U.S.C.G. Merchant Marine Exam

First Assistant Engineer

Q517 Electrical – Electronic – Control Engineering

(Sample Examination)

Choose the best answer to the following Multiple-Choice Questions:

1. What would be the total current in figure "A" of the circuit illustrated if the value of capacitor C1 was 100 microfarads, capacitor C2 was 200 microfarads and the power supply was 240 volts at 60 Hz? Illustration EL-0038

   A. 27 amps
   B. 37 amps
   C. 47 amps
   D. 57 amps

   Correct answer: A

2. If the values of "C1" and "R1" shown in the illustration were 1 microfarad and 3 megohms respectively, which of the listed intervals of time would equal one "time constant"? Illustration EL-0086

   A. 0.33 second
   B. 3 seconds
   C. 6 seconds
   D. 15 seconds

   Correct answer: B

3. As shown in figure "D" of the illustrated digital power meter, what type of single-phase load is under test for power measurement? Illustration EL-0256

   A. a purely resistive load
   B. a resistive-capacitive load
   C. a purely inductive load
   D. an inductive-resistive load

   Correct answer: D

4. What can a typical common analog or digital multimeter be used to measure?

   A. voltage, frequency, and current
   B. frequency, current, and resistance
   C. voltage, power, and current
   D. voltage, resistance, and current

   Correct answer: D

5. Under what circumstance would a hand-held portable phase sequence indicator be used should the main switchboard mounted fixed phase sequence indicator be inoperative?

   A. installing a new synchroscope
   B. paralleling alternators
   C. replacing a defective solenoid
   D. preparing to make the shore power connection

   Correct answer: D

6. Why are external shunts sometimes used with ammeters?

   A. to reduce reactive power factor error
   B. to increase meter sensitivity
   C. to permit shunts with larger resistances to be utilized
   D. to prevent damage to the meter movement from heat generated by the internal shunt

   Correct answer: D

7. How should the shunt used in an ammeter be connected?

   A. in series with the load and in parallel with the meter movement
   B. in parallel with the load and in parallel with the meter movement
   C. in series with the load and in series with the meter movement
   D. in parallel with the load and in series with the meter movement

   Correct answer: A

8. With what kind of starting equipment are most three-phase induction motors of five horsepower or less started?

   A. resistor starters
   B. reactor starters
   C. across-the-line starters
   D. autotransformer starters

   Correct answer: C

9. A three-phase, induction-type motor experiences an open in one phase. Which of the listed automatic protective devices will prevent the motor from being damaged?

   A. Overspeed trip
   B. Thermal overload relay
   C. Magnetic blowout coil
   D. Three-pole safety switch

   Correct answer: B

10. Which of the following statements is true concerning the cleaning of electrical contacts?

    A. Compressed air should be used to blow out metallic dust.
    B. The contact surfaces should be greased to increase contact resistance.
    C. Magnetic brushes should be used to remove metallic dust.
    D. Delicate parts should be cleaned with a brush and an approved safety solvent.

    Correct answer: D

11. By what means should motor controller contacts be routinely cleaned?

    A. dressing with crocus cloth
    B. filing with a bastard file
    C. blowing with compressed air
    D. wiping with a clean dry cloth

    Correct answer: D

12. Why are motor controllers seldom troubled by grounds?

    A. shock mounts on controller panels greatly reduce vibration
    B. special insulation is used on wire for vital circuits
    C. cabinet heaters always keep internal components dry
    D. contactors and relays are mounted on non-conducting panels

    Correct answer: D

13. As shown in the illustration, what mechanism will disconnect the motor from the line in case of a sustained motor overload? Illustration EL-0080

    A. transformer primary fuses FU4 and FU5
    B. disconnect switch fuses FU1, FU2, and FU3
    C. transformer secondary fuses FU6 and FU7
    D. overload relay heaters and overload relay NC contacts (OL)

    Correct answer: D

14. As shown in figure "A" of the illustration, what is the primary reason that the propulsion transformers are configured differently so as to produce a 30 degree phase shift in the pulses between the two synchroconverters supplying separate stator windings? Illustration EL-0160

    A. to maximize motor power factor
    B. to minimize motor shaft vibration
    C. to maximize motor power output
    D. to minimize AC sine wave distortion

    Correct answer: B

15. Which of the listed devices is most likely to be installed on a large modern diesel-electric alternating current propulsion generator for commercial ship propulsion for the purposes of fire suppression?

    A. A CO2 fire extinguishing system
    B. A Halon fire extinguishing system
    C. A dry chemical fire extinguishing system
    D. A foam fire extinguishing system

    Correct answer: A

16. An electric propulsion drive system in which the propulsion generator only supplies power to the propulsion motor is referred to as what type of system?

    A. a multi-purpose system
    B. an integrated system
    C. a composite system
    D. a dedicated system

    Correct answer: D

17. As shown in figure "B" of the illustration, what statement is true concerning "regenerating" operation? Illustration EL-0162

    A. by applying torque in the same direction of rotation direction, the motor briefly regenerates power back into the mains, which rapidly speeds up the motor
    B. by applying torque in the opposite direction of rotation direction, the motor briefly regenerates power back into the mains, which rapidly slows down the motor
    C. by applying torque in the same direction of rotation direction, the motor briefly regenerates power back into the mains, which rapidly slows down the motor
    D. by applying torque in the opposite direction of rotation direction, the motor briefly regenerates power back into the mains, which rapidly speeds up the motor

    Correct answer: B

18. Which of the following electric propulsion motor types requires no brushes or electrical connections to the rotor?

    A. AC synchronous motor
    B. AC squirrel cage induction motor
    C. DC shunt wound motor
    D. AC wound rotor induction motor

    Correct answer: B

19. Which of the following statements is TRUE concerning Azipod propulsion systems?

    A. The system integrates propulsion and steering into one function.
    B. The system requires the need for a separate rudder.
    C. The pod assembly swivels on a horizontal axis.
    D. The system requires the use of a controllable-pitch propeller.

    Correct answer: A

20. An AC diesel-electric drive ship with synchronous propulsion motors has the capability for power factor correction. If the power factor associated with the main power distribution including all motors is 0.7 lagging, what statement is true?

    A. The synchronous propulsion motors are normally excited.
    B. The excitation status of the synchronous motor cannot be determined.
    C. The synchronous propulsion motors are over-excited.
    D. The synchronous propulsion motors are under-excited.

