Chapter 5 Electrical Motor Controls

1. How many loads should be placed in any one circuit line between L1 and L2? 1
2. If more than one load is controlled by the same circuit how is the second load connected? Parallel with the first load
3. What is a load and where is it connected in the diagram? Device that converts electrical energy to motion, heat, light, or sound. Connects to L2 (directly or indirectly)
4. Where are NC overload contacts typically placed? Between the starter coil and L2
5. Where are control devices placed on a line diagram? Between L1 and the coil
6. How are two control devices connected in the circuit if either one is required to pass current to a device? Parallel
7. What is indicated by the numbers in parenthesis to the right of L2? Rungs where the contacts are that are controlled by this relay
8. How is a NC contact indicated in the numbers to the right of L2? Underlined
9. What is the purpose of circling wire reference numbers? Separate them from other numbering systems
10. What are two methods of indicating that contacts on different lines of the diagram belong to the same control switch? Dashed line or numerical cross-reference
11. What are the three basic sections of control circuits? Signals, decisions, and action
12. What devices are found in the signal section of a control circuit? Pushbuttons, limit switches, flow switches, foot switches, temperature switches, and pressure switches
13. How is the decision determined in the decision section of a control circuit? How the signal devices are connected in the circuit
14. What is an example of an indirect action in the action section? Coils in starters or relays being controlled that in turn control a motor or other load
15. Which logic function is shown when three NO pushbuttons are connected in series to control a load? AND
16. Which logic function is shown when three NO pushbuttons are connected in parallel to control a load? OR
17. What are three logic functions that utilize NC contacts? NOT, NOR, and NAND

18. Where are “Memory” contacts connected into a pushbutton circuit? Parallel with the start pushbutton

19. What logic function is provided by a NC stop pushbutton in a motor circuit? NOT

20. What logic function is used for multiple stop pushbuttons? NOR

21. What logic function is used for multiple start pushbuttons? OR

22. What is the meaning of the term “Cascade Control” or “Sequence Control”? One motor or more not starting unless another one is already operating

23. Which part of a control circuit is disabled when a selector switch is set to jog instead of run? Memory or auxiliary contact

24. What is the “Tie-down” method of troubleshooting a control circuit? One lead of a DMM is “tied down to L2 and the other one is moved along the circuit starting at L1

25. What is the voltage across the terminals of a good switch that is open? System voltage

26. What is the voltage across the terminals of a good switch that is closed? 0 V (Solid State will be slight voltage drop)

27. What precaution must be taken before testing a circuit using a continuity tester? Ensure it is disconnected from the source

28. What is a “short circuit” or “dead short”? Large current flowing outside the normal path or taking a short cut bypassing the load

29. What are some indications of the source of a short circuit? Burn marks or discolored insulation

Chapter 14

1. What are the four major categories of timers? Dashpot, synchronous clock, solid-state, and programmable

2. What is a programmable logic relay? Device that includes internal relays, timers, counters, and other functions that can be programmed and reprogrammed

3. How is the travel time of the piston adjusted with a dashpot timer? Adjust the size of the orifice

4. Which timer would be affected most by temperature? (Think about it) Dashpot
5. Why are synchronous clock motors accurate? Power companies regulate their frequency strictly (clock speed depends on frequency)

6. What are some advantages of solid-state timers? Very accurate, resin encapsulated, and modular design

7. What is a retentive timer? One that maintains the current accumulated time value when the signal or power to the timer is interrupted

8. What happens to preset values in a non retentive timer when there is a power failure? They are saved.

9. What is the term used to describe the amount of time a timer counts before performing an action? Preset

10. What are the three things that must be programmed into a PLR timer? Mode, time base, and preset

11. What are some of the modes for a PLR timer? On-delay, Off-delay, One-shot, recycle, etc.

12. What is the value of a preset of 743 with a time base of .1 sec? 74.3 sec

13. What is the value of a preset of 298 with a time base of .01 sec? 2.98 sec

14. What is the value of a preset of 1298 with a time base of .001 sec? 1.298 sec

15. What is the 12 hour clock equivalent of 21:00 hours on the 24 hour clock? 9:00

16. What is the 12 hour clock equivalent of 16:00 hours on the 24 hour clock? 4:00

17. What are the three standard timer instructions used with PLCs? On-delay (TON), Off-delay (TOF), and Retentive (RTO)

18. Which timer has a preset time period that must pass after it is energized before any action occurs on the timer contacts? On-delay

19. Which timer has starts a timing function when the power is removed from the timer? Off-delay

20. Which type of timer would be used to make sure a projector bulb is cooled after use before the fan stops? Off-delay (timed to open)

