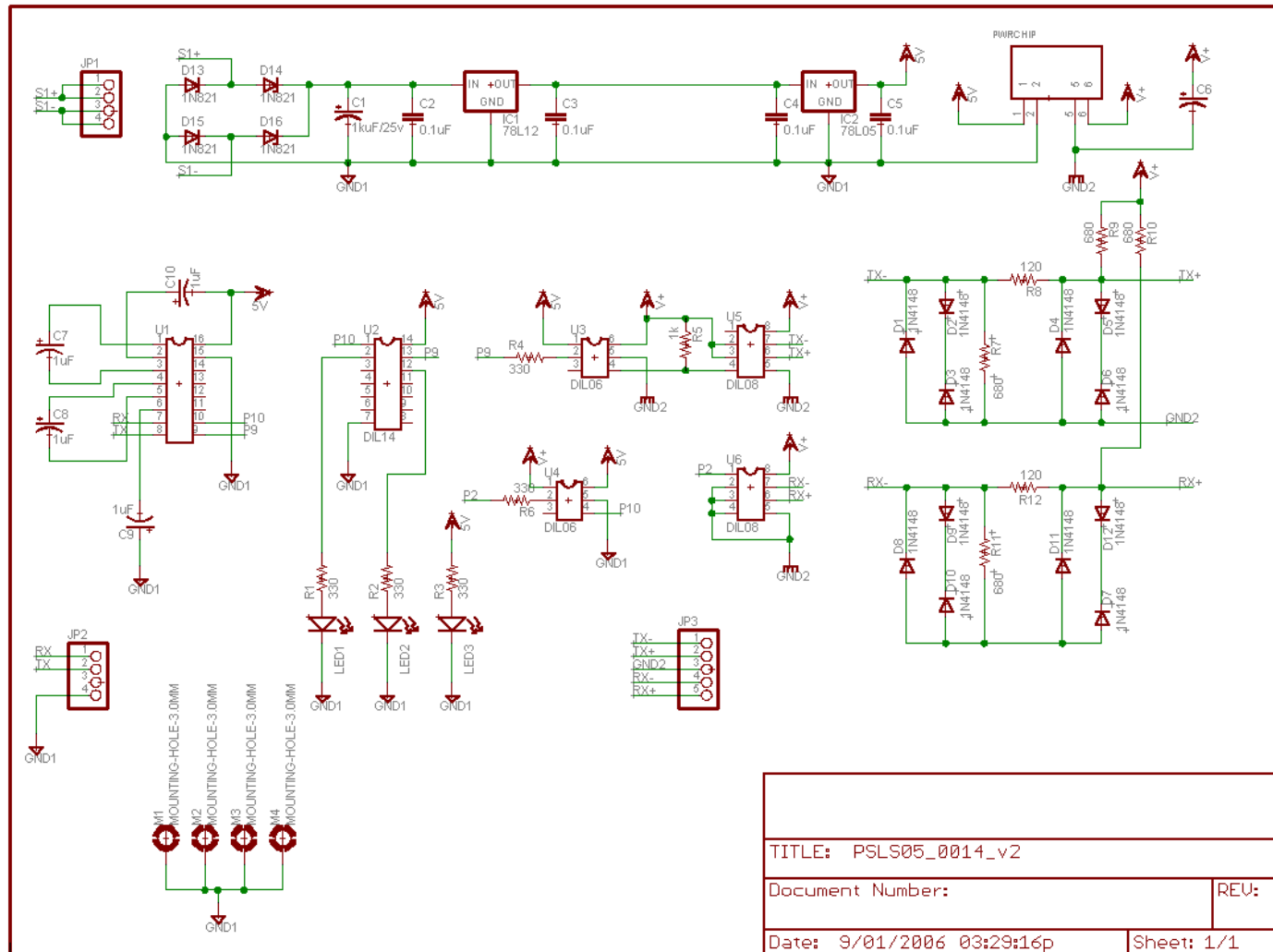
- A schematic diagram is a graphical representation of interconnections of various electronic, electrical and electromechanical components of an equipment.
- A PCB designer must learn how to read and interpret the schematic diagram.
- However, the schematic diagram does not show any of the mechanical details of the printed circuit board.

Schematic Diagram

- The schematic provides the most broadly used view of the design and includes all components. In addition:
 - It gives visibility into the status of all parts of the design process;
 - Schematics are the primary source for developing deliverables to product design and manufacturing groups;

Schematic Diagram

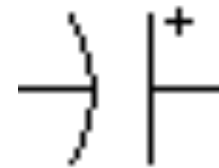
- Design variants are built around slightly differing schematics;
- Test departments rely on schematics;
- Field service relies on schematics and
- Bills-of-materials are generated from schematics.
- In short, a schematic is the focal point for a product's electronic data and can be viewed as set of crucial business documents that capture the decisions affecting all aspects of the product.



Schematic drawn by using a CAD software.

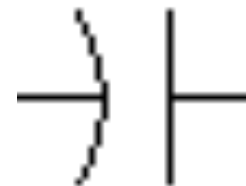
Schematic Diagram

- In a schematic diagram the symbol represents either what the component does in the circuit or how it is physically constructed.



Fixed, Polarized
(electrolytic)

General (any package)



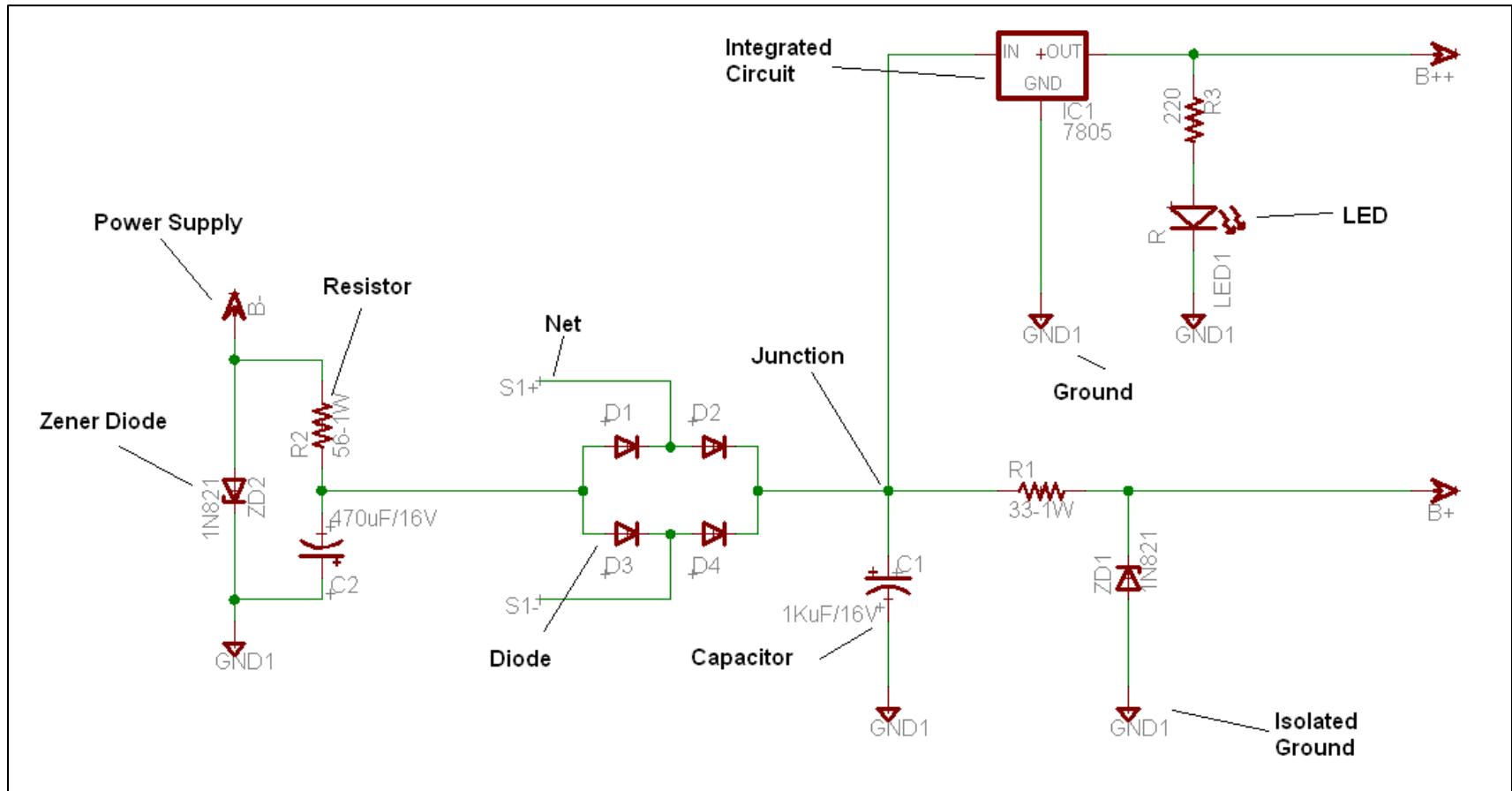
Fixed, Non-Polarized
(mylar, ceramic)

