CHAPTER 20

Electricity/Electronics Drafting

Chapter Objectives

- **Use** standard ASME/ANSI/IEEE symbols in the development of electrical and electronic diagrams.
- **Differentiate** between schematic diagrams and functional block diagrams.
- **Draw** electrical/electronic diagrams.
- **Create** a schematic diagram using board-drafting and CAD techniques.

Discuss The Photo

Light Show Lighting design often emphasizes functionality, whereas Maurer brings an artistic sensibility to his designs. ***Should lighting always be useful? Would you consider this lighting design useful? Why or why not?***

Arne Dedert/epa/Corbis

Drafting Career Success

Ingo Maure, *Lighting Designer*

From Concept

Ingo Maurer's Delirium Yum lamp appears at first to be a tornado in a bottle. You see a clear cylinder containing a swirling column of water, but floating at the top of the swirl-cone is an egg of pure light. Then you realize that the light can move up and down as the column changes. Maurer has combined light, movement, and water in a piece that is at the same time a magical sculpture and a practical source of light for your living room.

To Reality

The clear cylinder is made of corian, a space-age material that does not burn or scratch, crystal glass, carbon fiber, and silicone. There's a bar at the bottom of the cylinder that is set to spinning by magnetic field. This spinning bar creates the swirling vortex. Maurer created this piece with his colleague, Sebastian Hepting. It's more magical than a lava lamp.

Academic Skills and Abilities

- Technical knowledge
- Creativity
- Verbal and written communication skills
- Sketching and drawing
- Self-discipline

Career Pathways

Lighting designers often start out in educational programs geared for industrial designers. Art schools and other postsecondary institutions with art and design programs sometimes offer degrees in industrial design. Many require successful completion of one year of basic art and design courses before entering the bachelor's program.

Go to **glencoe.com** for this book's OLC to learn more about Ingo Maurer and lighting design.

20.1 Types of Electrical and Electronic Diagrams

READING GUIDE

Before You Read

Preview Much of what you have read so far has been about how to draw geometric shapes, 3D objects, and architecture. How do you think mechanical drawing will be applied to electricity and electronics?

Content Vocabulary

- schematic diagram
- functional block diagram
- connection diagram

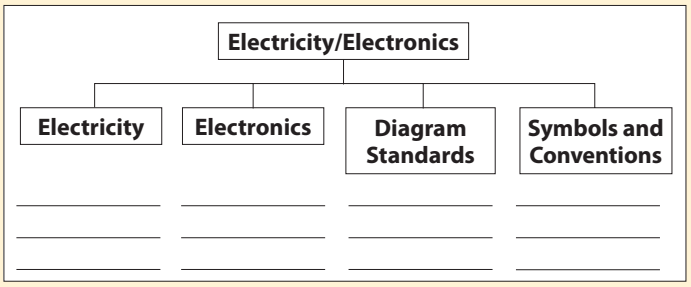
Academic Vocabulary

Learning these words while you read this section will also help you in your other subjects and tests.

- manipulating
- incorporate

Graphic Organizer

Use a chart like the one below to organize notes about electricity/electronics.



Go to **glencoe.com** for this book's OLC for a downloadable version of this graphic organizer.

Academic Standards

English Language Arts

Read texts to acquire new information (NCTE)

Mathematics

Measurement Understand measurable attributes of objects and the units, systems, and processes of measurement (NCTM)

Science

Physical Science Interactions of energy and matter (NSES)

Industry Standards

ADDA Section 7

Electrical/Electronic Drafting (ANSI Y14.15, ANSI Y14.15a, ANSI Y32.9, ANSI C84.1, ISA S5.1, ANSI/IEEE 315)

NCTE *National Council of Teachers of English*
NCTM *National Council of Teachers of Mathematics*
NSES *National Science Education Standards*
ADDA *American Design Drafting Association*
ANSI *American National Standards Institute*

Mark Dreukel

Concepts Related to Electricity and Electronics

What are some common applications for electricity and electronics?

Progress in making electrical power started in New York City in 1882, with Thomas Alva Edison's electricity generator. Since then, electricity has completely changed the communication, manufacturing, and utility industries. Electricity and electronics make a powerful team for space shuttles, computers, communications systems, automated machinery, and everyday appliances.

As an electrical/electronics device, computers are everywhere, not only as tools themselves, but as adjuncts to automobiles, airplanes, appliances, and toys. "Smart homes" have computerized systems that control indoor and outdoor lights, garage doors, security systems, and appliances.

Symbols for Electrical/Electronic Diagrams

How should you draw a schematic diagram following established standards?

Many types of electrical and electronic diagrams are used for numerous purposes. The major types are discussed here. For additional information about national standards for these diagrams, see ASME Y14.24, "Types and Applications of Engineering Drawings." Electrical/electronic drafting requires the use of symbols that are dedicated to this field. Symbols can be drawn quickly and easily on board drawings using templates like the one shown in **Figure 20-1**. In CAD drawings, the symbols are usually inserted from a symbol library. To avoid confusion, drafters use standard symbols defined by ASME and the Institute of Electrical and Electronics Engineers (IEEE). See **Figure 20-2** for some of the basic symbols used for electrical and electronics drafting. Refer to ANSI/IEEE Y32E, "Electrical and Electronics Graphics Symbols and Reference Designations," for a complete collection of standard symbols.

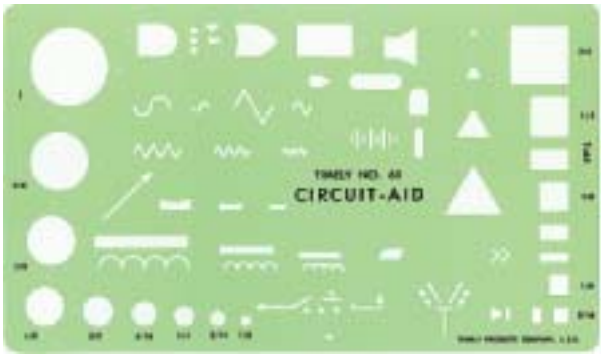


Figure 20-1
Template for electrical and electronic circuits

Schematic Diagram

A **schematic diagram**, or circuit diagram, shows how a *circuit* is connected and what it does. The schematic diagram in **Figure 20-3** does not show the physical size or shape of the parts of the circuit. It does not show where the parts of the circuit actually are. Instead, it is used to illustrate the details of the circuit design and to help troubleshooters trace the circuit and its functions.

Layout

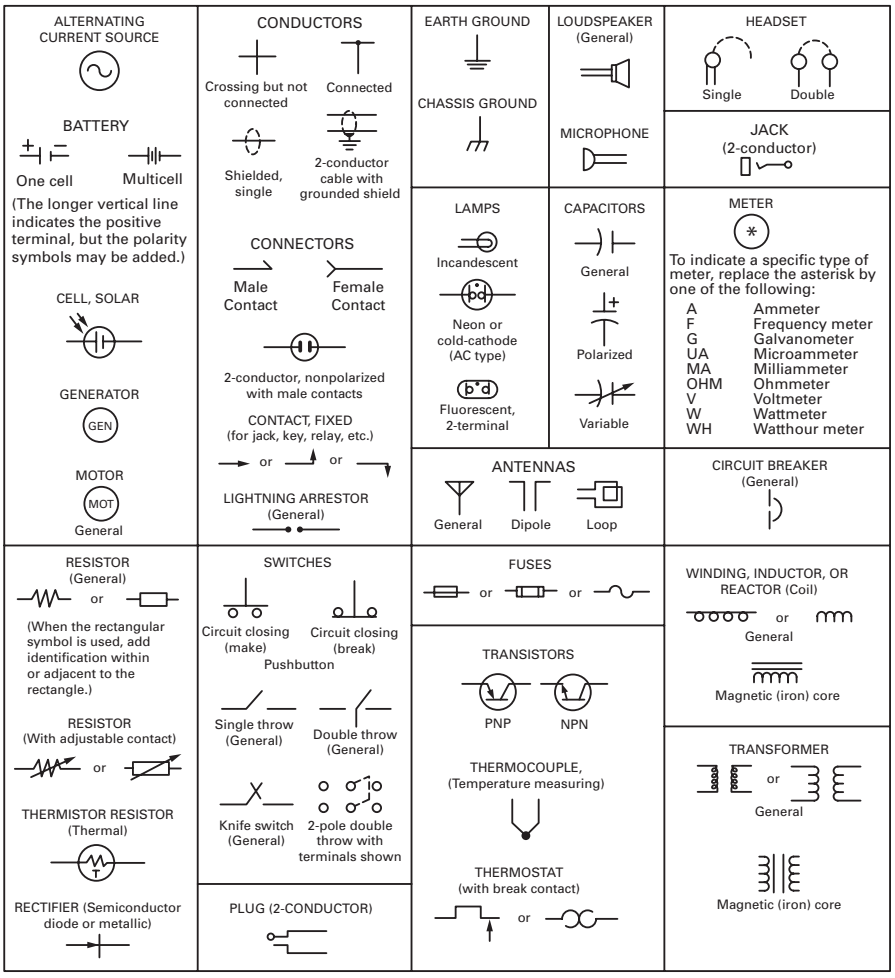
The layout of a schematic diagram should follow the circuit, signal, or transmission path from input to output, from power source to load, or in the order in which the equipment works. In general, schematic diagrams should be laid out so they can be read from left to right with the input on the left and the output on the right as in Figure 20-3. Complex diagrams should generally be laid out in two or more layers and be read from upper left to lower right. Each layer should be read from left to right. When possible, include endpoints for outside connections at the outer edges of the circuit layout. Functional groups are often outlined with dashed lines to make the schematic easier to read.