    Correct answer: D

21. An AC diesel-electric drive ship with synchronous propulsion motors has the capability for power factor correction. If the power factor associated with the main power distribution including all motors is 0.7 leading, what statement is true?

    A. The synchronous propulsion motors are normally excited.
    B. The excitation status of the synchronous motor cannot be determined.
    C. The synchronous propulsion motors are under-excited.
    D. The synchronous propulsion motors are over-excited.

    Correct answer: D

22. What equipment for modern SCR rectified DC propulsion drive systems is usually included in the package?

    A. propulsion generators which produce DC power that is directly delivered to the series-wound DC propulsion motor
    B. propulsion generators which produce DC power that is converted to AC power for the propulsion motor
    C. propulsion generators which produce AC power that is converted to DC power for the shunt wound DC propulsion motor
    D. propulsion generators which produce AC power that is directly delivered to the synchronous AC propulsion motor

    Correct answer: C

23. In addition to improper brush pressure or seating, what can result in excessive sparking at the brushes of a DC propulsion motor?

    A. operating at continuously varying loads such as during maneuvering
    B. reversed armature polarity with respect to the field
    C. reversed main field polarity with respect to the armature
    D. improper positioning of brush rigging outside the neutral plane

    Correct answer: D

24. What is the purpose of the device labeled "Man-Auto Sw." in the illustrated switchboard? Illustration EL-0003

    A. to enable the operator to read the field voltage on device "Volt. Reg. Adj. Pot." or device "Man. Volt. Adj. Rheo."
    B. to shift the governor control from manual to automatic/zero droop or vice versa
    C. to supply regulated control power to the switchboard
    D. to shift from the automatic voltage regulator to manual voltage control or vice versa

    Correct answer: D

25. As shown in the illustrated switchboard, what is the function of the switch labeled "PFM Sel. Sw."? Illustration EL-0003

    A. to determine frequency of either generator
    B. to determine power factor of either generator
    C. to determine bus frequency
    D. to determine reactive volt amperes of the bus

    Correct answer: B

26. As shown in the illustration, which of the following pieces of equipment is supplied with a circuit breaker providing both overload and short-circuit protection? Illustration EL-0165

    A. S.W. Cooling Circ. Pump No.1
    B. Sewage Treatment Plant
    C. Cargo Oil Transfer Pump No.1
    D. Lube Oil Service Pump No.1

    Correct answer: B

27. Why are transformer cores laminated?

    A. to reduce eddy currents
    B. to reduce secondary flux
    C. to reduce hysteresis
    D. to reduce leakage flux

    Correct answer: A

28. What is the basic principle of operation by which a transformer works?

    A. self-impedance
    B. increasing power
    C. mutual induction
    D. attraction and repulsion

    Correct answer: C

29. How are fuses usually rated?

    A. watts only
    B. amps only
    C. volts and amps only
    D. volts, amps, and interrupting capacity

    Correct answer: D

30. Due to the operating characteristics of the system, time lag fuses (or dual-element fuses) are necessary for use in what types of circuits?

    A. main lighting circuits
    B. emergency lighting circuits
    C. motor starting circuits
    D. general alarm circuits

    Correct answer: C

31. As shown in figure "A" of the illustration, under what conditions will the thyristor conduct? Illustration EL-0154

    A. when the anode is more positive than the cathode and when the gate is briefly pulsed with a voltage more negative than the cathode
    B. when the anode is more negative than the cathode and when the gate is briefly pulsed with a voltage more negative than the cathode
    C. when the anode is more negative than the cathode and when the gate is briefly pulsed with a voltage more positive than the cathode
    D. when the anode is more positive than the cathode and when the gate is briefly pulsed with a voltage more positive than the cathode

    Correct answer: D

32. As shown in the illustration, which electrical symbol represents a PNP type bipolar junction transistor? Illustration EL-0065

    A. 1
    B. 2
    C. 3
    D. 4

    Correct answer: A

33. What is the functional purpose of a heat sink, as frequently used with transistors?

    A. to compensate for excessive doping
    B. to prevent excessive temperature rise
    C. to increase the reverse current
    D. to decrease the forward current

    Correct answer: B

34. Why is it necessary to perform periodic testing of correctly rated and properly installed circuit breakers?

    A. to insure they can trip faster as they increase in age
    B. to insure they do not exceed their interrupting capacity
    C. to insure they will continue to provide the original degree of protection
    D. to insure they will be able to withstand at least 125% of applied voltage

    Correct answer: C

35. Which of the listed classes of electrical insulation is suited for the highest operating temperature?

    A. Class 90 (O)
    B. Class 105 (A)
    C. Class 130 (B)
    D. Class 180 (H)

    Correct answer: D

36. To test fuses in an energized circuit, what testing apparatus or meter should be used?

    A. continuity tester
    B. megohmmeter
    C. resistance meter
    D. voltmeter

    Correct answer: D

37. To check the three-line fuses protecting a three-phase motor using a multimeter set up as a voltmeter, what should be done FIRST?

    A. place the leads across the "hot" ends of the fuses
    B. place the starter in the "stop" position
    C. make sure the motor is operating at full load to guard against a false reading
    D. place the leads across the bottom ends of the fuses

    Correct answer: B

38. In the lighting distribution circuit shown in the illustrated lighting panel L110 of the illustration, if all circuit breakers are closed and due to a problem with the relevant feeder circuit breaker, there is a loss of power on the incoming phase A, which of the following statements is true? Illustration EL-0013

    A. Half of the accommodation lighting circuits on the 01 deck, port side would lose power.
    B. All of the receptacles in the laundry would lose power.
    C. Half of the passageway lighting circuits on the 01 deck would lose power.
    D. All of the accommodation lighting circuits on the 01 deck, starboard side would lose power.

    Correct answer: A

39. What is the name of the digital logic gate represented by figure "1" of the illustration? Illustration EL-0035

    A. OR gate
    B. Exclusive OR gate
    C. AND gate
    D. NOR gate

    Correct answer: A

40. As shown in figure "A" of the illustration, what type of converter unit is represented? Illustration EL-0240

    A. digital to analog converter
    B. analog to digital converter
    C. multiplexer
    D. de-multiplexer

    Correct answer: B

41. The conversion of the throttle command voltage to the signal necessary to achieve the desired shaft RPM is accomplished by what circuit?

    A. feedback resistor of the summing amplifier circuit
    B. operational amplifiers in the autorotation circuit
    C. ahead or astern function generator of the throttle control circuit
    D. long time constant amplifier circuit

    Correct answer: C

42. In process control terminology, continuously variable values which change without distinct increments, such as temperature, pressure, or level are correctly referred to as what type of values?