Standards

- All electronic components have been designated when represented on a schematic diagram. The common classification are
 - ANSI (American National Standards Institute)
 - IEEE (Institute of Electrical and Electronic Engineers)
 - IEC (International Electrotechnical Commission)

Component	ANSI/ IEEE	IE C	Component	ANSI/IEEE	IEC
Amplifier	AR	A	Jumper	W, P or R	
Capacitor	C		Microprocessor	U	
Pack	C		Oscillator	Y (crystal or G (other)	G
network	C				
Polarized	C				
Variable	C		Relay	K	
Connector	J or P		Resistor	R	
Crystal	Y	B	Pack	R	
Delay Line	DL		network	R	
			Potentiometer	R	
Diode	D or CR	V	Variable	R	
Light Emitting Diode	DS (display)	E	Thermistor	RT	
Voltage Rectifier	D or CR	V	Varsistor		
Zener Diode	D or VR	V	Asymmetrical	D or CR	
			Symmetrical	RV	
Filter	FL	Z	Socket	X, XAR, XU, XQ, etc.	
Fuse	F				
Header	J or P		Switch	S	
Inductor, Choke	L		Test point or Pin	TP	V
Integrated Circuit	U, IC		Transistor	Q	
Insulated Jumper	W or P				
			Transformer	T	
Battery	BT		Voltage Regulator	VR	
Meter, Instrument	M		Antenna, Spark	E	
Plug, Connector Male	P		Gap, Shield		
			Attenuator	AT	
Power Supply	PS		Motor, Fan,	B	
Test Point	TP		Synchro		

Reference Designators (Component Identification, IPC-DRM-18 F, Desk Reference Manual)



Objects in a schematic diagram.

Guidelines in Drawing Schematic Diagram

- Signal flow moves from left to right across the page with inputs on the left and output on the right.
- Electronic potentials (voltages) should increase as you move from bottom to the top of the page.
- Use the 'unit number' convention for assigning a unique IC package identification.

Guidelines in Drawing Schematic Diagram

- Components like resistors, capacitors and inductors should have a value with the correct unit.
- All components must have a designator following the IEEE or IEC standard.
- Every component in the schematic should have a unique designator. Multiple components with the same designator must have must use a numbering system for example: R1, R2, R3 etc.

Guidelines in Drawing Schematic Diagram

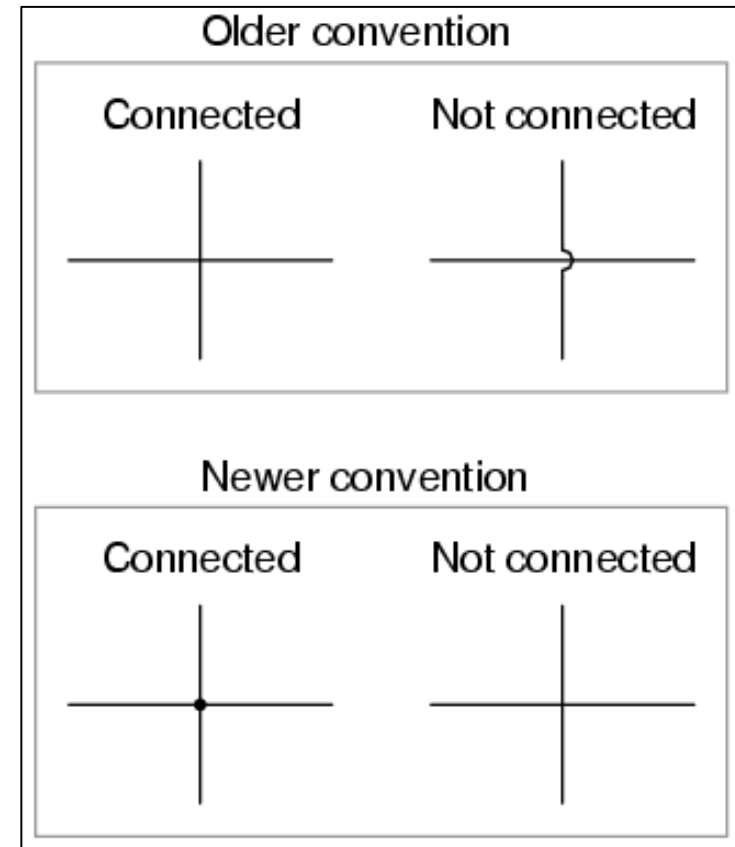
- Schematic symbols for electrical and electronic components should be standard.
- All power and I/O connections should be terminated with a connector.
- Documentations can be added in the schematic diagram if necessary.
- The title of the schematic diagram and the author, document number and version control should included.