Connecting Lines

The lines that connect the components of a circuit should be drawn horizontally or vertically, when possible. Use as few bends and

Figure 20-2

Standard electricity/electronics symbols



crossovers as possible. Do not connect four or more lines at one point if they can just as easily be drawn another way.

When you draw connecting lines parallel to each other, the spacing between the lines should be no less than .06″ (approx. 2 mm) at the final drawing size. Group parallel lines according to what they do. It is best to draw them in groups of three. Allow double spacing between groups of lines.

Interrupted Group Lines

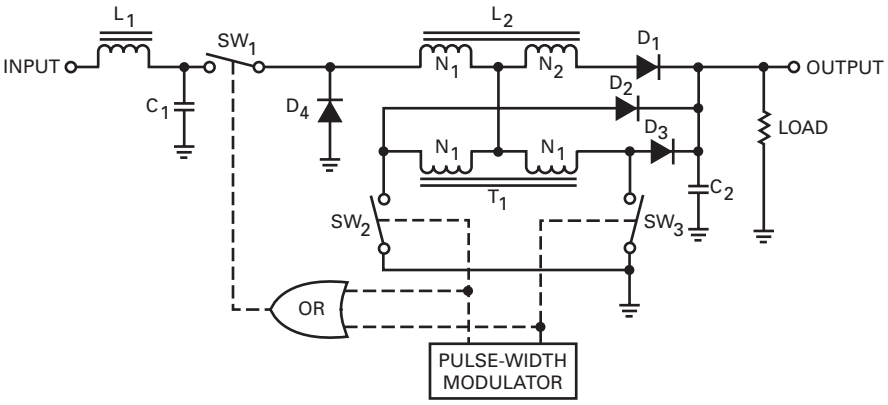
When interrupted lines are grouped and bracketed, identify them as shown in **Figure 20-4**. You can show at the brackets where the lines are meant to go or to be connected. Do this using notes outside the brackets as in **Figure 20-4A** or by using a dashed line between brackets as in **Figure 20-4B**. When using a dashed line to connect brackets, draw it so that it will not be mistaken for part of one of the bracketed lines. Begin the dashed line in one bracket and end it in no more than two brackets.

Interrupted Single Lines

When a single line is interrupted on a schematic diagram, show where the line is going in the same place where you identify it. Identify single interrupted lines in the same way as grouped and bracketed lines.

Figure 20-3

A schematic diagram of a voltage regulator



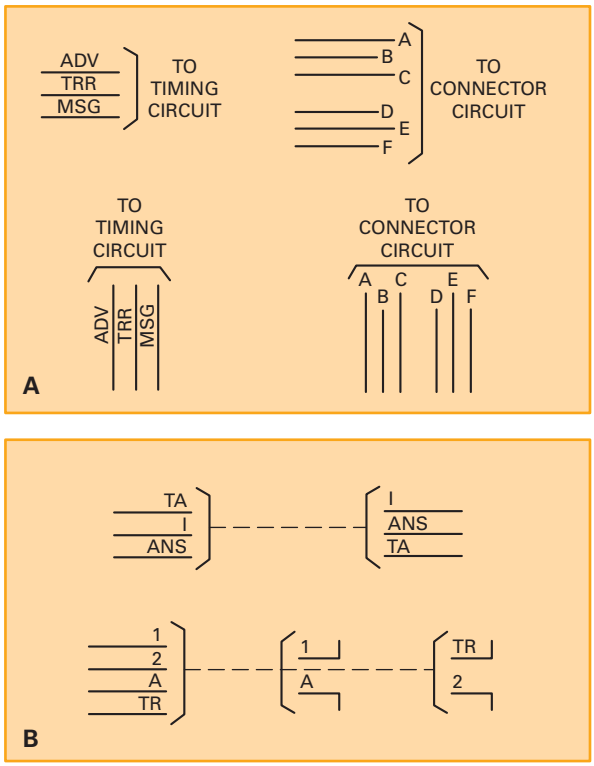


Figure 20-4

Typical arrangement of line identifications and circuit destinations

Reading Check

Explain How do you draw the lines that connect a circuit's components?

Single-Line Diagram

Figure 20-5 is an example of a single-line diagram. This type of diagram is a schematic diagram that shows the course of an electric circuit and the parts of the circuit using single lines and symbols. The diagram tells in a basic way how a circuit works, leaving out much of the detailed information shown on

