Chapter 5

Components, Symbols, and Circuitry of Air-Conditioning Wiring Diagrams
Objectives

• Upon completion of this course, you will be able to:
  – Explain what electrical loads are and their general purpose in heating, cooling, and refrigeration systems
  – Give examples of common loads used in heating, cooling, and refrigeration systems
  – Identify the symbols of common loads used in heating, cooling, and refrigeration systems
Objectives (cont’d.)

– Explain the purpose of relays and contactors in heating, cooling, and refrigeration systems

– Identify the symbols of relays and contactors in heating, cooling, and refrigeration systems

– Explain the purpose of switches and the types used in heating, cooling, and refrigeration systems
Objectives (cont’d.)

– Identify the symbols of switches in heating, cooling, and refrigeration systems
– Identify the symbols and purpose of other miscellaneous controls in heating, cooling, and refrigeration systems
– Identify the different types of wiring diagrams used in the industry and the purpose of each
Key Terms

- Contactor
- De-energized
- Disconnect switch
- Energized
- Factual diagram
- Fuse
- Heater
- Installation diagram
- Load
- Magnetic overload
- Magnetic starter
- Motor
Key Terms (cont’d.)

- Normally
- Normally closed
- Normally open
- Pictorial diagram
- Pilot duty device
- Pole

- Pressure switch
- Push-button switch
- Relay
- Schematic diagram
- Signal light
- Solenoid
Key Terms (cont’d.)

• Switch
• Thermal overload
• Thermostat
• Throw
• Transformer
Introduction

• Electric wiring diagrams
  – Wealth of information
    • Electrical installation
    • Operation of equipment
  – Depended upon for correct installation of wiring to the unit
  – Used as a guide in troubleshooting
  – Symbols are used to represent components
Loads

• Electrical devices that consume electricity to do useful work
  – Motors, solenoids, resistance heaters, and other current-consuming devices

• Most important part of a heating, cooling, or refrigeration system
  – They do all the work
Motors

• Electrical devices that consume electric energy to rotate a device
  – Used to rotate compressors, condenser fan motors, pumps, etc.

• Largest and most important loads in heating, cooling, and refrigeration systems
Figure 5.8 Symbols representing some common letter designations. *(Delmar/Cengage Learning)*
Solenoids

• Devices that create a magnetic field when energized
  – Cause some action to an electric component (e.g., relay or valve)

• Considered to be loads
  – Consume electricity to do useful work
Figure 5.10
(a) Solenoid valve with coil; (b) Symbol for Solenoid.
(Delmar/Cengage Learning)
Heaters

- Loads found in many systems and wiring diagrams
  - Convert electrical energy to heat
    - In some cases, electric resistance heaters are used to heat homes
    - May be used to heat a small object or area
Figure 5.11 Symbols for commonly used electric heaters.

(Delmar/Cengage Learning)
Signal Lights

• Lights that are illuminated to denote a certain condition in a system
  – Show that equipment is operating or is operating in an unsafe condition

Figure 5.12 Symbols for signal lights showing the color of the light.
(Delmar/Cengage Learning)
Contactors and Relays

- Open and close a set or sets of electric contacts by action of solenoid coil
  - Composed of a solenoid and contacts
    - When solenoid is energized contacts open or close, depending on original position

- Main difference between a contactor and relay is size
  - Contactor is simply a large relay
Figure 5.13 Relay. 
(Delmar/Cengage Learning)

Figure 5.14 Contactor. 
(Delmar/Cengage Learning)
Contactors and Relays (cont’d.)

- Composed of three parts
  - Contact
    - Pole is one set of contacts
  - Coil or solenoid
    - Is energized and closes the contact(s)
  - Mechanical linkage

- Symbols
  - Usually shown in de-energized position
Contactors and Relays (cont’d.)

• Important terms
  – Normally: position of a set of contacts when device is de-energized
  – Normally open: set of contacts that are normally open
    • When relay is energized, contacts close
  – Normally closed: set of contacts that are normally closed
    • When relay is energized, contacts open
Figure 5.15 Symbol for a normally open pole of a relay or contactor. (Delmar/Cengage Learning)

Figure 5.16 Symbol for a normally closed pole of a relay or contactor. (Delmar/Cengage Learning)

Figure 5.17 Symbols for relay or contactor coil; either symbol may be used for each device. (Delmar/Cengage Learning)
Magnetic Starters

- Same type of device as a contactor in terms of ampere rating
  - Also has a means of overload protection

Figure 5.20 (a) Magnetic starter; (b) Symbol.
(Delmar/Cengage Learning)
Switches

• Open and close to control some load in an electric circuit
  – Can be opened and closed by temperature, pressure, humidity, flow, or manually
  – Throw indicates how the switch may be operated
Switches (cont’d.)

• Important terms
  – Disconnect switch: opens and closes the main power source
  – Push-button switch: opens and closes a set of contacts by pressing a button
  – Thermostats: mechanically operated switches used in most control systems
  – Pressure switches: used for different functions in modern control circuits
Figure 5.23 Symbols for manual switches.
(Delmar/Cengage Learning)

Figure 5.25 (a) Push-button switch; (b) Symbol.
(Delmar/Cengage Learning)

Figure 5.26 Symbols for heating and cooling thermostats.
(Delmar/Cengage Learning)
Figure 5.28 Symbols for pressure switches.
(Delmar/Cengage Learning)

Figure 5.29 Pressure switches.
(Delmar/Cengage Learning)
Safety Devices

- Important in today’s modern systems
  - Fuse: simplest type of overload device
    - Effective against a large overload, but less effective against small overloads
  - Thermal overload: operated by heat
    - Example: bimetal element
  - Magnetic overload: operated by magnetism
    - Directly proportional to current draw
Transformers

• Decrease or increase incoming voltage to a desired voltage

Figure 5.36
(a) Symbol;
(b) Transformer.
(Delmar/Cengage Learning)
Schematic Diagrams

• Modern heating, cooling, and refrigeration systems
  – Becoming more complex with more controls and safety devices

• Schematic diagram
  – Most useful and easiest to follow
    • Tells how, when, and why a system works
    • Includes symbols and line representations
Pictorial Diagrams

• Also known as label or line diagrams
  – Intended to show actual internal wiring
    • Shows all control panel components as a blueprint
    • Components not shown in the control panel are shown outside the panel and labeled

• Factual diagram
  – Consists of a pictorial diagram along with a schematic diagram
Installation Diagrams

• Used to help wire the unit properly
  – Give specific information about terminals, wire sizes, color coding, and breaker or fuse sizes
  – Do not provide details about equipment operation
  – Show little internal wiring