Schematic Symbols

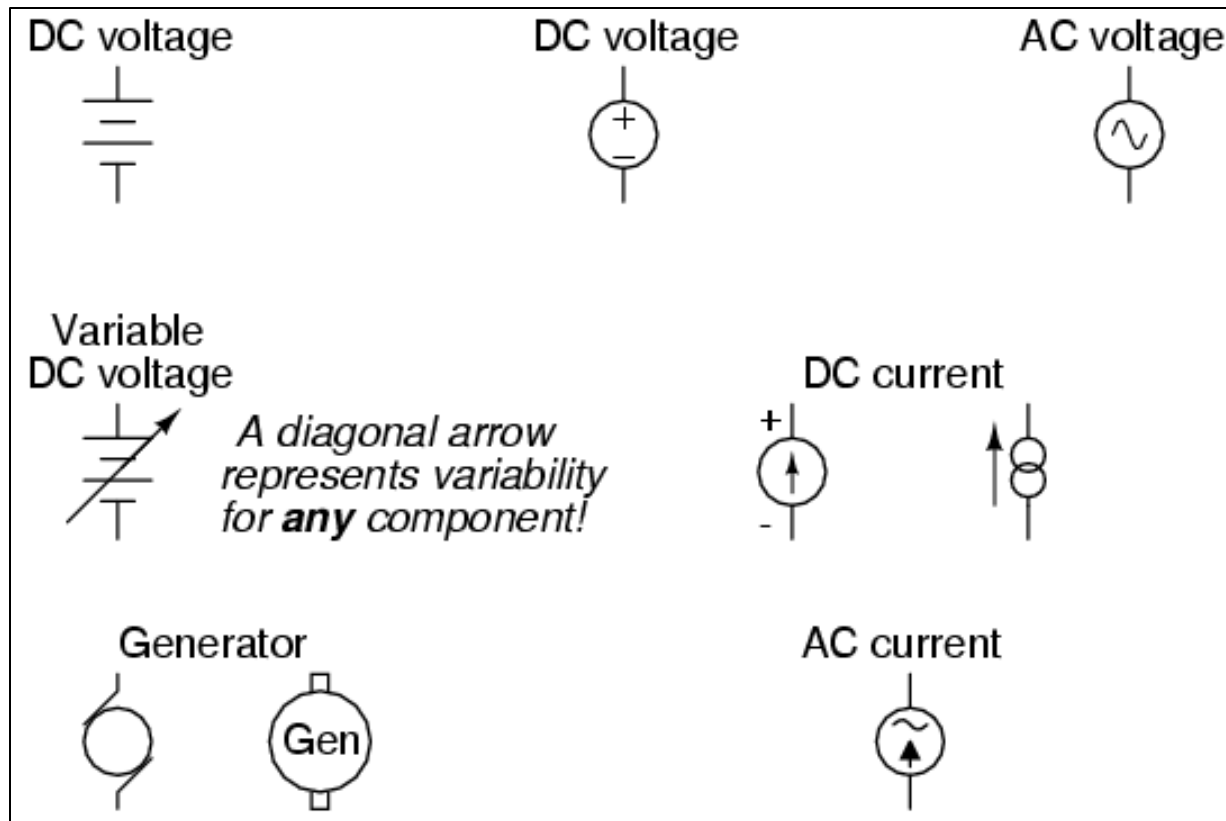
- Schematic diagrams always use standardized schematic symbols for the different active and passive components.

Wires and Connections

- Older electrical schematics showed connecting wires crossing, while non-connecting wires "jumped" over each other with little half-circle marks.
- Newer electrical schematics show connecting wires joining with a dot, while non-connecting wires cross with no dot.