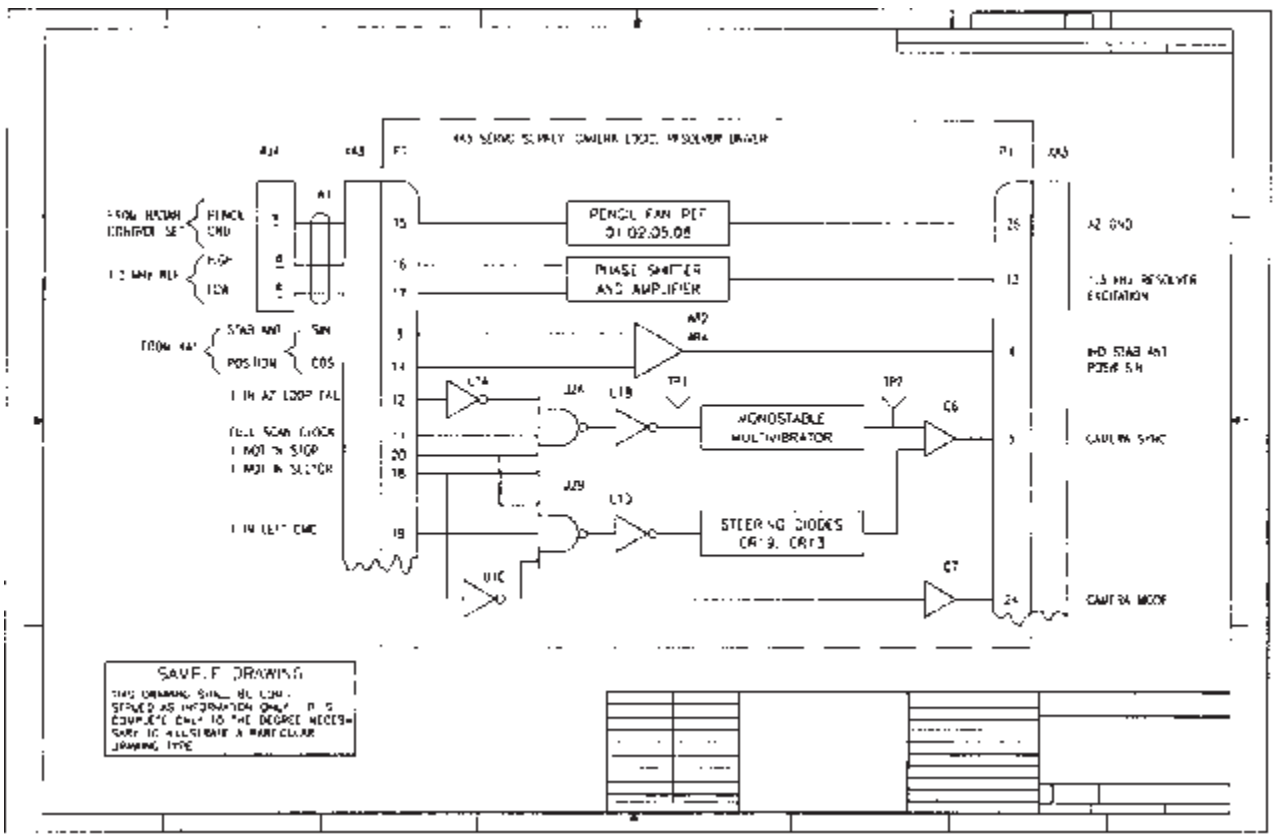


Figure 20-5

Single-line diagram

STEM

Do The Math

Algebra and Ohm's Law

The Ω symbol that appears in Figure 20-6 refers to *ohms*, a measurement of electrical resistance that was developed by Georg Ohms in 1827. If you know the value of any two of the variables in the formula for Ohm's law, you can find the value of the third by **manipulating** the formula algebraically. For example, if you know the voltage and the resistance of a circuit, you can find the current. According to the rules of algebra, the value of an equation does not change as long as you perform the same operation on both sides of the equal sign.

A 110 volt outlet supplies a light with resistance of 2400 ohms. Compute the current flowing through the light.

Example:

In a circuit in which the voltage (*V*) is 120V and the resistance (*R*) is 20Ω, what is the current?

Math Concept To solve for current (*I*), first divide both sides of the formula by *R*:

$V/R = I \times R/R$

The *R*s on the right side cancel out, so the equation can be rewritten as:

$V/R = I$

So, you can find the current, measured in amps, by dividing the voltage by the resistance:

$120V/20\Omega = 6$ amps

Academic Standards

Mathematics

Represent and analyze mathematical situations and structures using algebraic symbols (NCTM)

For help with this math activity, go to the Math Appendix located at the back of this book.

other types of diagrams. Single-line diagrams make it possible to draw complex circuits in a simple way. For example, in a single-line diagram of a communications or power system, a single line may stand for a multiconductor communication or power circuit.

Functional Block Diagram

Another type of circuit drawing is the **functional block diagram**, which shows the functions of major elements of a circuit or system in a greatly simplified form. The drawing consists of rectangular blocks that represent the elements of the circuit joined by single lines and clarified by explanatory notes (see **Figure 20-6**). The blocks show how the components or stages are related when the circuit is working. Note the arrowheads at the terminal ends of the lines. These arrowheads show which way the signal path travels from

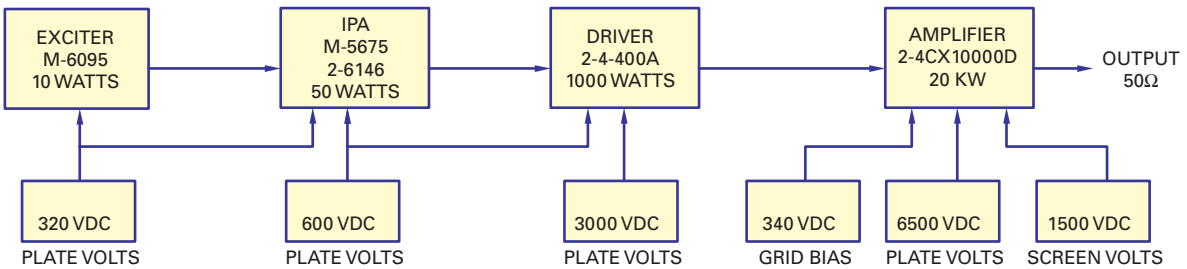


Figure 20-6

Functional block diagram of a 20,000W broadcast transmitter

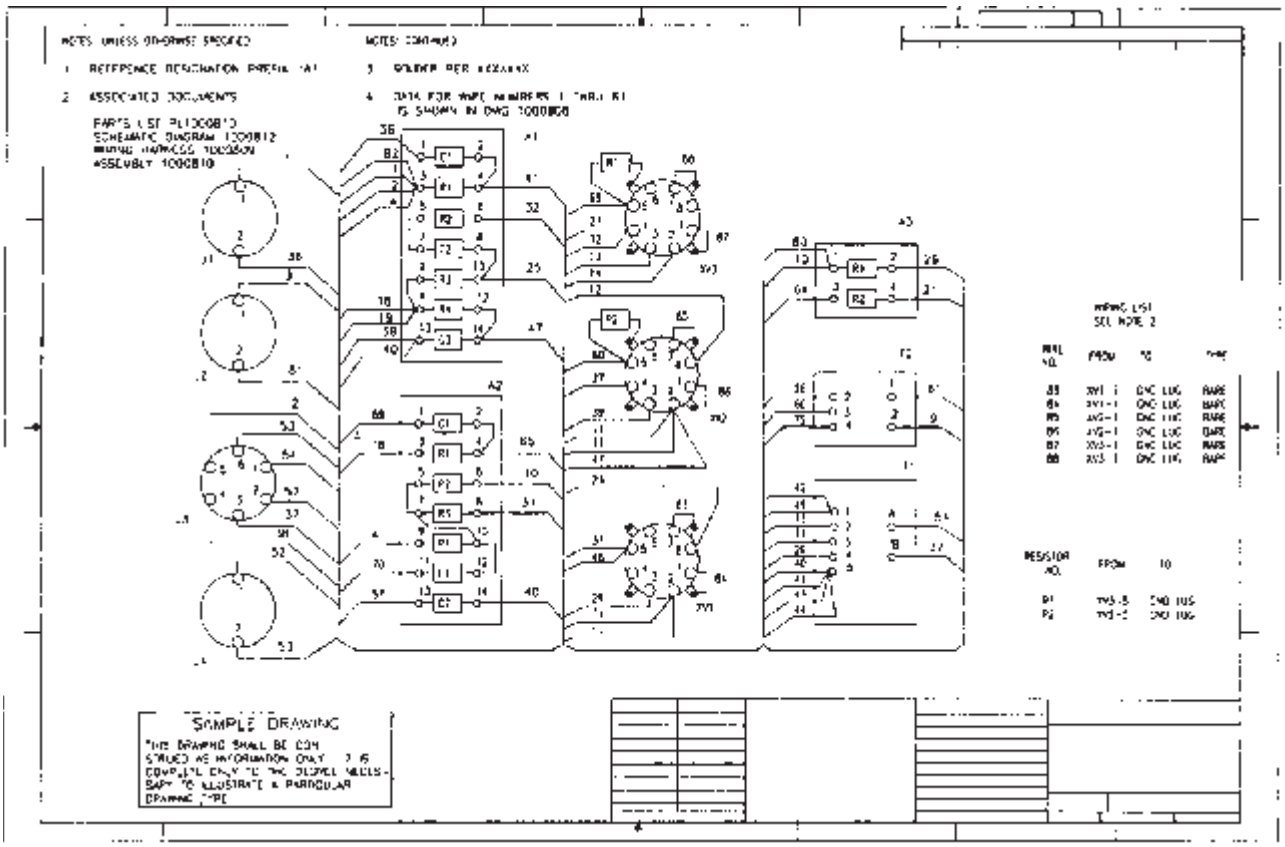


Figure 20-7
Connection or wiring diagram

input to output, reading the diagram from left to right. The size of a block is generally determined by the amount of text that needs to be included. Graphic symbols are not generally used on functional block diagrams.