    A. bumpless values
    B. binary values
    C. analog values
    D. digital values

    Correct answer: C

43. What is the name of the device shown in figure "1" of the illustration? Illustration EL-0068

    A. silicon-controlled rectifier
    B. rectifier bridge
    C. light-emitting diode
    D. rectifier diode

    Correct answer: D

44. If a digital multimeter is set up as shown in figure "B" of the illustration to test a capacitor, what would the display read if the capacitor was functioning properly? Illustration EL-0213

    A. the actual capacitance value of the capacitor will be displayed which should be within the tolerance range of the capacitor
    B. the charging voltage would be displayed which will initially be low and gradually rise to the internal battery voltage
    C. initially a very low ohmic value will be displayed, followed by a gradual rise in resistance until a very high value is displayed (OL ohms)
    D. initially a very high ohmic value will be displayed (OL ohms), followed by a gradual drop in resistance until a very low value is displayed

    Correct answer: A

45. When troubleshooting a printed circuit board, one technique that can be used is swapping the suspected damaged board with a new board. When installing the new board which was stored in a specially manufactured antistatic bag, how may damage due to electrostatic discharge be prevented?

    A. Before touching the board, you should discharge any static buildup on yourself by touching a conductive surface or use a grounding wrist strap, and the board should be handled by its insulated edges only.
    B. Before touching the board, you should discharge any static buildup on the board by touching the board to a conductive surface, and the board should be handled by its insulated edges only.
    C. Before touching the board, you should discharge any static buildup on the board by touching the board to a conductive surface, and the board should be handled by grasping trace solder surfaces.
    D. Before touching the board, you should discharge any static buildup on yourself by touching a conductive surface or use a grounding wrist strap, and the board should be handled by grasping trace solder surfaces.

    Correct answer: A

46. What problem with a printed circuit board may resolve itself once a board is removed from its edge card connector and then reinstalled?

    A. Discolored or darkened components
    B. Corroded pin connectors
    C. Open traces or broken connections
    D. Leaking components

    Correct answer: B

47. Some shipboard high voltage systems have the neutral point of the generators bonded to the ship's hull with a neutral grounding resistor. What is the purpose of this resistor?

    A. To completely eliminate ground fault current
    B. To prevent nuisance ground fault trips
    C. To minimize the magnitude of the ground fault current
    D. To maximize the magnitude of the ground fault current

    Correct answer: C

48. For the purposes of shipboard practice, voltages above what threshold would be considered high voltage?

    A. 440 VAC
    B. 1000 VAC
    C. 4160 VAC
    D. 6600 VAC

    Correct answer: B

49. Before work may safely commence on a high voltage system, what must first be done after disconnection and isolation?

    A. The circuit must be grounded first, then tested and proved dead with an off-line tester.
    B. The circuit must be grounded first, then tested and proved dead with a live-line tester.
    C. The circuit must be tested and proved dead first with a live-line tester, then grounded.
    D. The circuit must be tested and proved dead first with an off-line tester, then grounded.

    Correct answer: C

50. When a high voltage system insulation test value is suspect or recorded during an annual survey, a polarization index test is performed. What is the polarization index?

    A. The polarization index is the ratio of the insulation resistance taken at thirty minutes to the insulation resistance taken at one minute.
    B. The polarization index is the insulation resistance taken at ten minutes.
    C. The polarization index is the ratio of the insulation resistance taken at one minute to the insulation resistance taken at ten minutes.
    D. The polarization index is the ratio of the insulation resistance taken at ten minutes to the insulation resistance taken at one minute.

    Correct answer: D

51. For troubleshooting purposes, the key indicator to the safety and general condition of high voltage circuitry is insulation resistance. For a 6.6 kV high voltage system, what would be the recommended minimum insulation resistance value?

    A. 1 megohm
    B. 5.6 megohms
    C. 6.6 megohms
    D. 7.6 megohms

    Correct answer: D

52. Overheating is suspected in a high voltage bolted bus-bar joint. If the local continuity resistance is to be checked off-line after the necessary safety precautions have been taken, what instrument would be used for the resistance test?

    A. A conventional ohmmeter
    B. A special high resistance tester (megohmmeter)
    C. A special low resistance tester (microhmmeter)
    D. Any of the above ohmmeters would be suitable

    Correct answer: C

53. What Ethernet cabling technology supports the greatest data transfer speeds?

    A. Gigabit Ethernet
    B. Fast Ethernet
    C. Thin Ethernet
    D. Thick Ethernet

    Correct answer: A

54. What statement is true concerning random access memory (RAM)?

    A. RAM is volatile memory and the contents of RAM are not lost when the power is removed.
    B. RAM is non-volatile memory and the contents of RAM are not lost when the power is removed.
    C. RAM is volatile memory and the contents of RAM are lost when the power is removed.
    D. RAM is non-volatile memory and the contents of RAM are lost when the power is removed.

    Correct answer: C

55. What would be considered the first line of defense in trying to prevent the build-up of dust on printed circuit boards associated with computer network devices?

    A. Removal of access panels, followed by blowing out the equipment with compressed air
    B. Periodically cleaning or replacing any equipment enclosure air filters
    C. Periodically flushing out the equipment enclosure with an approved solvent
    D. Removal of access panels, followed by vacuuming out the equipment with a vacuum cleaner

    Correct answer: B

56. If a computer display is flickering, how may this be remedied?

    A. Decrease the resolution bandwidth
    B. Decrease the refresh rate
    C. Increase the resolution bandwidth
    D. Increase the refresh rate

    Correct answer: D

57. A very useful Windows utility for discovering or verifying IP addressing information of a network is "ipconfig". How is this utility program launched?

    A. It is run from the command prompt screen by default by simply bringing up the command prompt.
    B. It is run by clicking on the "ipconfig" icon in start menu or under programs.
    C. It is run from the command prompt screen by typing "ipconfig/all".
    D. It is run by clicking on the TCP/IP shortcut icon on the desktop.

    Correct answer: C

58. What is the name of a TCP/IP application run from the command prompt which provides routing information by determining the path through the network to a destination which is entered by the user?