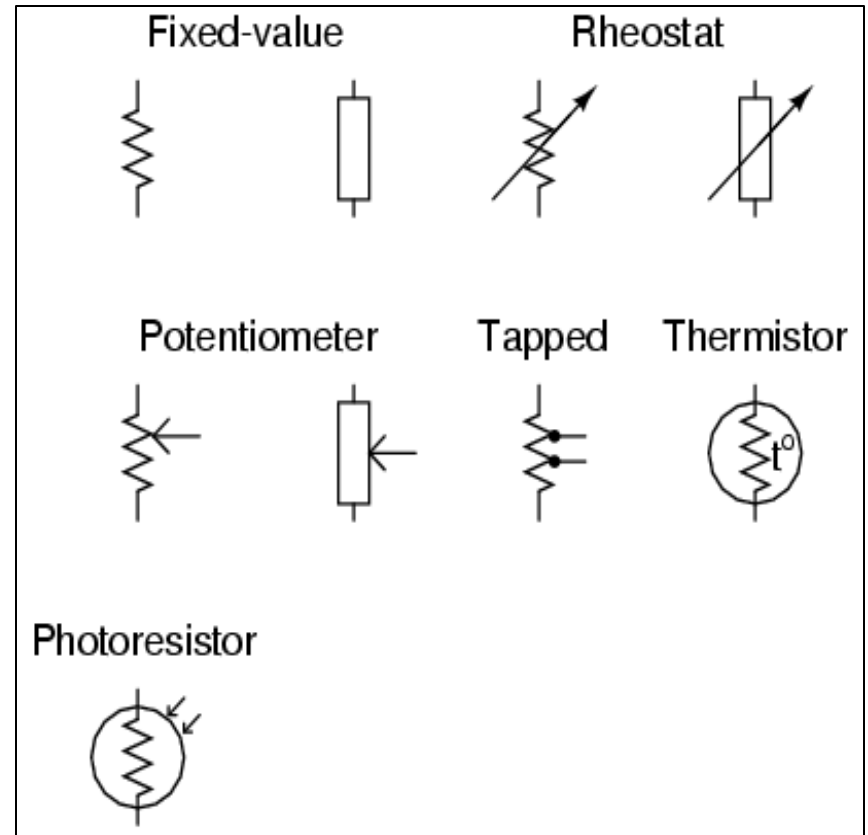


Power Sources

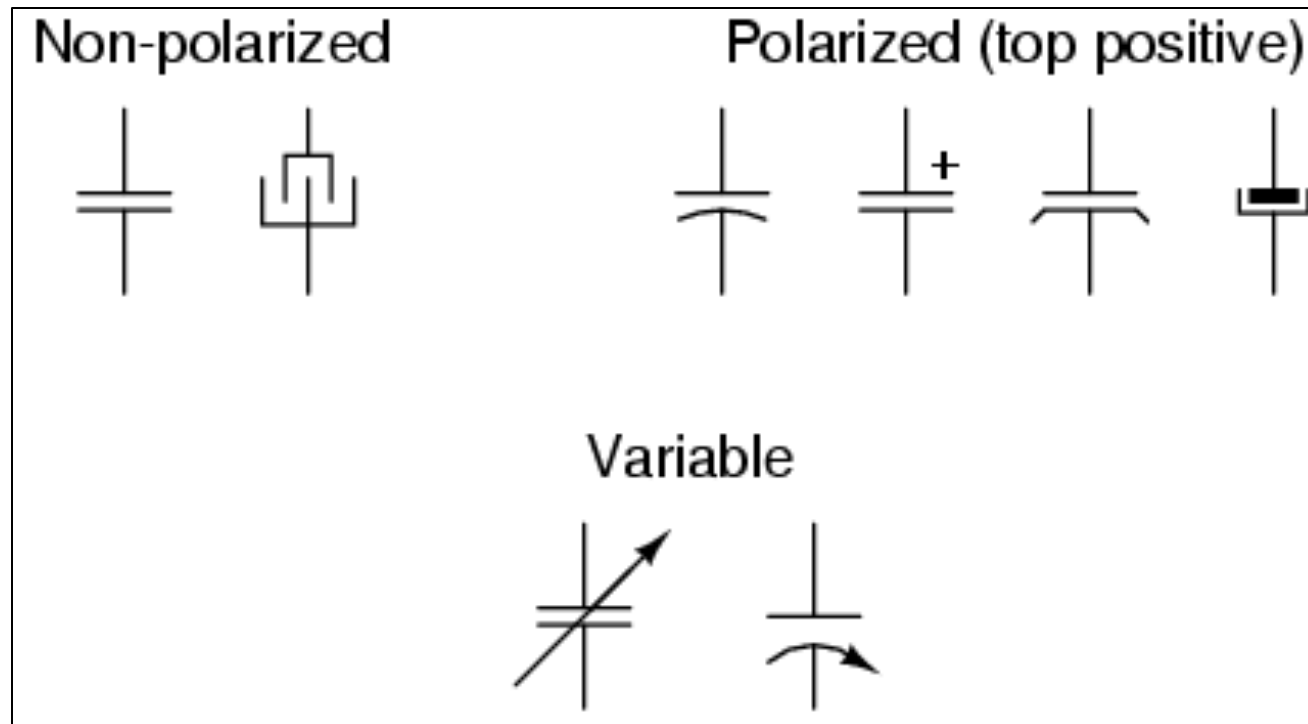


Resistors

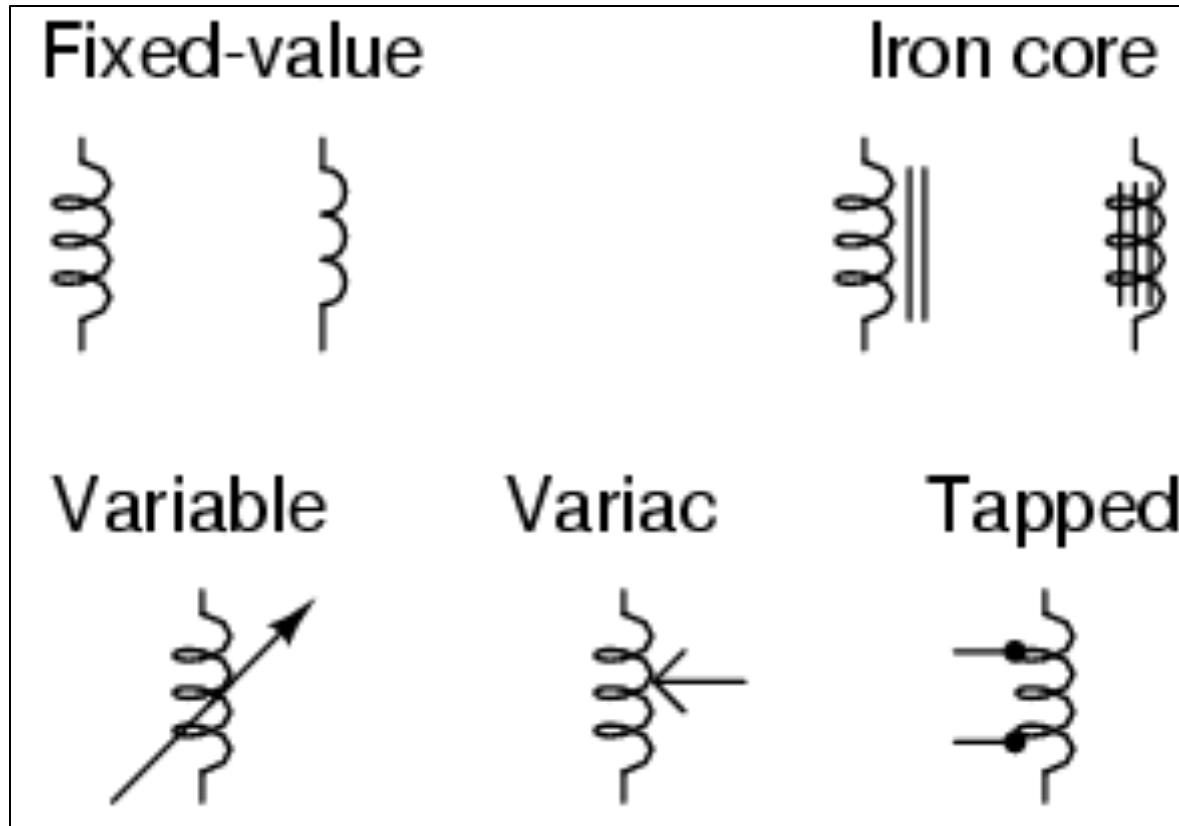
- Symbol Variants
 - US
 - EU



Capacitors

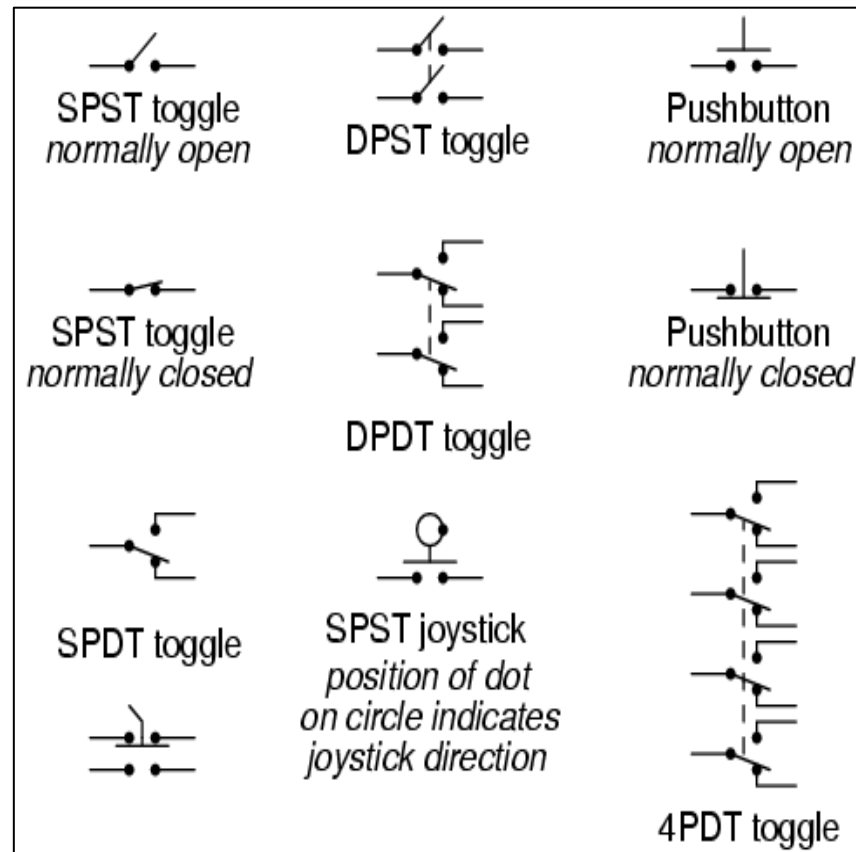


Inductors



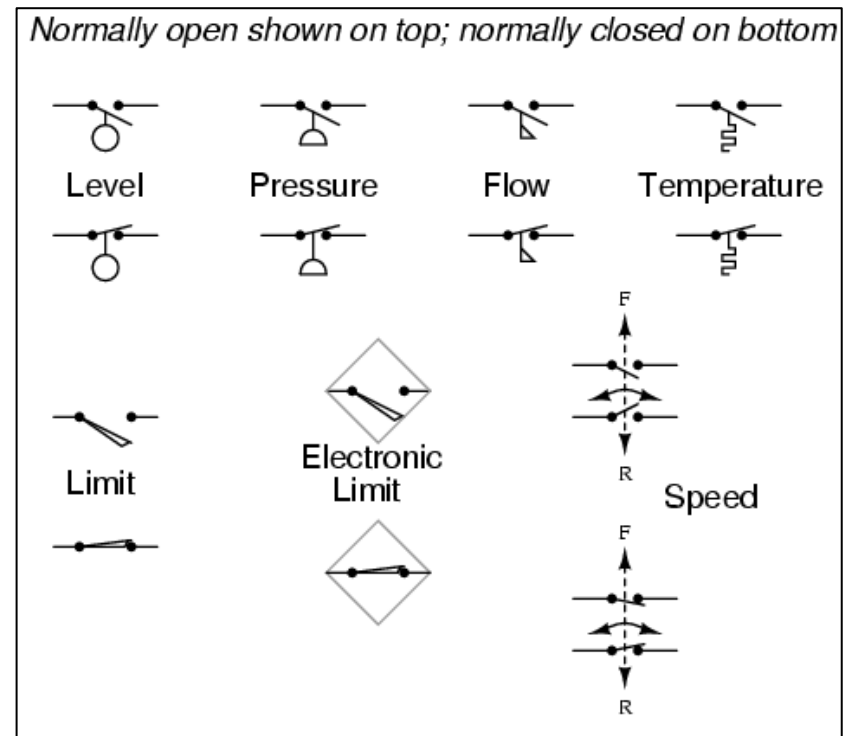
Switches (Mechanical)