Engineers often draw or sketch functional block diagrams as a first step in designing new equipment. Because blocks are easy to sketch, the engineer can try many different layouts before deciding which to use. Block diagrams are also used in catalogs, descriptive folders, and advertisements for electrical equipment. In technical service literature, functional block diagrams aid in troubleshooting problems and repairing equipment.

Connection Diagram

A diagram that shows how the components of a circuit are connected is a **connection diagram**, often referred to as a *wiring diagram*. A connection diagram shows in detail the physical arrangements of electrical connections and wires between elements within a circuit (see **Figure 20-7**). Ordinarily, only the wiring for internal connections and the connections that have one internal terminal are shown in the diagram. External wiring is omitted.

Interconnection Diagram

An interconnection diagram is similar to a connection diagram, but it shows only external connections between components. The connections inside each component are not shown. Refer to **Figure 20-8** for an example of an interconnection diagram. As you can see, each component is shown on the diagram by a broken rectangle. The name of the component is included for clarity.

Reading Check

Describe What type of graphic symbols are used on functional block diagrams?

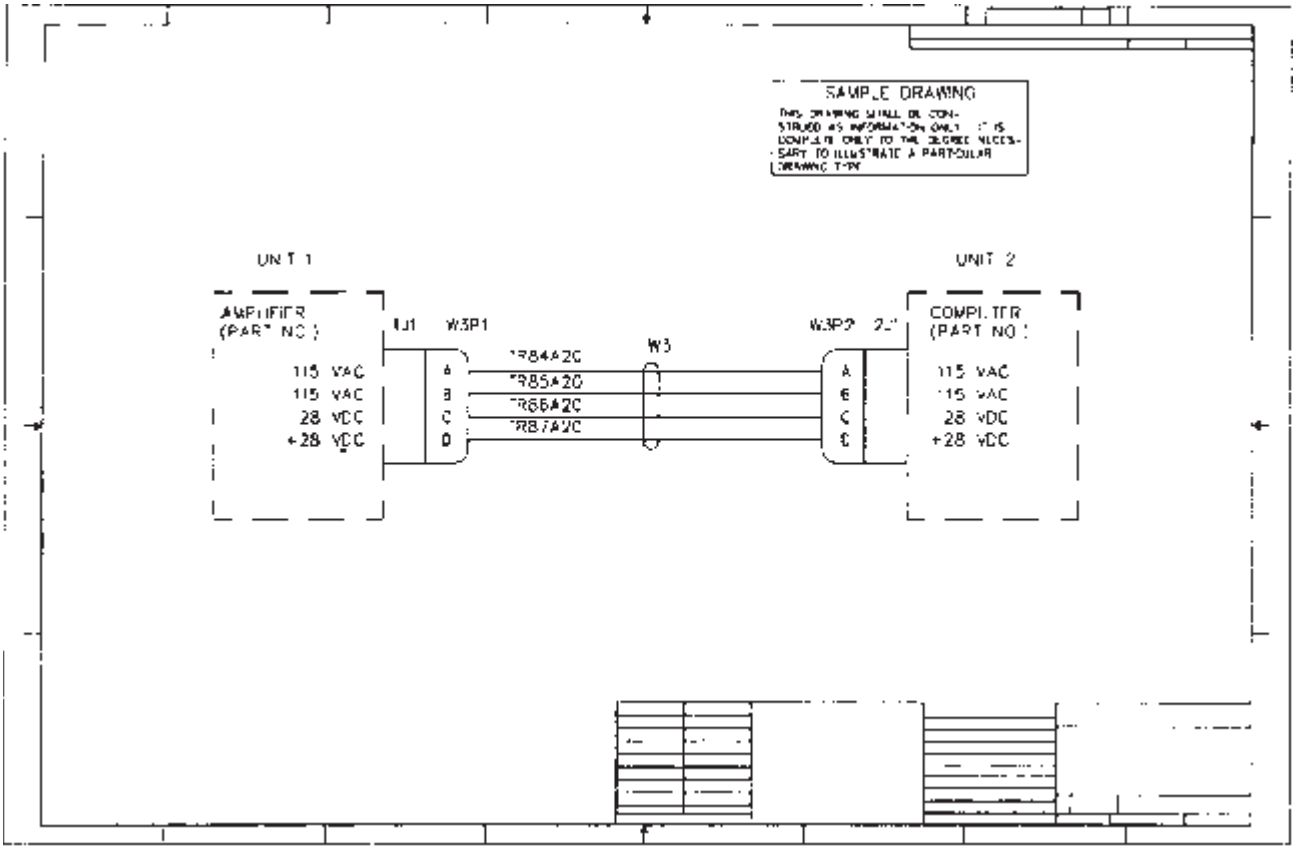


Figure 20-8
Interconnection diagram

Logic Circuit Diagram

Logic circuit diagrams are diagrams that show a circuit's logic functions. In addition to the logic symbols discussed earlier, a logic circuit diagram usually includes the pin numbers on integrated circuits, test points, boundaries of the assembly, and any nonlogic functions that might be necessary to describe the circuit completely. See **Figure 20-9** for an example of a logic circuit diagram.

Printed Circuit Drawings

Many electronic devices **incorporate** printed circuit boards into a product's design. A *printed circuit board* is a rigid or flexible board made of a dieletric base material onto which circuitry can be added. The term *printed* refers to the process used to deposit the circuitry on the board. Common processes include etching, screen printing, and bonding.

Printed circuit drawings are used to make printed circuit boards. Each drawing is an exact layout of the pattern of the circuit needed. The drawing is made at actual size or larger. If drawn larger, it can be photoreduced. The conductor lines on the drawing should be at least .03″ (1 mm) wide and spaced at least .03″ apart (see **Figure 20-10**).

Electrical Layouts for Buildings

The diagram in **Figure 20-11** shows the usual way in which an architect locates electric outlets and switches in a building. This plan shows where only the lights, base plugs, and switches are to be placed. See **Figure 20-12** for a list of the symbols used in architectural electrical drawings.

Note that you cannot build a good electrical system using the diagram in Figure 20-12. A complete and detailed set of electrical drawings is needed to create the actual system. These drawings must be made by someone who knows the system's engineering needs.

Reading Check

Identify What processes can be used to add "printed" items to a circuit board?