    A. TRACERT
    B. PING
    C. FTP
    D. IPCONFIG

    Correct answer: A

59. As shown in the illustrated digital gyrocompass functional block diagram and the associated communication protocols table, what would the rate of turn signal voltage be if the rate of turn is 30 degrees per minute to port? Assume that the rate of turn to port signal voltage is negative in polarity and that the rate of turn to starboard signal voltage is positive in polarity. Illustration EL-0194

    A. -0.5 VDC
    B. -1.0 VDC
    C. -1.5 VDC
    D. +1.5 VDC

    Correct answer: C

60. As shown in the illustration, what is the magnetic phase differential in degrees between the reference signal magnetic axis and the control signal magnetic axis of the illustrated diagram for a two-phase induction servomotor for an automatic radio direction finder? Illustration EL-0196

    A. 45
    B. 90
    C. 135
    D. 180

    Correct answer: B

61. As shown in the illustrated adaptive digital steering control system functional block diagram and listed system interface signals table, what would the rudder order signal output voltage to the rudder servo amplifier be for a rudder order of 20 degrees left rudder, assuming left rudder signals are negative and right order signals are positive in polarity? Illustration EL-0191

    A. -2.25 VDC
    B. -4.0 VDC
    C. -5.0 VDC
    D. +5.0 VDC

    Correct answer: C

62. As shown in the illustrated adaptive digital steering control system functional block diagram and listed system interface signals table, what would the rudder order signal output voltage to the rudder servo amplifier be for a rudder order of 15 degrees right rudder, assuming left rudder signals are negative and right order signals are positive in polarity? Illustration EL-0191

    A. -1.33 VDC
    B. -3.75 VDC
    C. +3.75 VDC
    D. +5.0 VDC

    Correct answer: C

63. Which of the electronic schematic symbols represents the capacitor illustrated in figure 1 of the illustration? Illustration EL-0015

    A. A
    B. B
    C. C
    D. D

    Correct answer: B

64. Which figure represents the schematic symbol shown in figure "2"? Illustration EL-0034

    A. figure "A"
    B. figure "B"
    C. figure "C"
    D. figure "D"

    Correct answer: B

65. As shown in the illustration, if the port propulsion motor field excitation circuit experienced a failure, what individual component failure would allow the use of the standby excitation transformer and standby field controller to resume normal operation? Illustration EL-0164

    A. port motor field winding
    B. port rotating rectifier
    C. port rotary transformer
    D. port field controller

    Correct answer: D

66. As shown in the illustrated one-line diagram of a two-tiered emergency power system for a passenger ship, what statement is true? Illustration EL-0166

    A. On a loss of normal ship's power, the final emergency loads power source is battery (from AC/DC UPS "A"), whereas the temporary emergency loads power source is the emergency generator.
    B. On a loss of normal ship's power, the final emergency loads power source is battery (from AC/DC UPS "B"), whereas the temporary emergency loads power source is the emergency generator.
    C. On a loss of normal ship's power, the temporary emergency loads power source is battery (from AC/DC UPS "B"), whereas the final emergency loads power source is the emergency generator.
    D. On a loss of normal ship's power, the temporary emergency loads power source is battery (from AC/DC UPS "A"), whereas the final emergency loads power source is the emergency generator.

    Correct answer: C

67. When a self-excited alternator's field has lost its residual magnetism due to a prolonged idle period, it will fail to produce a voltage. Flashing the field is the procedure used to restore the residual magnetism. Using a 12-volt storage battery, how is this performed?

    A. The F+ and F- leads are disconnected from the alternator field. The F+ lead is connected to the negative terminal of the battery, and the F- lead is connected to the positive terminal.
    B. The F+ and F- leads are disconnected from the alternator field. The F+ lead is connected to the positive terminal of the battery, and the F- lead is connected to the negative terminal.
    C. The S+ and S- leads are disconnected from the alternator stator. The S+ lead is connected to the positive terminal of the battery, and the S- lead is connected to the negative terminal.
    D. The S+ and S- leads are disconnected from the alternator stator. The S+ lead is connected to the negative terminal of the battery, and the S- lead is connected to the positive terminal.

    Correct answer: B

68. What is the minimum threshold voltage which requires electrical workers to be insulated from energized conductors or circuit parts by wearing the appropriate PPE while working in open enclosures?

    A. 24 V
    B. 50 V
    C. 120 V
    D. 480 V

    Correct answer: B

69. When performing an absence-of-voltage test before commencing repair work, at the minimum where must the absence-of-voltage test be performed?

    A. At the load side disconnect switch
    B. At the point of contact where the work will take place
    C. At the main feeder circuit breaker
    D. At the source disconnect branch circuit breaker