Requires hand
or mechanical
manipulation.

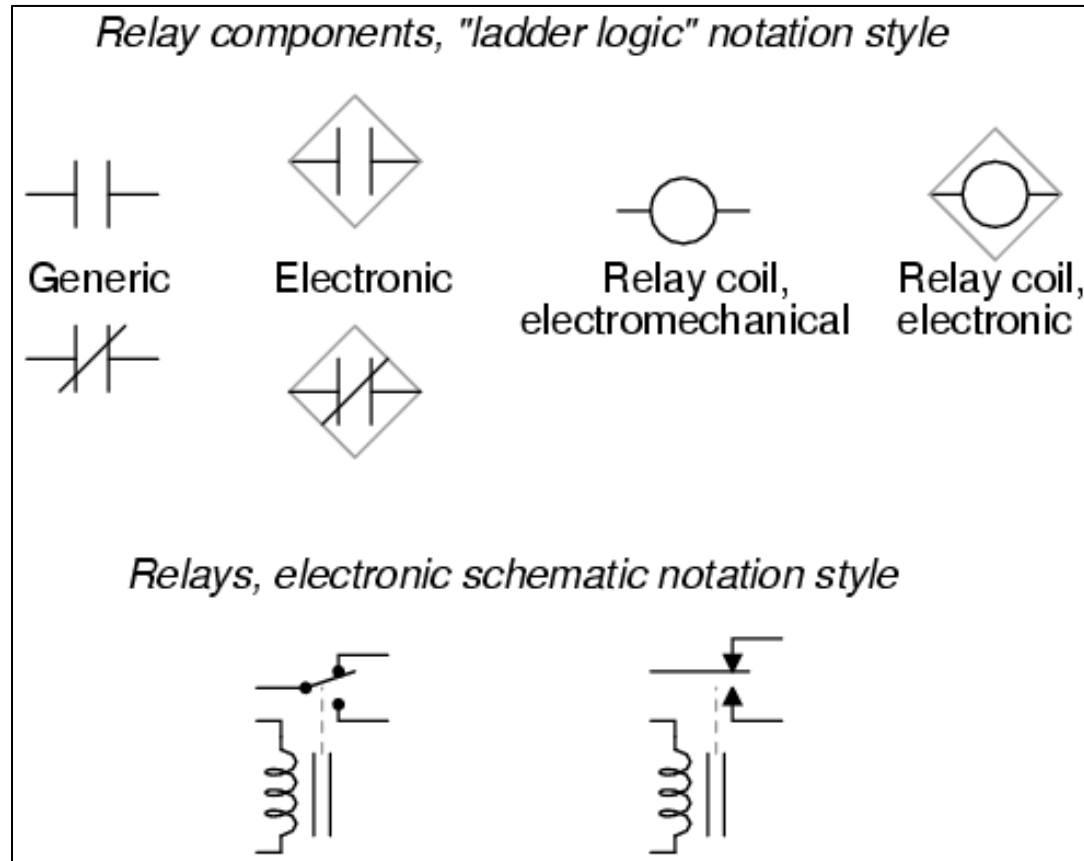


Switches (Process Actuated)

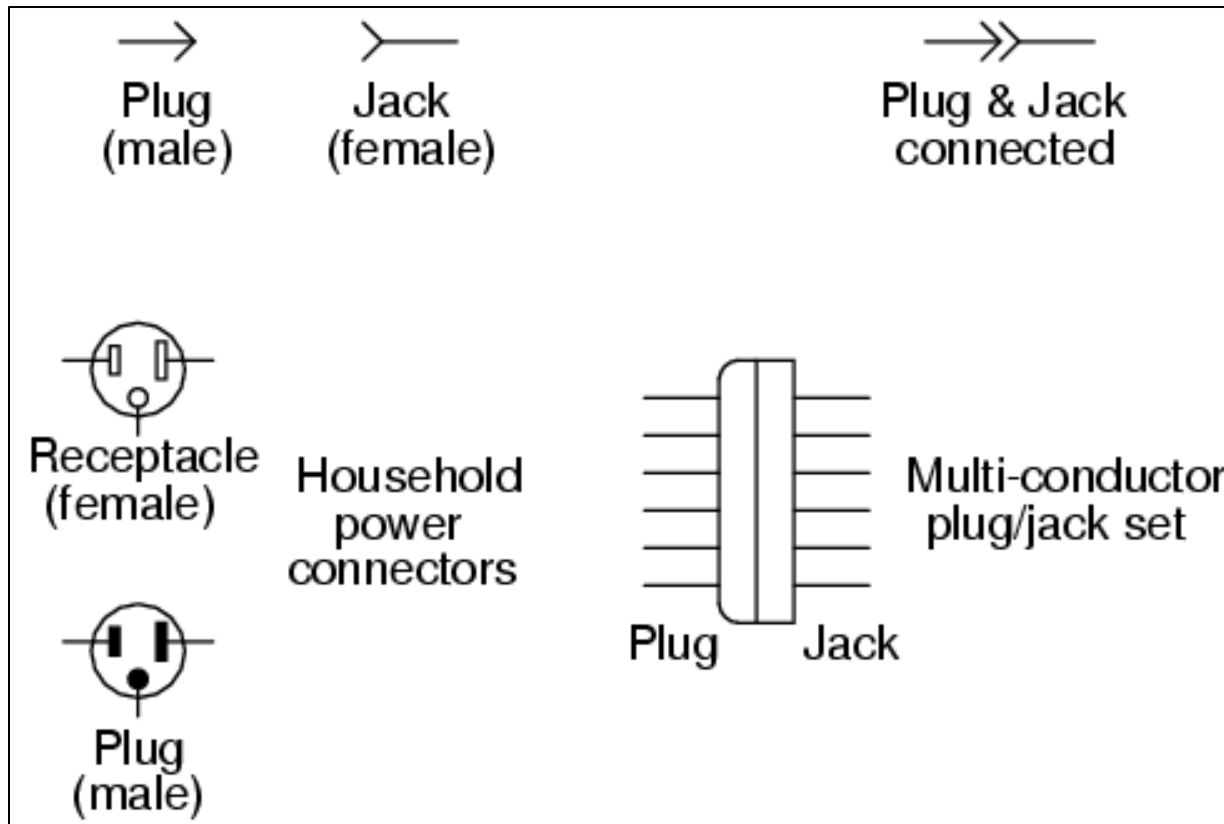
- The "normal" contact status of a process-actuated switch refers to its status when the process is absent and/or inactive, *not* "normal" in the sense of process conditions as expected during routine operation.
- A *limit* switch is one actuated by contact with a moving machine part. An *electronic limit* switch senses mechanical motion, but does so using light, magnetic fields, or other non-contact means.