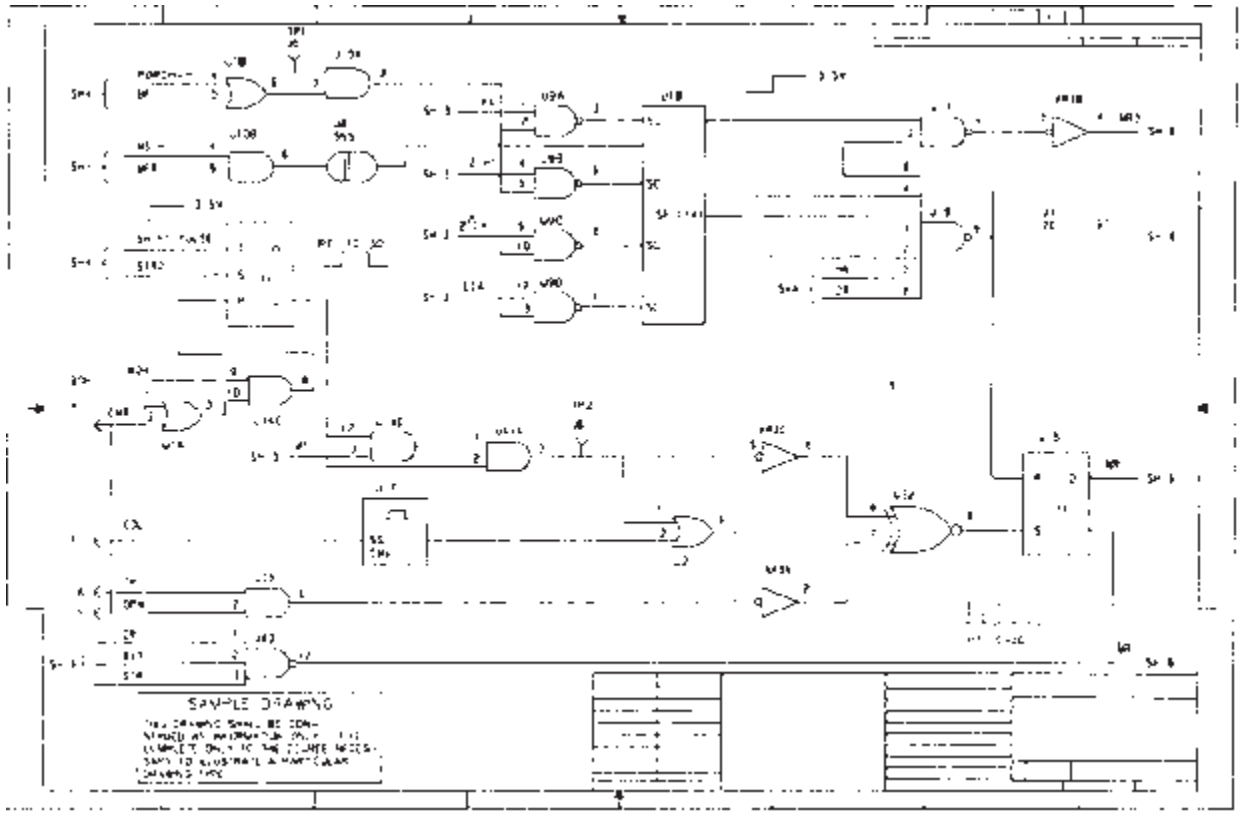


Figure 20-9
Logic circuit diagram

Drawing Conventions

How do you use color codes when you draw circuit diagrams?

Drafters follow standard conventions when drawing electrical or electronic diagrams. These standards make it easier for people to read and understand the diagrams.

Color Codes

The use of color codes is an easy way to show information when you draw circuit diagrams. Color codes are also used on the actual wiring of the circuit. In electrical and electronic work, drafters use a color code to show certain characteristics of components, to identify wire leads, and to show where wires are connected. When using a color

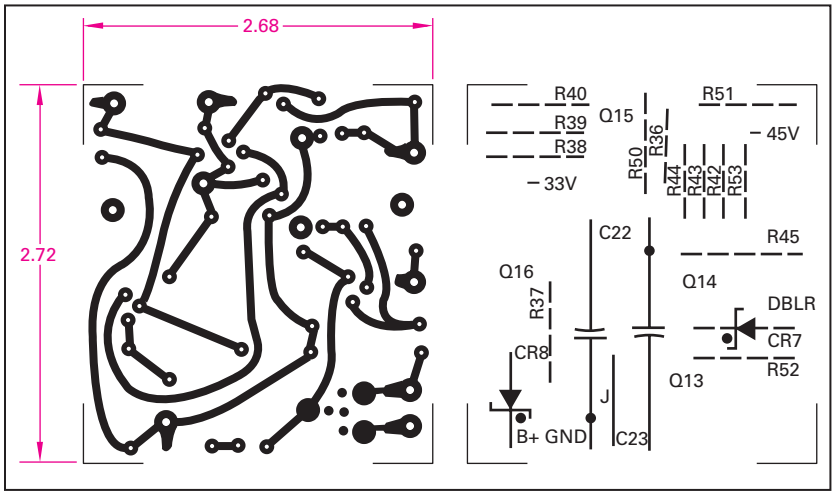


Figure 20-10
A printed circuit layout with a component identification overlay

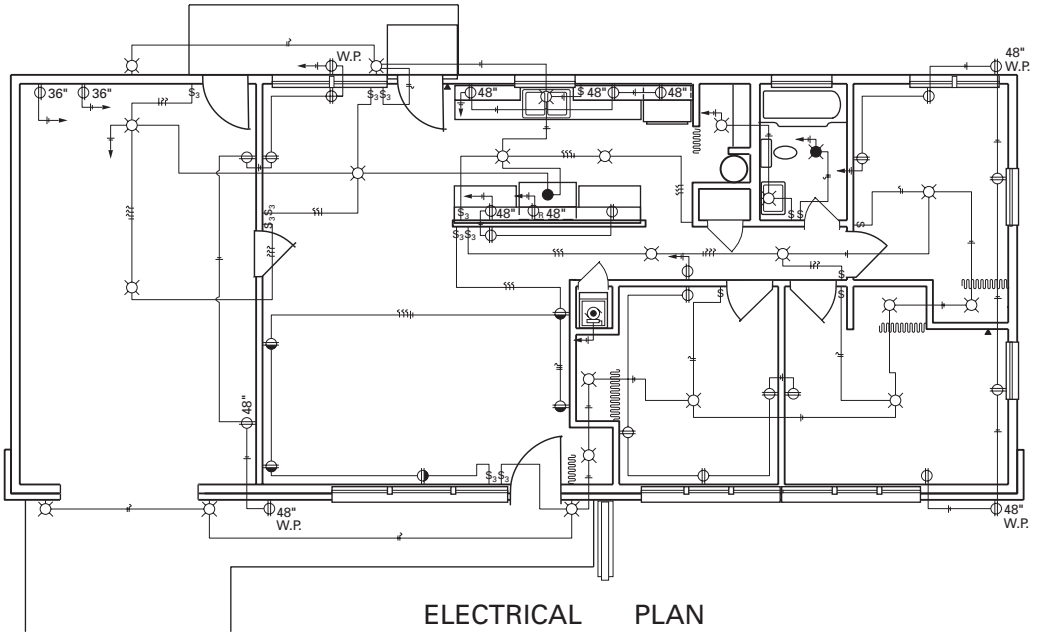


Figure 20-11

Electrical plan for a ranch house

code, you should look up the standards of the Electronic Industries Association (EIA) and any other color code that might be needed. See **Table 20-1** to learn what each color in the EIA color code represents.

Refer to Figure 20-13 for one common example of the use of the EIA color code in electricity and electronics. Resistors are banded as shown in **Figure 20-13A**. The color bands show the resistor's value in ohms. The first band represents the first digit of the value, the second band represents the second digit, and the third band represents the number by which the first two digits are multiplied. For this purpose, the colors in the EIA color code are assigned a multiplier, as indicated in the third column of Table 20-1. Notice that the number of zeros in the multiplier for each color is the same as the number the color represents. For example, the multiplier represented by a blue band is 100,000 (five zeros). See **Figure 20-13B** for the way to read the bands on the resistor shown in Figure 20-13A. If a fourth band is present, it identifies the resistor's tolerance. A gold band represents a tolerance of 5%, and a silver band represents a tolerance of 10%. If no fourth band is present, the resistor's tolerance is 20%.

Color	Number	Multiplier (for Resistor Identification)
BLACK	0	1
BROWN	1	10
RED	2	100
ORANGE	3	1,000
YELLOW	4	10,000
GREEN	5	100,000
BLUE	6	1,000,000
VIOLET	7	10,000,000
GRAY	8	100,000,000
WHITE	9	1,000,000,000
Color		**Tolerance**
SILVER		± 10%
GOLD		± 5%
NO TOLERANCE BAND		± 20%

Table 20-1

The EIA Color Code Standard

Line and Symbol Conventions

When using electrical or electronic symbols on a drawing, keep the following rules in mind:

1. Line conventions for electrical/electronic drawings should be as shown in **Figure 20-14**.

Arnold and Brown

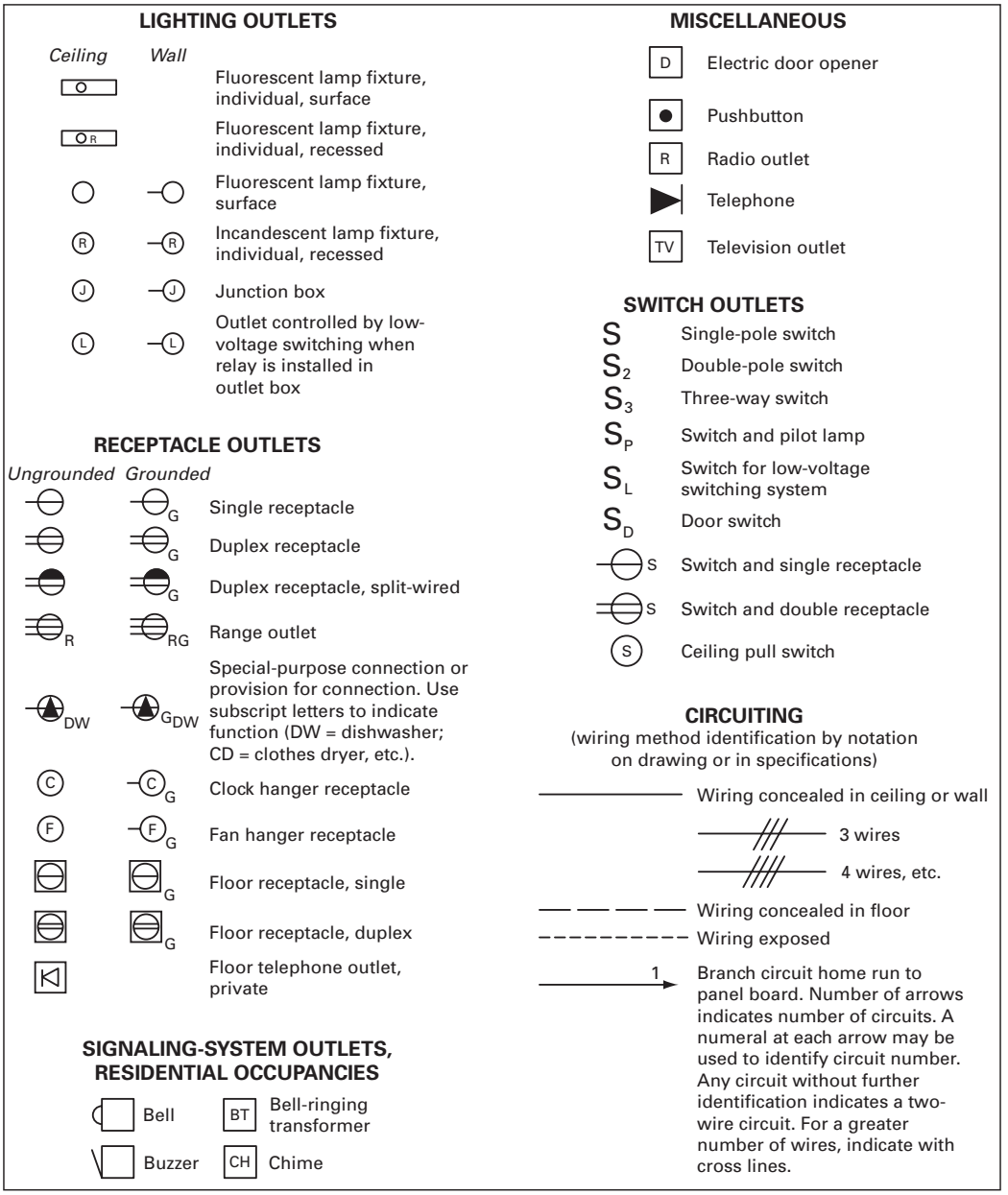


Figure 20-12

Electrical wiring symbols for architectural design and floor plan layout

2. The width of a line does not affect the symbol's meaning. Sometimes, however, a wider line can be used to show that something is important.
3. Most of the time, the angle of a line connected to a symbol does not matter. Generally, lines are drawn horizontally and vertically.
4. Sometimes it may be desirable to draw paths and equipment that will be added to the circuit later or that are connected to the circuit but are not part of it. Show

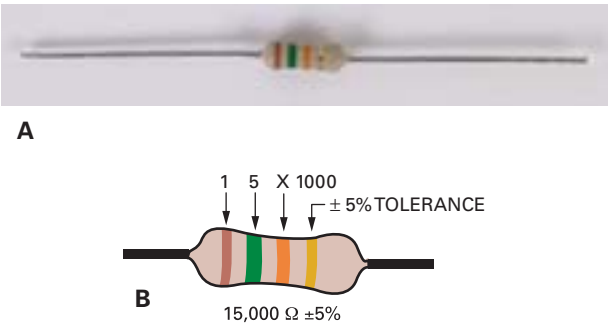


Figure 20-13

Color coding on a resistor

this by drawing lines made up of short dashes (- - - -).

5. A symbol is made up of all its various parts.
6. The direction a symbol is facing on a drawing does not change its meaning. This is true even if the symbol is drawn backward.
7. Symbols are not drawn to scale but can be drawn at any size needed. However, a symbol's size must fit with the rest of the drawing, and each symbol must be in proportion to the others, as indicated in the standard. That is, if one symbol is drawn twice the size shown in the standard, all other symbols should be drawn at double size.
8. The arrowhead of a symbol can be drawn closed → or ⇨ open.
9. The standard symbol for a terminal ○ can be used where connecting lines are attached. These are not part of the graphic symbol, unless the terminal symbol is part of the symbol shown in the standard.
10. If details of type, impedance, rating, and so on are needed, they may be added next to a symbol. The abbreviations used should be from ASME Y14.38, "Abbreviations and Acronyms." Letters that are joined together and are standard parts of symbols are not abbreviations.
11. Use the ground symbol only when the circuit ground is at a potential level equivalent to that of earth potential. Use the symbol when you do not get an earth potential from connecting the ground wire to the structure that houses or supports the circuit parts. This is known as a *chassis ground*.

LINE APPLICATION	LINE THICKNESS
FOR GENERAL USE	MEDIUM
MECHANICAL CONNECTION, SHIELDING, AND FUTURE CIRCUITS LINE	MEDIUM
BRACKET-CONNECTING DASH LINE	MEDIUM
USE OF THESE LINE THICKNESSES OPTIONAL	
BRACKETS, LEADER LINES, ETC.	
BOUNDARY OF MECHANICAL GROUPING	
FOR EMPHASIS	

Figure 20-14
Line conventions for electrical and electronic drawings

Section 20.1 Assessment
After You Read

Self-Check

1. **Summarize** how to use standard ASME/ANSI/IEEE symbols in the development of electrical and electronic diagrams.
2. **Describe** the difference between schematic diagrams and functional block diagrams.

Academic Integration
Mathematics

3. In a circuit in which the voltage (E) is 240V and the resistance (R) is 60Ω, what is the current?

Math Concept Problem Solving

Solve for current (I) by dividing both sides of the formula by R:

$E/R = I \times R/R$. The Rs on the right side cancel out. The equation can be rewritten as $E/R = I$. Find the current by dividing the voltage by the resistance.

Drafting Practice

4. Prepare a block diagram of the broadcast transmitter in Figure 20-6.
5. On an A-size sheet, draw the schematic diagram of the voltage regulator in Figure 20-3.

Go to **glencoe.com** for this book's OLC for help with this drafting practice.

20.2 Drawing Electrical and Electronic Diagrams

READING GUIDE

Before You Read

Connect In preparing electrical/electronic diagrams, board drafters have somewhat different concerns than those using CAD techniques do. What do you think those could be, and how could you address them?

Academic Vocabulary

Learning these words while you read this section will also help you in your other subjects and tests.

- conform

Graphic Organizer

Use a chart like the one here to organize notes about electrical/electronic diagrams.

Making Electrical / Electronic Diagrams	
Board Drafting Techniques	CAD Techniques

Go to **glencoe.com** for this book's OLC for a downloadable version of this graphic organizer.

Academic Standards

English Language Arts

Develop an understanding of and respect for diversity in language use, patterns, and dialects across cultures, ethnic groups, geographic regions, and social roles (NCTE)

Mathematics

Data Analysis and Probability Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer (NCTM)

Industry Standards

ADDA Section 7

Electrical/Electronic Drafting (ANSI Y14.15, ANSI Y14.15a, ANSI Y32.9, ANSI C84.1, ISA S5.1, ANSI/IEEE 315)

NCTE *National Council of Teachers of English*
NCTM *National Council of Teachers of Mathematics*
ADDA *American Design Drafting Association*
ANSI *American National Standards Institute*

Board-Drafting Techniques

What should you consider when choosing the line width for an electrical diagram?