21. Which type of timer has contacts that change immediately when energized and remain changed for a set period of time before returning to the original position? One-shot
22. Which type of timer opens and closes repeatedly once the timer receives power until the power is removed? **Recycle**

23. What is an asymmetrical recycle timer? **One where the on and off periods can be adjusted independently**

24. How are multi-function timers typically programmed for different functions? **DIP Switches**

25. What feature of the newer solid-state switches allows for a great deal more flexibility? **Control switch does not have to be same voltage as timer coil**

26. What is the main disadvantage of supply-voltage controlled timers? **Control wiring must be higher (120 V) and properly enclosed using No.14 wire**

27. Where is the voltage supply for the control switch circuit in a contact-controlled timer? **Timer**

28. What is the typical voltage rating of the control circuit in a contact-controlled timer? **Less than 24 VDC**

29. What precaution must be taken when connecting wires to a contact-controlled timer? **Connect to proper voltage or timer is destroyed**

30. Which timer is typically used with proximity sensors and photoelectric sensors? **Sensor-controlled timers**

31. Loads connected to a multiple contact timer may utilize both the immediate and delayed contacts of the timer? **True or False**

32. What is typically the best timer where circuits don’t change function or time range? **Solid-state monofunction timers**

33. Which timer would be used to monitor a patients breathing and sound an alarm if he stopped for a period of time? **On-delay timer with a pressure switch**

34. How could an off-delay timer be used in an emergency shower? **Keep the water running for a period of time after the button is pressed**

35. What timer would be used to apply heat to an item for a set period of time when it moves into an area? **One shot**

36. Which timer would be used to mix a batch of product for 2 minutes in every 20? **Asymmetrical recycle timer**
37. What are the four steps to troubleshooting timing circuits? 1. Measure voltage at the control circuit 2. Measure voltage at the timer coil 3. Measure voltage into the timer contact 4. Measure voltage out of timer contact

38. What is the term used to describe a counter that displays a number but does not initiate an action? Totalizer

39. What are the two types of counters? Up counters and up/down counters

40. How is a counter with only one input reset? Remove power

41. What is one application of an up/down counter? Parking Garage Full indication

Chapter 15

1. What is the maximum amperage rating of most relays? 15 A

2. Which electronic component most closely resembles a relay? Amplifier

3. What is an electromechanical relay? Switching device with contacts operated by magnetic effect

4. What is a solid-state relay (SSR)? Switching device that has no contacts and operates by electronic means

5. What are the three types of EMRs? Reed, general-purpose, and machine

6. What is the term used to describe a hermetically sealed, single-pole, single-throw, switch with NO contacts? Reed switch

7. What is the typical amperage rating of a reed switch? .25 - .5 amps (google it)

8. Why is DC typically used for the magnetism of a reed switch circuit? Reed switch is so fast it could energize and de-energize on half cycles of 60 Hz AC

9. In a bias arrangement for a reed switch how many magnets are required? 2

10. What are some advantages of a general-purpose relay? Plug-in design for easy replacement, easy troubleshooting, and low cost

11. What is the typical voltage rating for general-purpose relays? 6 V - 240 V

12. What is the most common form for general-purpose relays? What contacts are on this type? Form C and 1 NO and 1 NC contact SPDT
13. What type of contact is a 3PDT-DB? Three pole, double-throw, double-break

14. What is the main difference between general-purpose and machine control relays? Machine-control relays are made better to last longer and control larger amounts of power

15. What are some other names for machine-control relays? Heavy-duty or industrial control

16. What are some of the accessories that may be added to machine-control relays? Indicating lights, transient voltage suppressors, latching controls, and time controls

17. What is the typical contact life for EMRs? 100,000 to 500,000 operations

18. What is the typical mechanical life of EMRs? 1,000,000 to 10,000,000 operations

19. Which loads when switched shorten the contact life? Arcing

20. What are three types of contact protection circuits? Diode, RC snubber, or varistor

21. What metal is the best conductor of electricity? Fine Silver

22. How is sulfidation minimized with silver contacts? Silver alloys

23. Where are gold-flashed silver contacts used? Switching loads of 1 A or less in intermittent applications

24. Where are tungsten contacts used? High-voltage repetitive switching

25. Why does switching incandescent lamps require relay contacts rated higher than the wattage of the lamp? High current surge when first turned on (cold)

26. What are some reasons for industrial control markets moving to solid-state relays? Declining costs, high reliability, and immense capability

27. Which solid-state relay turns a load on or off as the current crosses the horizontal axis? Zero switching relay

28. Which SSR switching method turns a load on when the control voltage is present at any point in the sine wave and turns it off when the load current crosses the horizontal axis? Instant-on

