CAD 1203
Chapter 4
Schematic and Logic Diagrams

Schematic Drawings
- Created after the block diagram and single line diagram have been created.
- The schematic is a symbolic representation of the data and components that will be used in an electronic circuit.
- Schematics are necessary for sales, service, manufacturing and engineering staff to be able to understand how the circuitry functions.

Creating Schematic Drawings
- The CAD Technician should be provided with a sketch depicting the schematic.
- The more experienced the CAD technician is the less formal the sketch will be.
- The CAD technician will use their knowledge of symbols and basic principles of schematics to lay out the schematic.

Example of Rough Sketch Provided to CAD Technician

Example of Engineering Input Provided to CAD Technician

Final Schematic Produced from Previous Two Sketches
Creating the Schematic

1. Schematic must be organized and laid out in a way that will fit the necessary drawing size.
2. Appropriate symbols and specifications must be provided for all components. (ANSI Y 32.16, 32.2, and Y32.14).
3. Provide necessary notes and legends.
4. Follow the rules for creating schematics.

Rules for Creating Schematics

1. Normal signal flow will be from left to right, and top to bottom.
2. Lines should be a minimum of .25 inches apart.
3. Lettering should be .125 inches high.
4. Lines between components should always take the shortest path.
5. Connecting lines should have a minimum of crossovers and jogs.

Rules for Creating Schematics (cont.)

6. Long parallel line should be arranged in groups of three.
7. Lines may be given emphasis to help the reader follow the signal.
8. Avoid four way points or four way functions.
9. Power Sources should go at top.
10. Ground lines placed at bottom.
11. Lines will run vertically or horizontally with changes in direction limited to 90 degree jogs.

Appropriate symbols and specifications must be provided for all components.

Signal Flowing from Left to Right, (from antenna to speaker)

Handling Jogged, Crossed, and Parallel Lines

As drawn it is difficult to follow these line.
Handling Jogged, Crossover, and Parallel Lines

Example: Power Sources at Top, Ground at Bottom

Note: When many lines will be crossed, use a common ground and power symbol.

Note: All lines must be vertical or horizontal. Any changes in direction will be 90 degrees.

Reference Designations

- Reference designations are the combinations of letters and numbers used to identify the components on a schematic.
- This information should be located as close as possible to the graphic symbol.

Method Used for Numbering Schematic Components

Components are to be numbered starting with one, and increasing from top to bottom and from right to left as shown.

Preferred way of Referencing Components

- When space is limited
- Preferred
Parallel and Series Circuits

- The CAD technician must understand the differences between parallel and series circuits, if they are to correctly represent them in a schematic.

Parallel Circuits

- Parallel circuits will have one end of each component going to a common source and the other end going to a common ground.

Series Circuits

- In a series circuit components are end to end, and the potential will vary across each component.
- The potential will be different at points 1, 2 and 3.

Parallel and Series Circuits

- It is not unusual for a circuit to be composed of groups of components arranged in both parallel and series.
- In the example below, two parallel circuits are combined in series.
- The potential at points, 1, 2 and 3 will all be different.

Logic Diagrams

- Logic diagrams are used to illustrate the logical elements and their interconnections.
- They typically do not show the components elements or internal details.
- They will use symbols and supplemental data to describe the function of each element.
- ANSI Y 32.14 is the standard for Graphical Symbols to Logic Diagrams.

In example B, the components are lined up vertically, making it easier to read and interpret.
Logic Diagrams

- There are two main types of Logic Diagrams:
  - Basic Diagrams and
  - Detail Diagrams
- Basic Diagrams will show logical functions and their relationships without any references to physical relationships.
- Detail Diagrams take the basic information and add specific and/or nonlogic data, (which may include pin numbers, test points, and other physical information).

Logic Elements

- Elements that are used in logic diagrams include:
  - AND, NAND, OR, NOR, INVERTER Gates, Operational Amplifiers, Flip Flops, Schmitt Triggers, Decoders, Counters, Shift Registers, and Oscillators.

AND Gate

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
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<tr>
<td>1</td>
<td>1</td>
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</tbody>
</table>

- No output signal will be produced unless a pulse is applied to all inputs simultaneously.
- In binary circuits this means all inputs must be “1” to get a “1” output.

NOT Gate

- A circuit that takes a positive signal input and puts out a negative signal output, or vice versa. Also called an Inverter.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>NOT A</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
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</tbody>
</table>

NAND Gate

- A combination of a NOT and AND function. Will have two or more inputs and one output.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
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<tr>
<td>0</td>
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<td>1</td>
<td>0</td>
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OR Gate

- The OR Gate will produce output whenever one or more of its inputs are energized.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
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<tr>
<td>0</td>
<td>1</td>
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<td>1</td>
<td>0</td>
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<td>1</td>
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</table>
NOR Gate

A combination of the or and not function. Will have an output of 0 if any logic input is 1. Will be 1 only if all inputs are 0.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A NOR B</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
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<td>1</td>
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Operational Amplifier, (Op Amp)

An operational amplifier IC is a solid-state integrated circuit that uses external feedback to control its functions. It is one of the most versatile devices in electronics. Inside the Op amp is a piece of silicon containing 24 transistors, 11 resistors and 1 capacitor.

Flip Flop

This device is stable in either of two states. When triggered by an input of a clock pulse it flip flops from one stable state to another. The JK flip flop is the most common.

Schmitt Trigger

A bistable pulse generator in which an output pulse of constant level will exist only as long as the input is constant.

Decoder

A decoder will translate a combination of signals into one signal. It will extract information from complex or coded signals.
**Counter**

- Counts input pulses, and outputs after a predetermined number of pulses.

**Shift Register**

This circuit can shift information from one flip flop to an adjacent flip flop when it receives a clock pulse.

4 Flip Flops combined to create a four stage shift register.

**Oscillator**

- An oscillator will generate alternating current of predetermined frequencies.

**Rules for Creating Logic Diagrams**

1. Draw each device so the input is at the left or on the top.
2. Outputs should exit the device from the right or bottom.
3. The basic rules for schematics will apply to logic diagrams.
4. The numbering of logic elements will be by physical positions in the equipment, (unlike schematic diagrams).