

SECTION 1 Introduction

Unit 1 General Principles of Electric Motor Control

1. A controller is a device or group of devices that govern the delivery of a predetermined amount of electric power to apparatus connected to it. The controller's function is to start, stop, reverse, accelerate, decelerate, regulate, or protect devices connected to it.
2. Controls that initiate or cause a change in the operation of an electrical device or apparatus, and are located at a different location from the device being controlled, are called remote controls. An example of a remote control is the push button that energizes a magnetic motor starter that starts a motor.
3. Current-limiting acceleration refers to the amount of current or voltage required to open or close magnetic switches. This type of control action is generally used for starting time periods on direct-current (DC) motor control.
4. Float switch—to raise or lower liquids
 Pressure switch—to maintain liquid, gas, or air pressures within a desired range
 Time clock—to provide a definite “on and off” action
 Thermostat—to maintain temperature ranges
 Limit switch—used as an overtravel stop on machines
 Interlock—to ensure that all systems are correct before the motor is started
5. d 6. c 7. b 8. d 9. d 10. c 11. d 12. d

Unit 2 Fractional and Integral Horsepower Manual Motor Starters

1. Insufficient cooling time was allowed for the heater before resetting, or an overload still exists.
2. There are two possible answers: The motor is overloaded, causing the starter contacts to open, thereby stopping the motor; or the disconnect or circuit breaker might be open.
3. The starter may be used for automatic operation by installing an automatic control device, such as a float switch, in the automatic position of a selector switch or in series with the starter and motor. In either case, the automatic control device contacts must have the capacity to pass the full-load motor current.
4. The handle on a manual starter cannot be held to keep the contacts closed on a sustained overload.
5. The motor will not start due to an open circuit.
6. d 7. c 8. d 9. d 10. d

Unit 3 Magnetic Line-Voltage Starters

1. A magnetic line-voltage motor starter is a magnetic closing switch with overload relays for starting motors at across-the-line voltage. A motor starter protects the motor from burnout due to overloads. It can be controlled remotely with push buttons or other pilot devices.
2. Two poles; three poles
3. The most common cause is the reset mechanism, which closes the overload relay contacts, has not been pressed after heaters (type) have cooled sufficiently.

4. To obtain time-delay characteristics, a valve disc is opened or closed to various sizes of fluid bypass holes in the piston, resulting in a change in the rate of fluid flow; tripping current adjustments are obtained by adjusting the plunger core with respect to the overload relay coil.
5. Chattering is the vibration due to zero holding power twice during each cycle; in other words, the contacting surfaces of the magnet separate and come together again twice during each cycle.
6. The phase relationship is 90.
7. The shaded-pole principle is used in AC electromagnets. It is also used to provide a time lag in the decay of flux in DC coils.
8. Look for the following: foreign matter on machined surfaces of the magnet or plunger; misalignment of nonmagnetic sealing surfaces; loose laminations or broken rivets; poorly matched machined sealing surfaces; broken shading coils, or possibly foreign objects preventing the magnet parts from contacting completely. Check Unit 59, Table 59–1.
9. General purpose NEMA 1 is commonly used.
10. The combination starter takes little space and makes compact electrical installations possible.
11. The cover of the combination starter enclosure is interlocked with the external operating handle of the disconnecting means. The door cannot be opened with the disconnect switch closed. When the door is open, the accessible parts in the enclosure are not connected to the power line.
12.
 - a. The armature is binding mechanically.
 - b. The air gap of the plunger is too near the part of the magnet that has residual magnetism, or the plunger may be contacting the magnet.
 - c. A short circuit fuses or welds the contacts closed.
 - d. The magnet faces are covered with a gummy substance.
13. The *National Electrical Code*[®] and local codes require the size of the overload heater to be a percentage of the full-load motor current, generally 125 percent. The actual motor nameplate current should prevail over the tables.
14. Hazardous location enclosure (explosion proof), NEMA 7, Class 1, group D is recommended.
15. d 18. b 21. d 24. a 27. a 30. d
16. c 19. a 22. d 25. c 28. d
17. d 20. a 23. b 26. b 29. b
31. 120 Volts
32. A grounded control system has one side of the control transformer secondary connected to ground. A floating system does not have the transformer secondary connected to ground.
33. 4.17 amps (500/120)