29. Why is peak switching preferred when voltage and current are around $90^\circ$ out of phase? Current is at zero

30. Which SSR switching method is best suited to switching transformers and large motors? Peak Switching
31. Which SSR switching method starts the load voltage at a low level and increases over a period of time? **Analog Switching**

32. Which SSR switching methods turn off when the control voltage is removed and the current in the load crosses zero? **All four**

33. What are the three parts of a SSR circuit? **Input circuit, control circuit, and output circuit**

34. What is the typical input voltage range for a SSR? **3-32 VDC**

35. Which circuit of an SSR determines when the output is energized or de-energized? **Control circuit**

36. What type of SSR output is typically used to switch high current DC loads? **SCR**

37. What type of SSR output is typically used to switch low current DC loads? **Transistors**

38. What type of SSR output is typically used to switch high current AC loads? **Antiparallel thyristors**

39. What type of SSR output is typically used to switch low current AC loads? **Triac and Thyristor in diode bridge**

40. What electronic device is used to switch a load with a momentary pushbutton when “Memory” is required after the pushbutton is released? **SCR**

41. How is the gate current limited when using an SCR in the control circuit of an SSR? **Resistor in gate circuit**

42. Where is the pushbutton connected into the control circuit when simulating a NC contact for a SSR? **Parallel with the control coil**

43. How is a three-phase load controlled when a multi-contact SSR is not available? **Three single-contact SSRs with control circuits connected in parallel**

44. How does temperature affect fail rates in SSRs? **Double with every 10° above 40°**

45. What is the term used to describe the ability of a device to impede the flow of heat? **Thermal Resistance**

46. What is the relationship between ability to dissipate and the thermal resistance number? **Lower number better heat dissipation**

47. What material has the highest thermal conductivity? **Silver**

48. What material has good thermal conductivity and is the most cost effective? **Aluminum**
49. How is maximum heat transfer ensured between the heat sink and the solid-state device? Thermal grease

50. How are SSRs typically protected from overcurrent damage? Ultrafast fuse

51. What device is used to protect SSR output circuits from transient voltage spikes? Varistor

52. What determines how much heat is produced in a SSR? Amount of current passing through the relay

53. How much power in watts is generated when 15 A current is flowing through a SSR relay with a 2 V drop? 30 W

54. Which type of relay would typically have a longer life? SSR – Unlimited if voltage and current ratings not exceeded

55. How do EMRs and SSRs compare for response time? EMR-hundreds of times a minute SSR- Thousands of times a minute with no chatter or bounce

56. What types of device are sometimes affected by leakage current through an SSR? Neon indicator lights and some programmable controllers

57. What are some advantages of PLRs over mechanical and solid-state relays? Low cost, Contacts not physical but programmed, Additional timers & counters, Programs easily changed/saved/printed, Simulation testing

Skip to “Troubleshooting Relays” on Page 460

58. What is the first check for electromechanical relays? See if the problem is the input circuit, output circuit, or relay

59. What is the proper voltage across the contacts of an EMR when they are open? System voltage

60. What is the proper voltage across the contacts of an EMR when they are closed? Little or none

61. What is evidence of problems with contacts? Severe contact wear or severe pitting

62. What precaution should be taken when manually operating a relay to test? Load may start

63. Which circuit is bypassed when you manually operate a relay? Control circuit

64. What is the cause of a reading of system voltage across a contact of a relay when it is energized or not? Defective relay (contacts not closing)
65. What is the cause of a reading of 0 Volts across a contact of a relay when it is energized or not? Contacts not opening (May be welded closed)

66. What has been determined when a reading of 3 V is present across the control relay contacts in an EMR? Contacts have too much resistance and need service

67. What are the two methods of troubleshooting SSRs? Exact replacement method or circuit analysis method

68. What are the three improper relay operations? 1. Won’t turn off 2. Won’t turn on 3. Operates erratically

69. What are some of the more common causes of a SSR not turning load off? Load drawing more current than the relay rating, heat sink too small (overheating), or transient voltages causing a breakover of the output

70. Current drawn by the load should be a maximum of what percentage of the SSR rating? 75%

71. What are the most likely causes of an SSR failing and not turning a load on? High voltage spike or input connected to a voltage higher than the rating

72. What is the most likely problem if a SSR input voltage is good and the output voltage is not? Relay

73. What are the three types of mechanical problems that can cause a SSR to operate erratically? Mechanical problems (loose connections), Electrical problems (incorrect voltage), or environmental problems (high temperature)

74. Why should control circuit wires be isolated from input or output circuit wires? Electrical noise may cause unwanted signal input