Board drafters must be careful to consider line width as they set up an electrical/electronic diagram. If there is a chance that the size of the drawing may be changed, they should choose a line thickness, symbol size, and letter size that will be readable after the diagram is enlarged or reduced. For most circuit diagrams meant to be used for manufacturing or in a smaller form, draw symbols about 1.5 times the size shown in Figure 20-12 or in ANSI/IEEE Y32E.

Line thickness and lettering used with circuit diagrams should **conform** with ASME Y14.2M and local needs. Draw lines of medium thickness for general use on circuit diagrams. Use thin lines for brackets, leader lines, and so on.

Refer to **Figure 20-15** for a schematic diagram of a power-factor controller. Follow these steps to create the drawing:

1. Prepare an A-size drawing sheet.
2. Lay out the connecting lines using light construction lines as in **Figure 20-16**.
3. Use a symbol template similar to the one in Figure 20-1 to add the necessary symbols to the drawing.
4. Add the dashed line that surrounds the ramp generator.
5. Add all necessary text and notes to the drawing.
6. Adjust the connecting lines as necessary to accommodate the text and symbols.
7. Darken all lines to finish the drawing.

Reading Check

Explain What size lines should be used for brackets and leader lines?

CAD Techniques

What rule should you remember when you add symbols to a diagram?

CAD drafters use symbol libraries to produce circuit diagrams. Follow these steps to create the schematic diagram in Figure 20-15.

1. Create a new drawing. Unlike other types of drafting, electrical/electronics drafting does not require exact distances between components or areas of the drawing. Therefore, you do not have to calculate precise drawing limits.
2. With Ortho on to force vertical and horizontal lines, use polylines to create the connecting lines for the drawing as in Figure 20-16. Draw the outside lines first and allow them to fill most of the drawing area. Then add the interior lines, adjusting the outer lines if necessary.
3. Using DesignCenter, open AutoCAD's electronics symbol library. Select the appropriate symbols and drag them into place on the drawing as in Figure 20-15. If necessary, scale the symbols, but remember to use the same scale for all of the symbols.
4. Add the dashed line around the ramp generator.

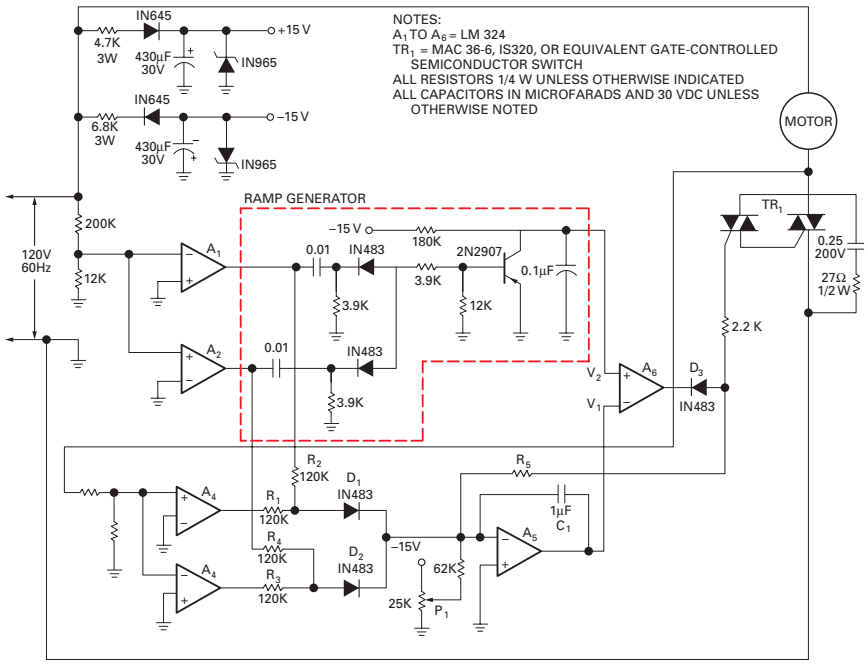


Figure 20-15
Schematic diagram of a power-factor controller

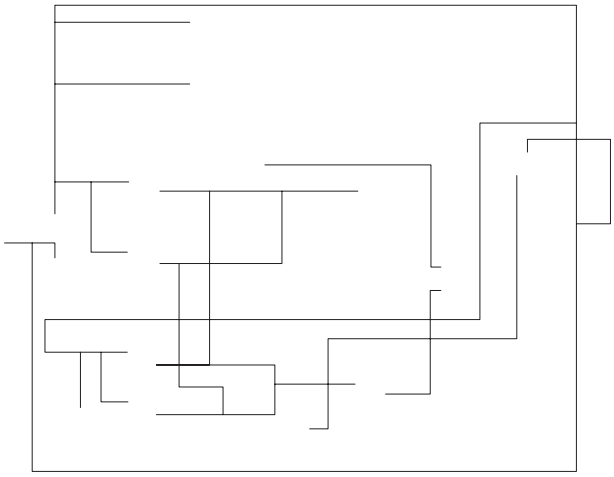


Figure 20-16

Use light construction lines to place the main connecting lines

5. Use the TEXT command to add all necessary text and notes.
6. Check the drawing against Figure 20-15 to be sure that all of the symbols are present and properly placed.
7. Adjust connecting lines as necessary to increase the diagram's readability.
8. Save the finished drawing.

CAD TIP

Streamlining TEXT

You need enter the TEXT command only once to add all of the text for the entire drawing. Instead of pressing Enter twice to end the command, when you finish entering a line of text, use the cursor to select another starting point for text. Each line of TEXT then becomes a separate object in the drawing database, so when you finish entering all of the text and press Enter twice, each line of text is editable separately.

Section 20.2 Assessment
After You Read

Self-Check

1. **Summarize** how to draw electrical/electronic diagrams using board techniques.
2. **Explain** how to use CAD techniques to create a schematic diagram.

Academic Integration
English Language Arts

3. Section 20.1 mentions the Institute of Electronic Engineers (IEEE), which defines standard electronic symbols for drafting. With more than 360,000 members, the IEEE is also the world's largest technical professional organization. Using the Internet or library, conduct research on the IEEE and present a list of ten facts in an oral report to the class.

Drafting Practice

4. Prepare a complete single-line diagram for the AM-FM stereo unit as in **Figure 20-17**. Estimate sizes and draw twice the size. Use a template if you are using board drafting techniques, or use a symbol library for a CAD drawing.

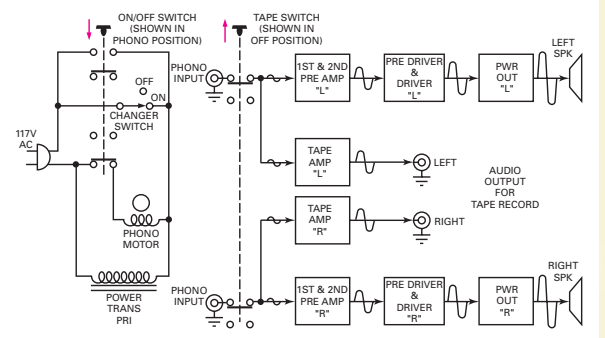


Figure 20-17

Go to **glencoe.com** for this book's OLC for help with this drafting practice.

CHAPTER 20

Review and Assessment

Chapter Summary

Section 20.1

- A series circuit is drawn to show the current flowing from the source through each load sequentially; a parallel circuit is drawn to indicate that the current can flow through more than one path simultaneously; and a series-parallel circuit allows many different arrangements with both series and parallel components.
- Schematic diagrams show how a circuit is connected and what it does; functional block diagrams show the relationships between a circuit's components or stages.

Section 20.2

- The type of lines used in making electrical/electronics diagrams should be chosen carefully.
- CAD drafters generally use symbol libraries to produce circuit diagrams.

Review Content Vocabulary and Academic Vocabulary

1. Use each of these Content Vocabulary and academic vocabulary words in a sentence or drawing.

Content Vocabulary

- schematic diagram (p. 691)
- functional block diagram (p. 694)
- connection diagram (p. 695)

Academic Vocabulary

- manipulating (p. 694)
- incorporate (p. 696)
- conform (p. 702)

Review Key Concepts

2. **Explain** how to use standard ASME/ANSI/IEEE symbols in the development of electrical and electronic diagrams.