Switches (Electrically Actuated)

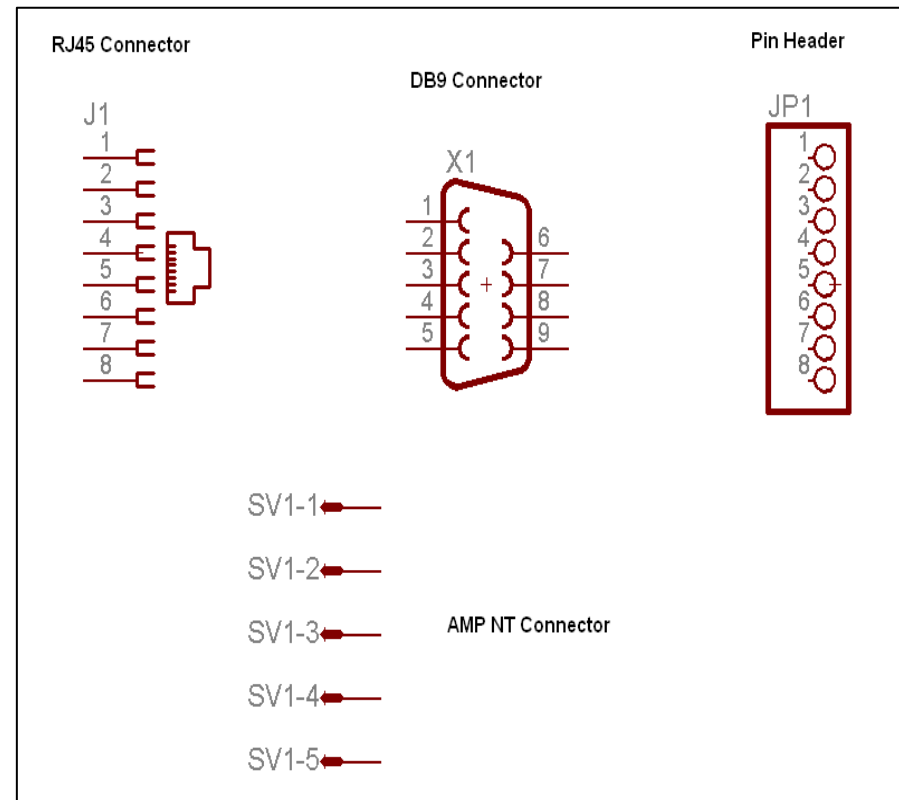


Connectors (Conventional)

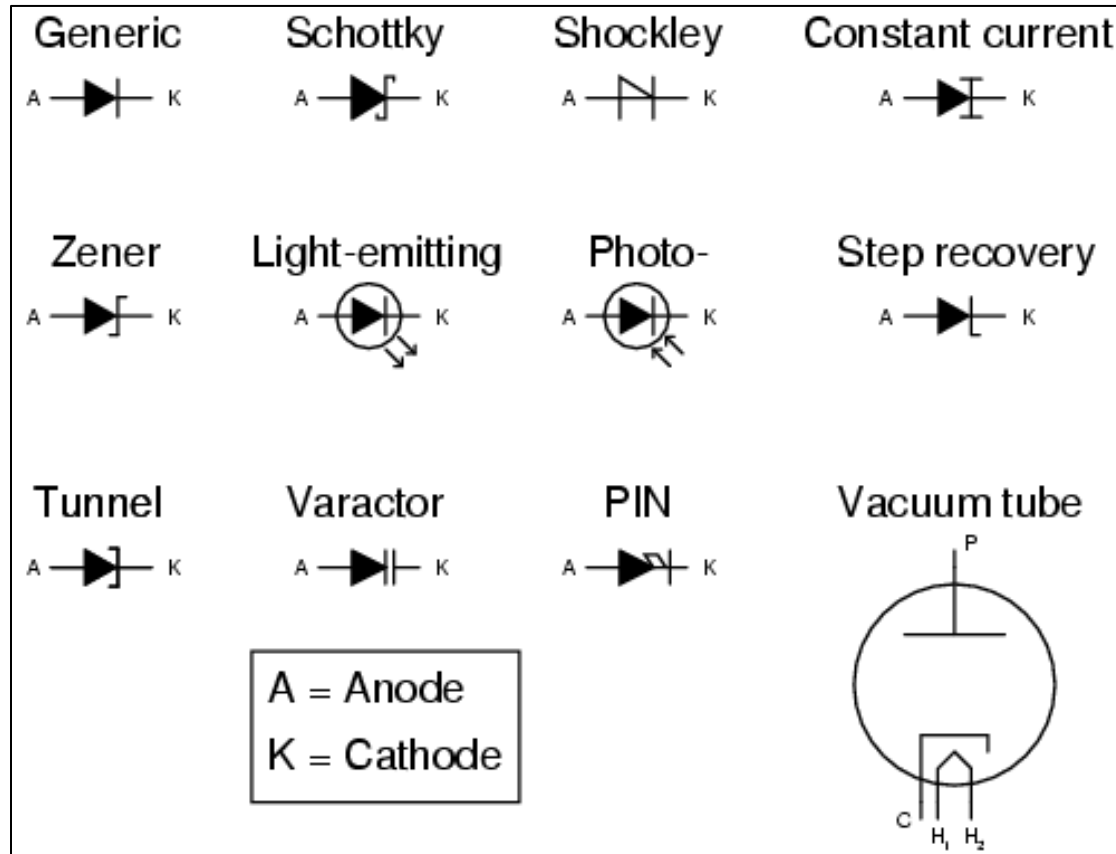


Connectors (Modern)