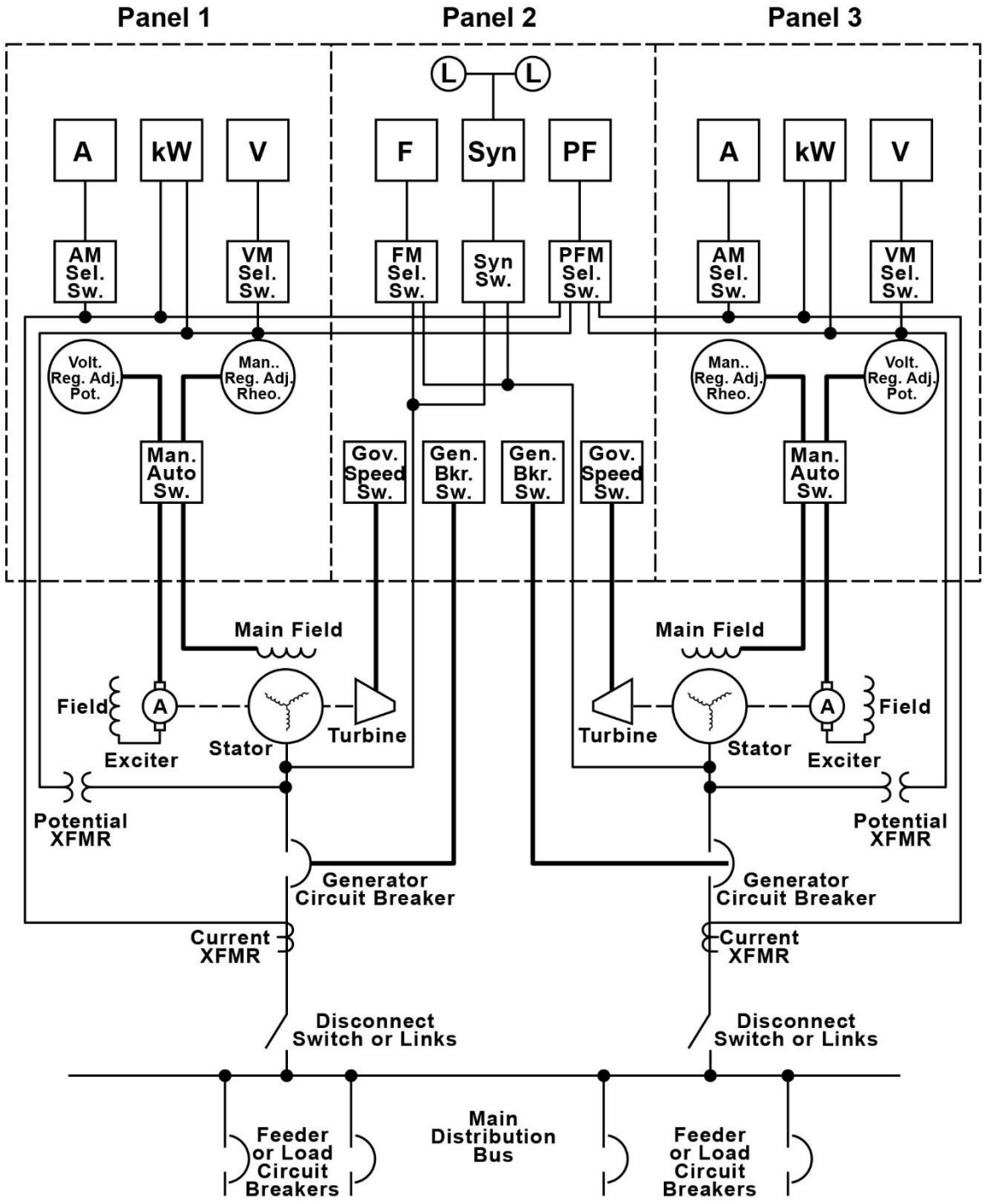
    Correct answer: B

70. A vessel is equipped with two ship's service generators. Generator No.1 is rated at 900 kW and generator No.2 is rated at 600 kW. During parallel operation, with a hotel load of 1,000 kW, what should be the kW load on generator No.2 if the load is shared proportionately?