3. **Contrast** between schematic diagrams and functional block diagrams.

4. **Describe** how to draw electrical/electronic diagrams.

5. **Explain** how to create a schematic diagram using CAD techniques.

STEM Science

6. The Structure of the Atom

The source of electrical energy is the atom, which is made up of electrons, that flow through wires or other metal conductors to create electricity. Using a science textbook or the Internet, draw and label a model of an atom and its parts. Below your drawing, define each of the main parts of the atom, and explain how the movement of electrons creates the charge that forms the basis of electricity.

21st Century Skills

7. Workplace Safety

Your awareness of safety-related issues in the workplace is important in any job you have. Using resources from the library, Internet, and appropriate organizations, research the roles of the government, employer, and employee in ensuring workplace safety. Outline the information obtained, including statistics on workplace accidents. Then make an interesting graphic illustrating the major points in two languages, the second with the help of a teacher or of someone whose first language is not English.

STEM Mathematics

8. Calculating Current

In a circuit in which the voltage (E) is 120V and the resistance (R) is 20Ω, what is the current?

Math Concept **Problem Solving**

Solve for current (I) by dividing both sides of the formula by R:

$E/R = I \times R/R$. The Rs on the right side cancel out. The equation can be rewritten as $E/R = I$. Find the current by dividing the voltage by the resistance.

Standardized Test Practice

Prep For ADDA

True/False Questions

Directions Read the following statements and determine whether each statement is true or false.

9. *Circuit* refers to something that is a complete path.

T

F

10. Electrical symbols may be drawn at any size, but the size used must be consistent and fit with the rest of the drawing.

T

F

TEST-TAKING TIP

Concentration can reduce anxiety when you are taking a test. Rather than worrying about whether you should have studied more, focus on one question at a time.

Win Competitive Events

SkillsUSA

Job Skills Demonstration

Organizations such as SkillsUSA offer a variety of architectural, career, and drafting competitions. Completing activities such as the one below will help you prepare for these events.

Activity Design a battery-operated light circuit for the outside of your home. It needs to run off an independent 12V battery. Draw the block diagram.

Go to **glencoe.com** for this book's OLC for more information about competitive events.

CHAPTER 20

Problems

Drafting Problems

The drafting problems in this chapter are designed to be completed using board drafting techniques or CAD.

1. Draw the audio signal-flow diagram shown in **Figure 20-18**. Note that when the tape player is turned on, all other functions (AM, FM, and CD player) are disabled. Also, the changer switch cannot turn on the CD motor.

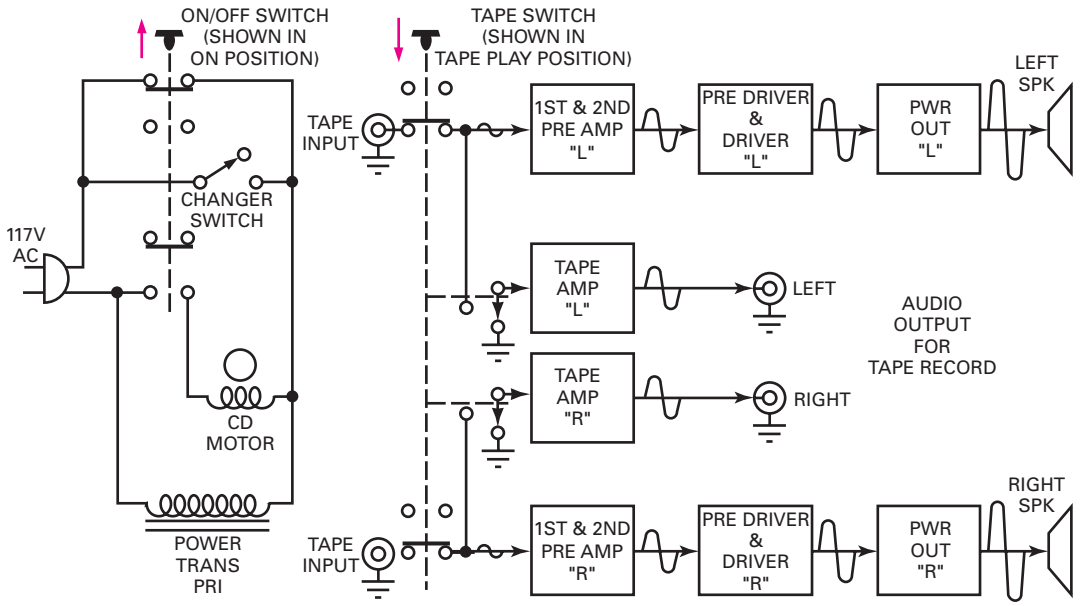


Figure 20-18

2. Prepare a schematic diagram of the signal conditioner shown in **Figure 20-19**.

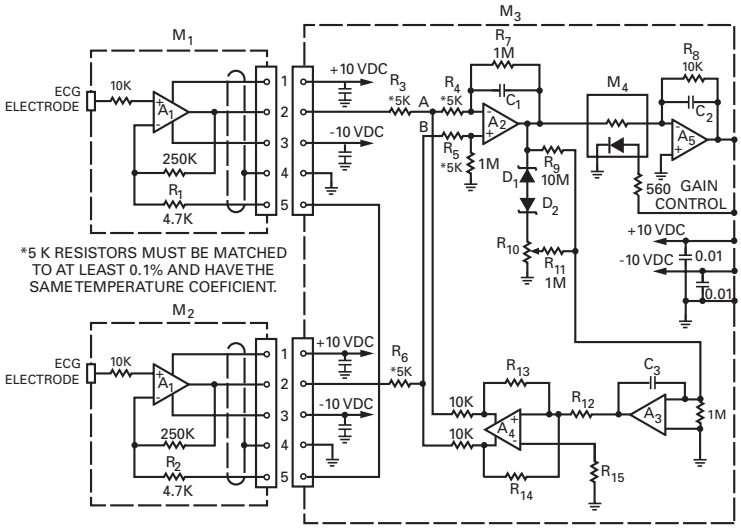


Figure 20-19

3. Draw a schematic diagram from the pictorial shown in **Figure 20-20**.

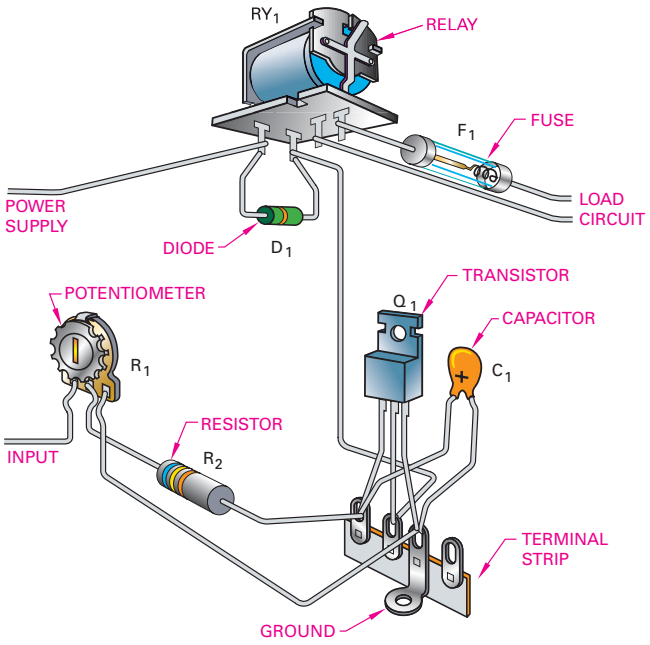


Figure 20-20

Design Problems

Design problems have been prepared to challenge individual students or teams of students. In these problems, you are to apply skills learned mainly in this chapter but also in other chapters throughout the text. The problems are designed to be completed using board drafting, CAD, or a combination of the two. Be creative and have fun!

1. Design a doorbell for a recreational vehicle to run off the RV's battery. Draw the schematic diagram.

2. You recently bought a cottage in Vermont, and the wiring needs to be updated. Draw the wiring diagram to control a stairway light that can be operated from both the top of the stairs and the bottom of the stairs.