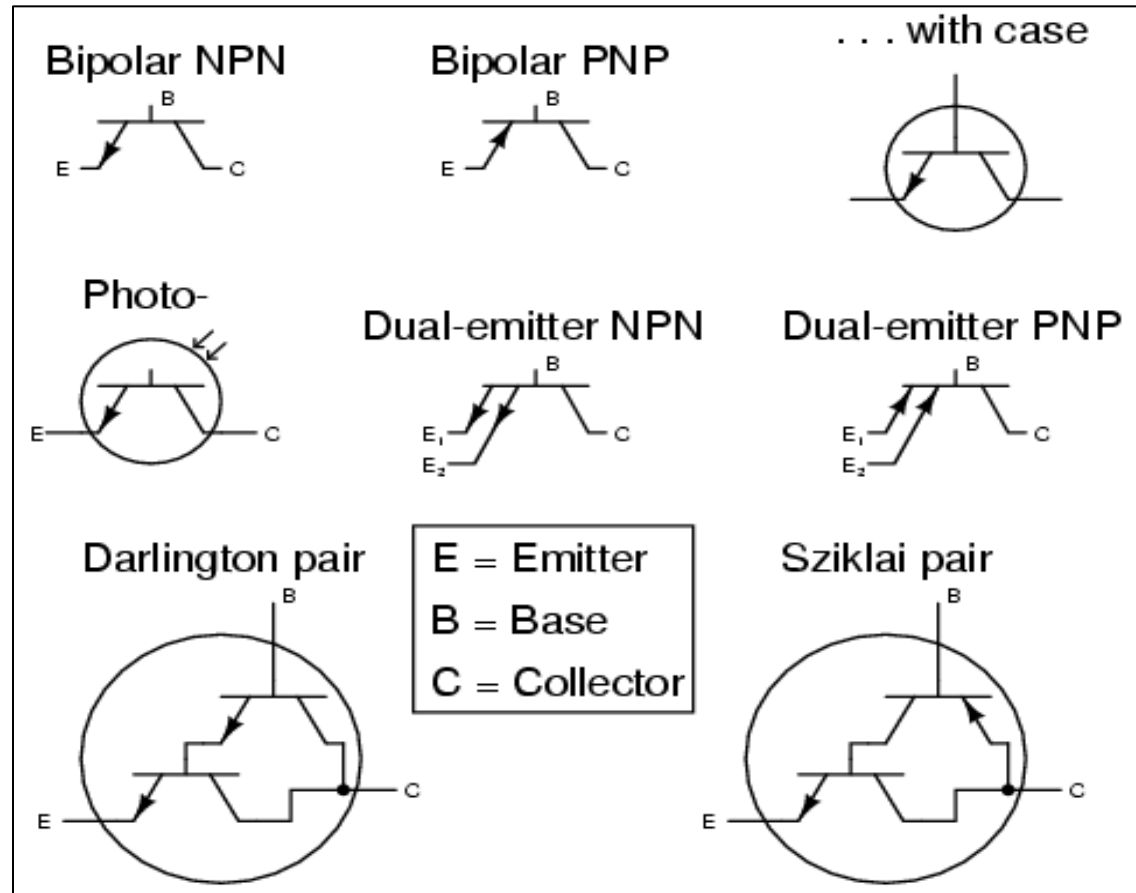
These connectors are used in modern electronics equipment like computers, data acquisition systems, control systems and many others.



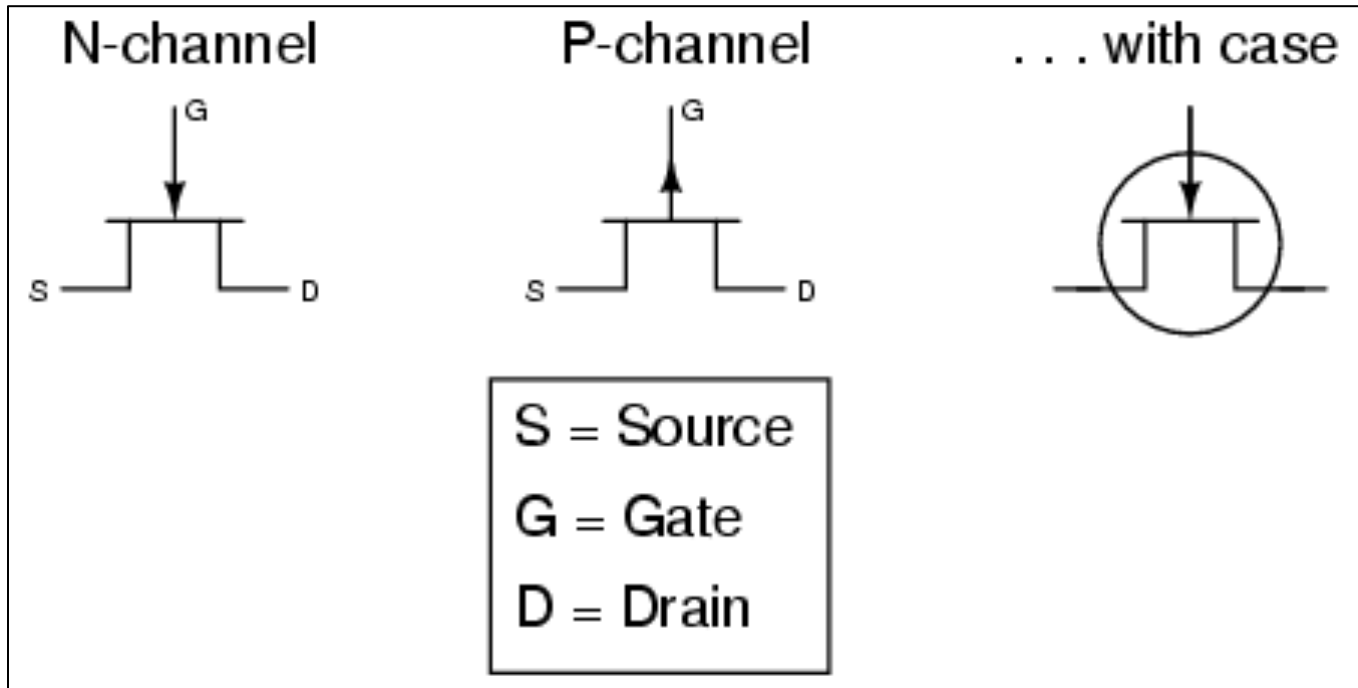
Diodes



Transistors (Bipolar)

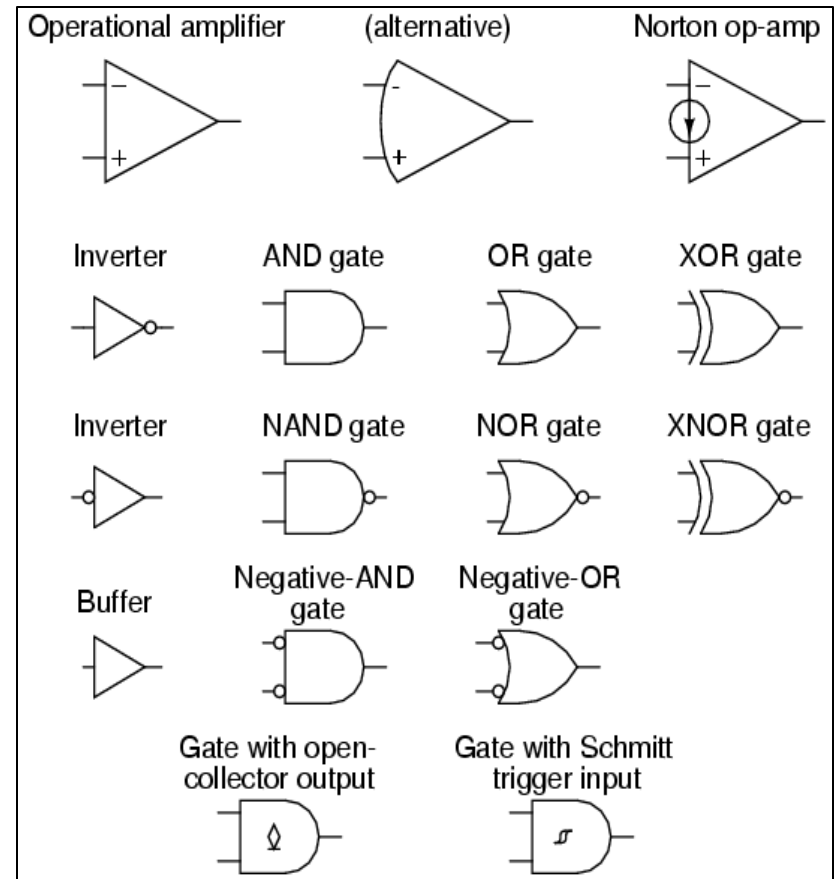


Transistors (JFET)