    A. 100 kW
    B. 400 kW
    C. 500 kW
    D. 600 kW

    Correct answer: B

EL-0003



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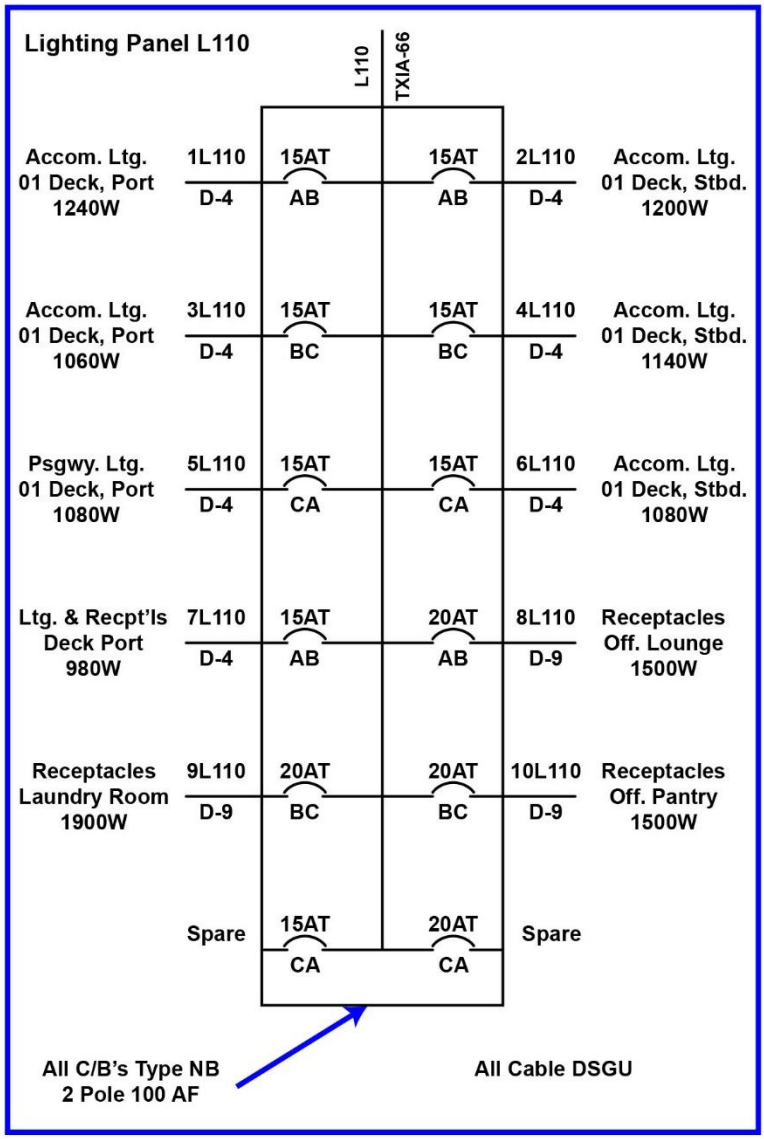
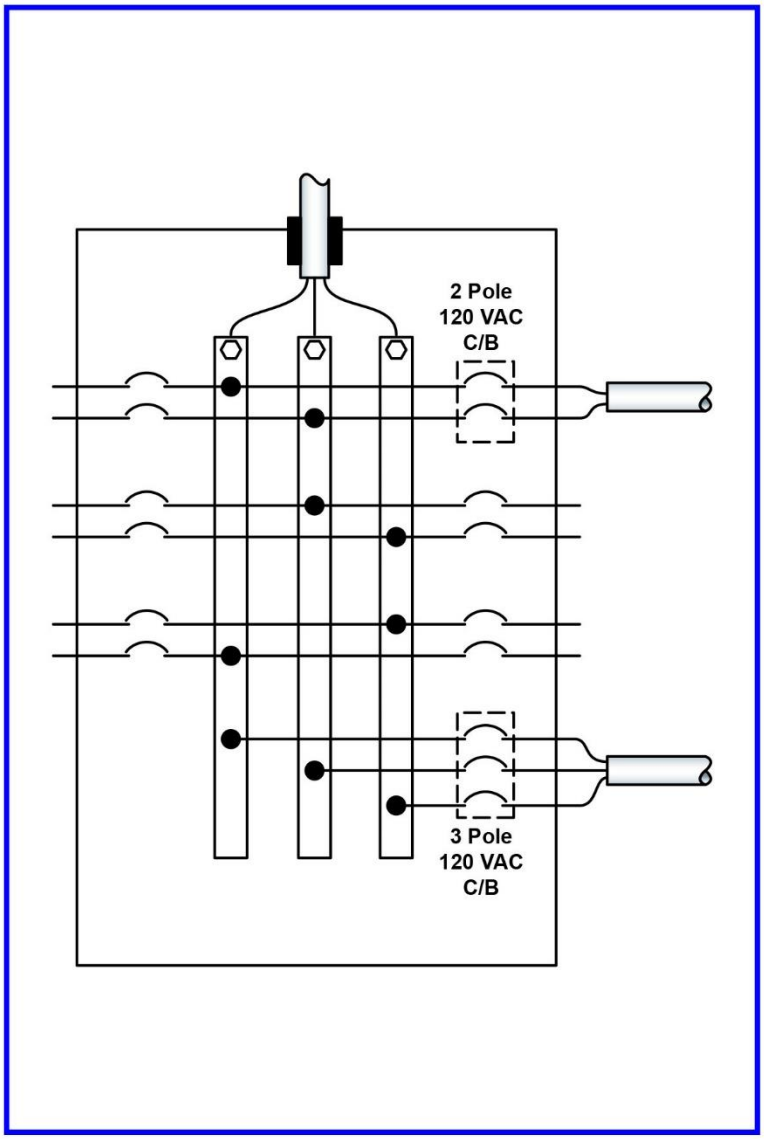
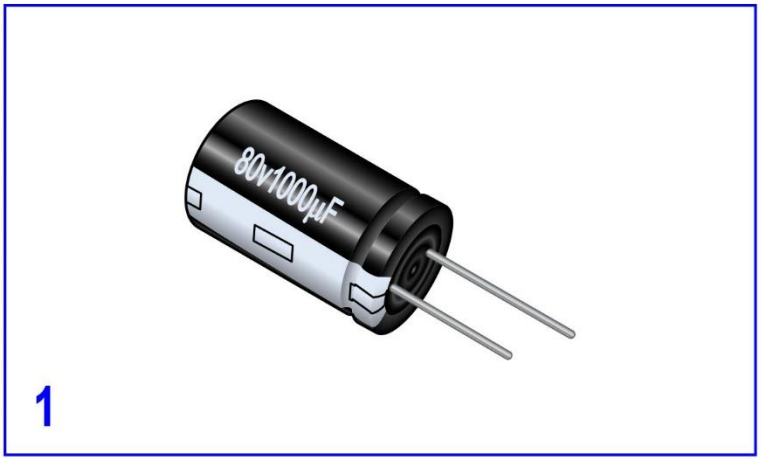
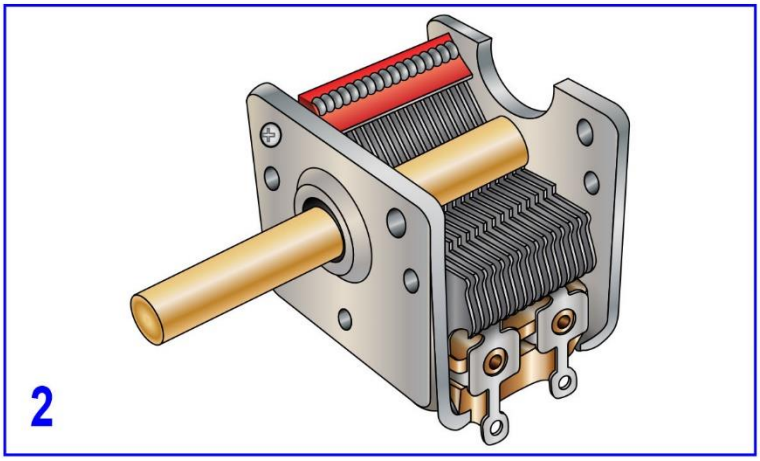
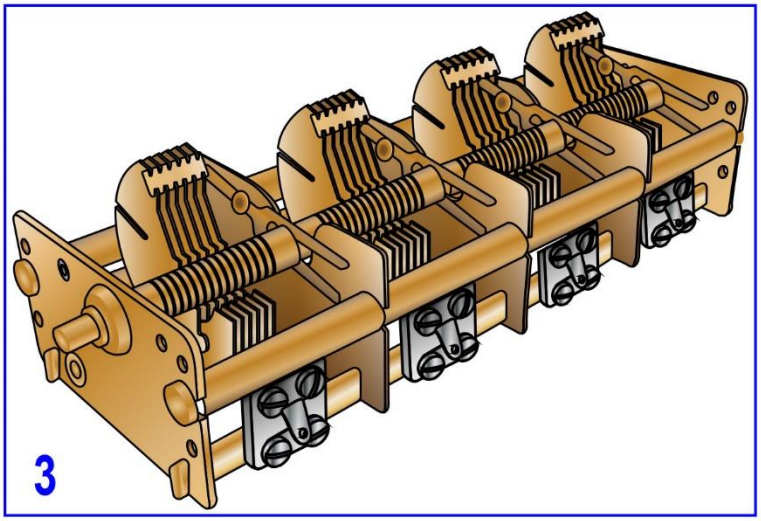