SECTION 2 Circuit Layout, Connections, and Symbols

Unit 4 Symbols

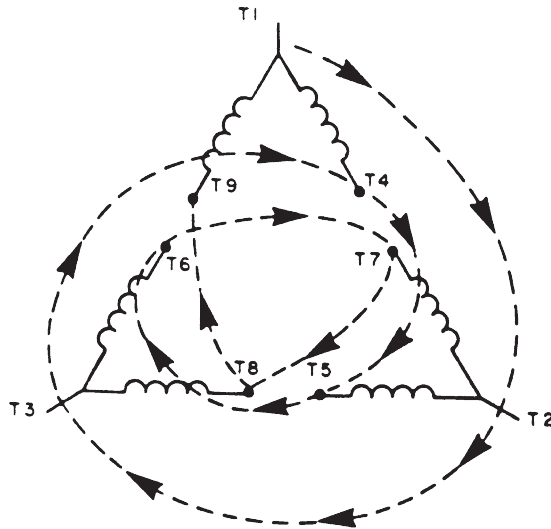
1.
 - a. Normally open, momentary contact push button
 - b. Double-acting, momentary contact push button
 - c. Mushroom head, normally closed, momentary contact push button
 - d. Normally open pressure switch
 - e. Normally closed float switch

- f. Three-phase squirrel cage motor
 - g. Current transformer
 - h. Three-phase disconnect switch
 - i. Normally open contact
 - j. Normally open, on-delay timer contact
 - k. Normally open, off-delay timer contact
 - l. Normally open limit switch
 - m. Node point showing connected conductors
 - n. Red pilot light
 - o. Normally open switch (single-pole single-throw switch)
 - p. Double-break switch
2. NEMA
3. a. single-pole single-throw d. double-pole double-throw
b. single-pole double-throw e. normally open
c. double-pole single-throw f. normally closed
4. d
5. d
6. b
7. a
8. d
9. c
10. b
11. Normally closed
12. CR coil
13. To permit letters and/or numbers to be written inside the circle to identify the coil
14. Control symbols are shown as they would be if the circuit is de-energized

Unit 5 Interpretation and Application of Simple Wiring and Elementary Diagrams

1. A wiring diagram matches physical wiring locations and devices.
2. The line diagram, also called the elementary or schematic diagram, conveys most information with least confusion.
3. These parts are not involved in the actual wiring of the circuit.
4. The two-wire control system may cause damage with sudden restarts.
5. Overload relays are placed in lines one, two, and three of the diagram.
6. Connection of the overload relay contacts is shown in line two.
7. Control circuit connection for a three-phase motor starter is shown in lines one and two.

8. Identification of terminal markings.



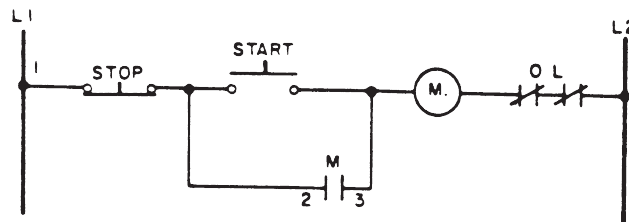
9. Contactor coil is connected in line two of a three-phase motor starter.

10. "X" indicates a closed contact.

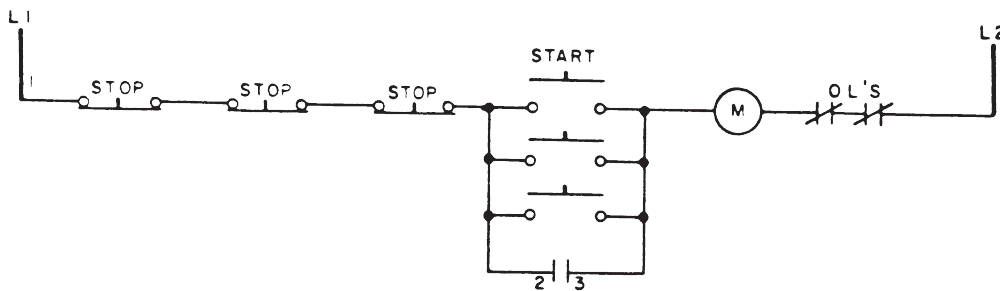
11. Fully loaded motor will draw 15 amperes.

12. The code letter on a motor nameplate indicates the locked rotor kVA input per horsepower.

13. Line diagram of control circuit from the text's wiring diagram.



14. Line diagram of the text's control circuit.



SECTION 3 Control Pilot Devices

Unit 6 Push Buttons and Control Stations

1. "Normally open" or "normally closed" refers to the position of the contacts at a rest position, held there by spring tension, and is not subject to either electrical or mechanical forces.