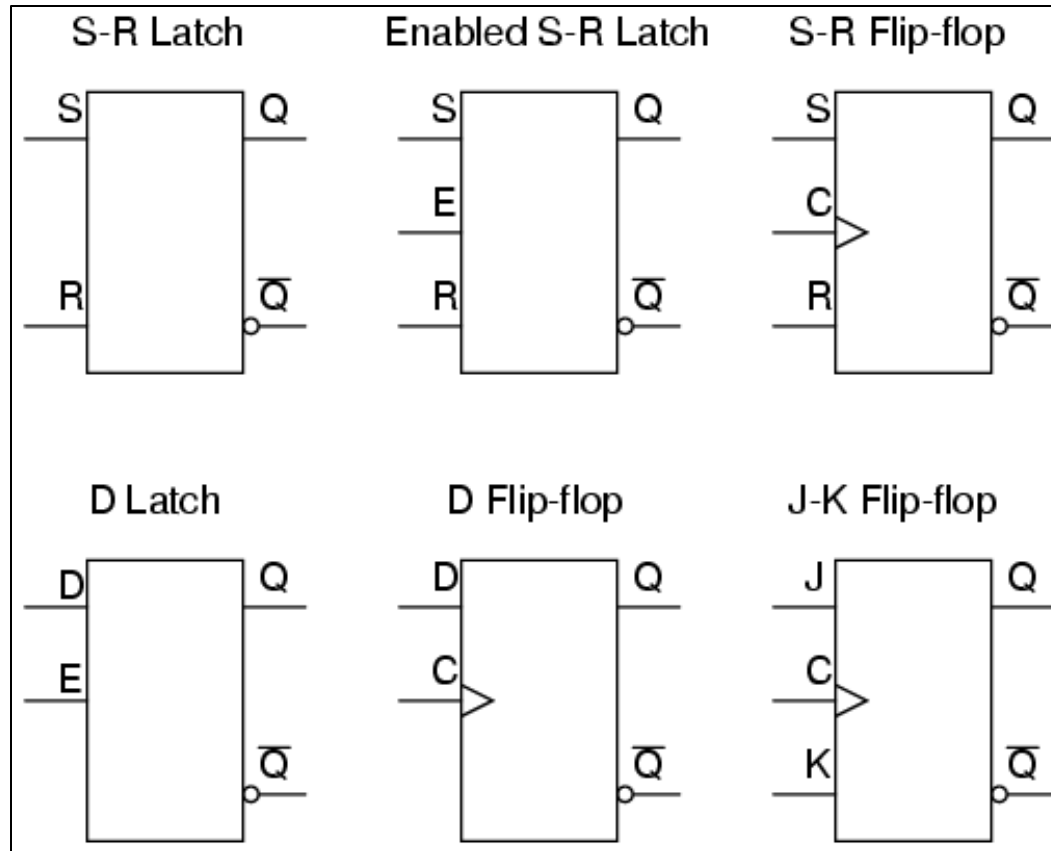


Integrated Circuits

- Integrated circuits can be represented as logic gates or MSI (flip-flops, decoders), VLSI (microcontrollers, microprocessors).

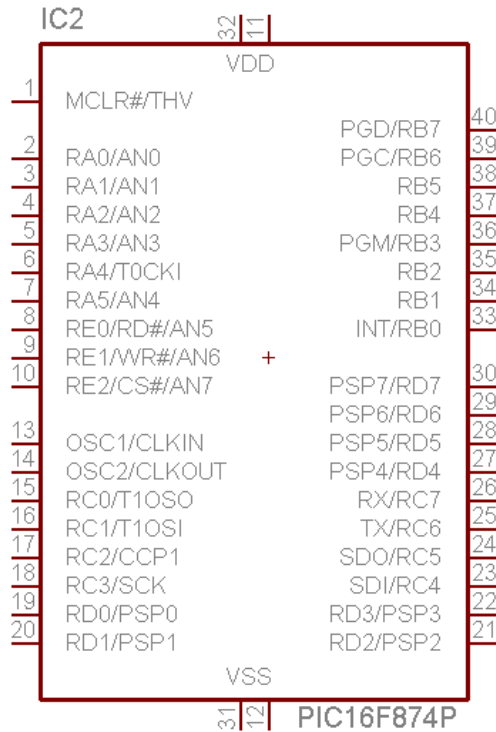


Integrated Circuits

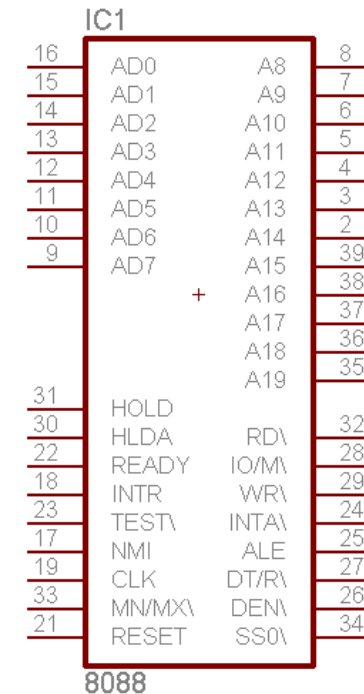


Integrated Circuits

Microchip PIC16F874 Microcontroller



Intel 8088 8-bit Microprocessor



Steps in Drawing a Schematic Diagram

1. Add or create a rectangle frame on the drawing canvas. All the schematic symbols, wires and documentation. should be with within the frame.
2. Add the components. Assign unique component designators.
3. Arrange the components based on its proximity to other components it connects to.
4. Place values for the components that requires one.
5. Connect the components using a wire/**net**.

Steps in Drawing a Schematic Diagram

6. Review the connections if they are correct.
7. Add documentations if necessary on the blank portion of the canvas.
8. Conduct an Electrical Rules Check (ERC) to make sure that no wires/nets are shorted or have illegal connections like connecting VCC and GND or an input signal connected to an output of a component.
9. Write the title of the schematic diagram, author, document number, version control on the lower left portion of the canvas.

Drawing Schematic Diagram using CAD Software

- Drawing schematic diagrams can be done by hand it is much quicker, accurate and correct when using CAD software.
 - CAD software allows drawing schematic diagram using vector graphics not raster.
 - It supports plenty of parts library.
 - It has features like automatic ERC.
 - Quick conversion to layout with forward & back annotation.
 - And features that allows to produce a professional looking schematic diagram.

Drawing Schematic Diagram using CAD Software

- Popular CAD Tools:
 - Autodesk EAGLE¹
 - Autodesk Fusion 360²
 - Altium Designer
 - Cadence OrCAD
 - Proteus Design Suite³



Altium
Designer.

OrCADTM
CADENCE PCB SOLUTIONS



¹ Will be replaced soon with Fusion 360

² EAGLE is integrated to Fusion 360

³ Includes Proteus ISIS and ARES



CpE 2303L
CpE Drafting and Design

End of Lecture

This material is prepared by Van B. Patiluna with contents from the reference textbook and other sources.

References:

R.S. Khandpur. Printed Circuit Boards: Design, Fabrication, Assembly and Testing. New York: McGraw-Hill, 2006.

http://www.allaboutcircuits.com/vol_5/chpt_9/1.html

http://library.thinkquest.org/10784/circuit_symbols.html