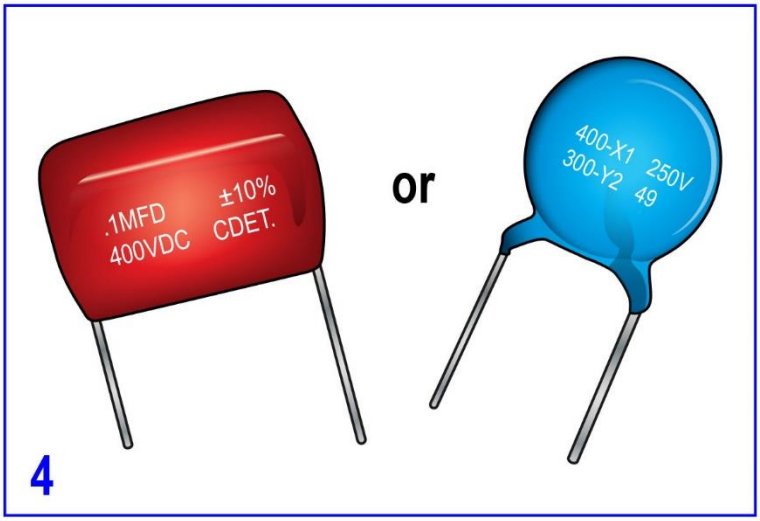


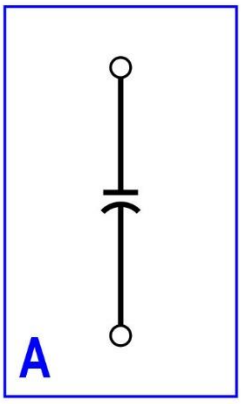
EL-0015

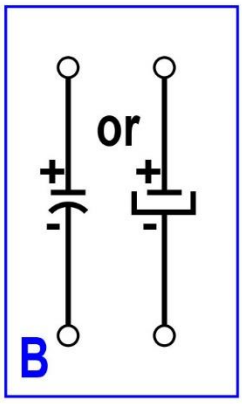


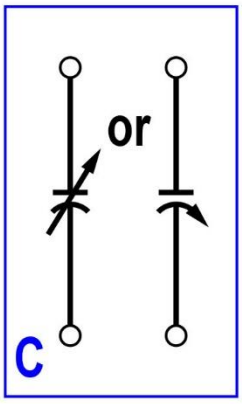


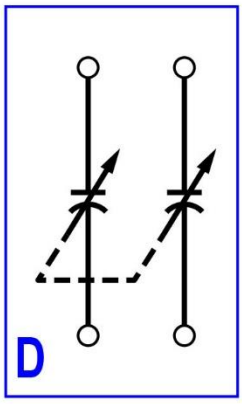












EL-0034

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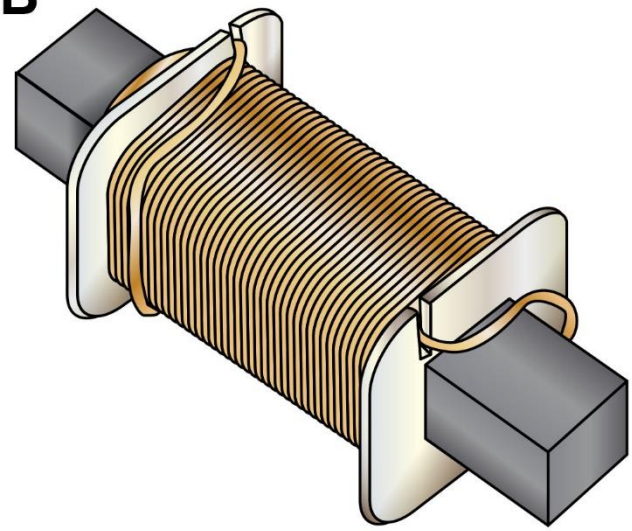

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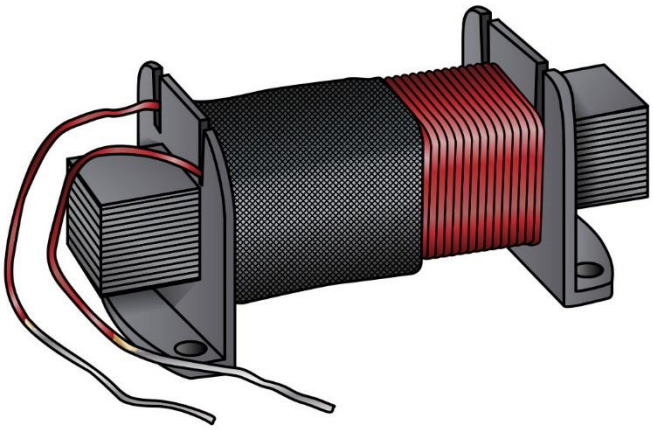

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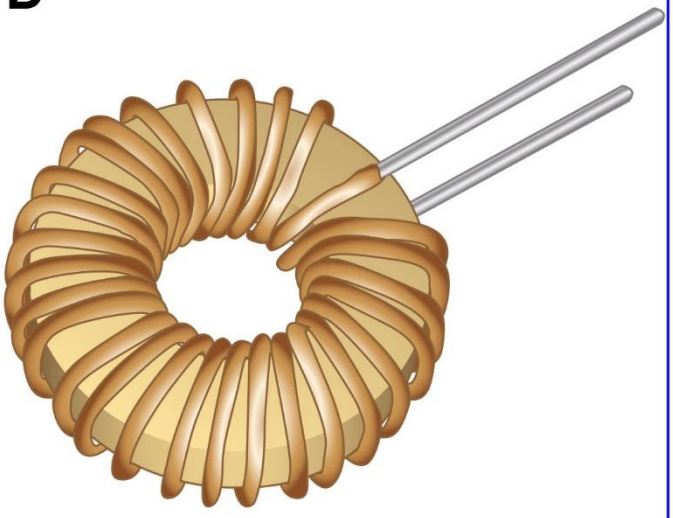

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EL-0035

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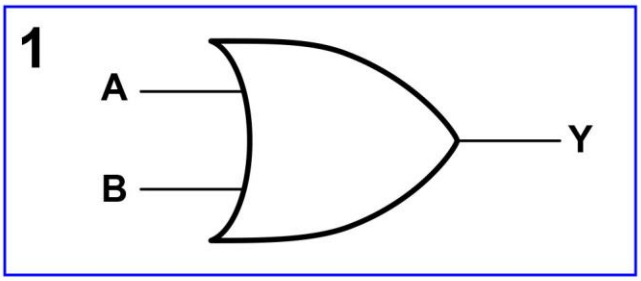

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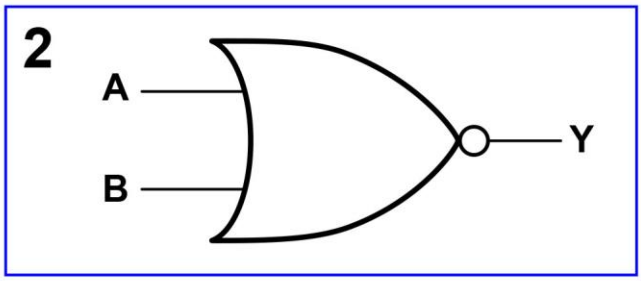

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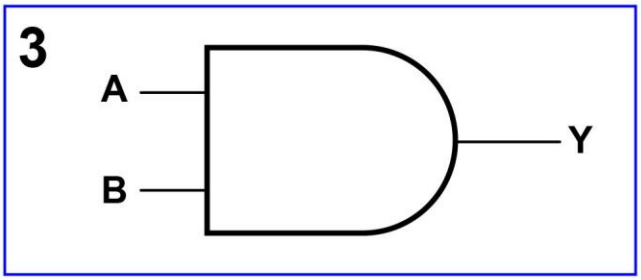

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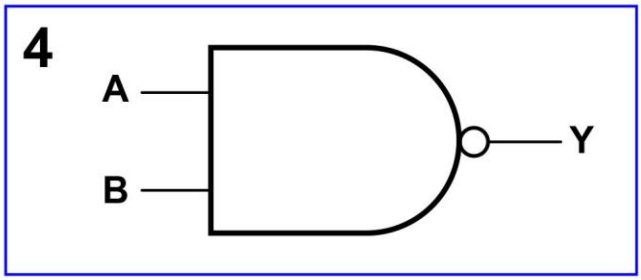

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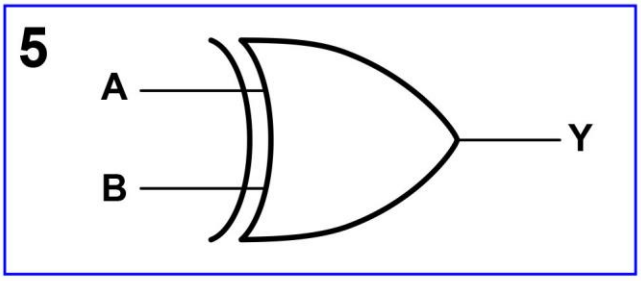

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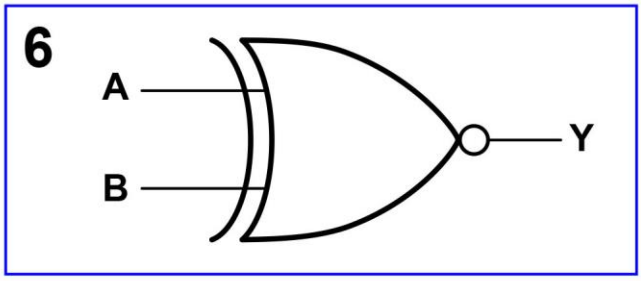

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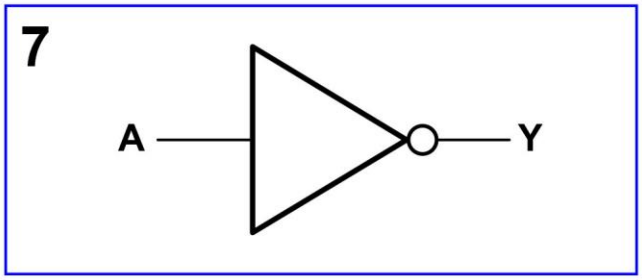

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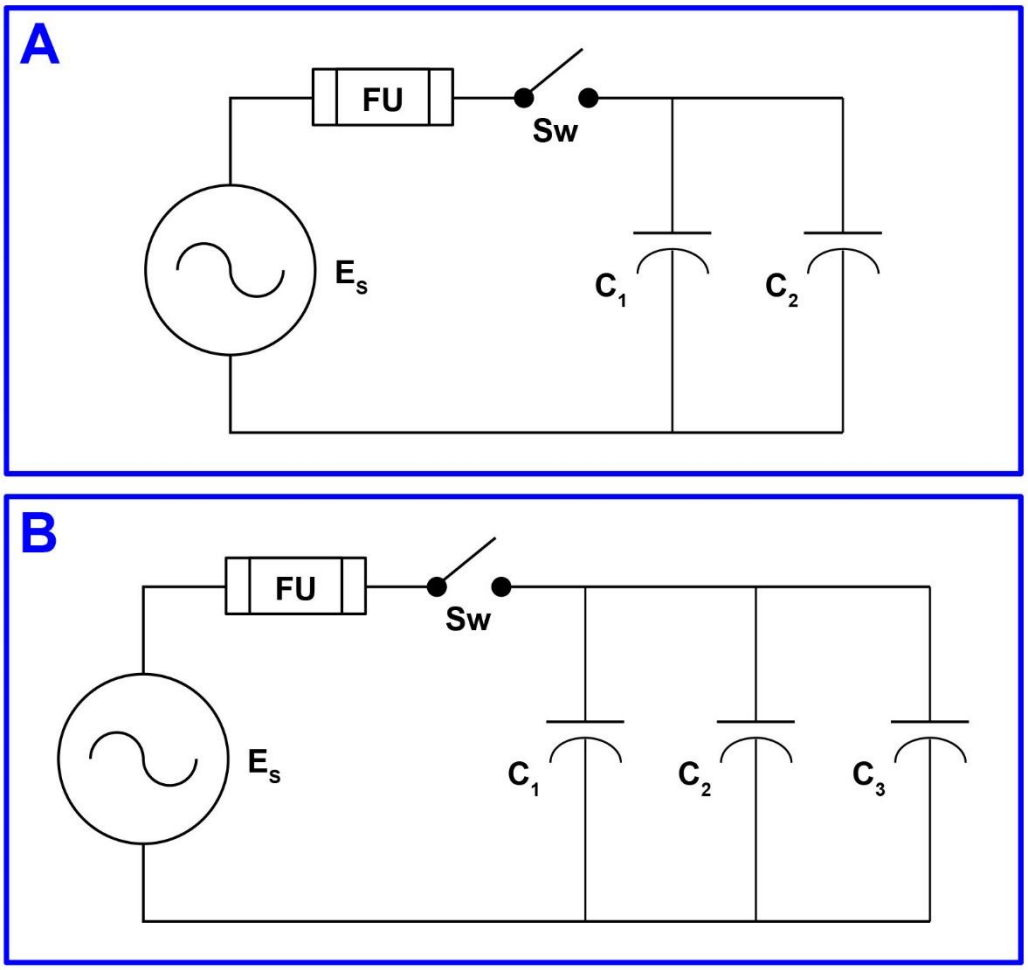

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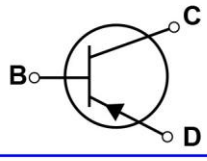

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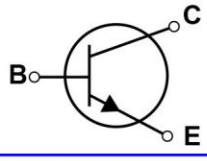

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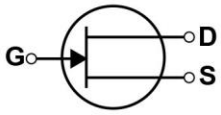

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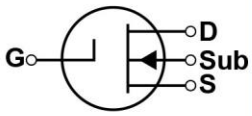

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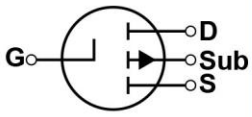

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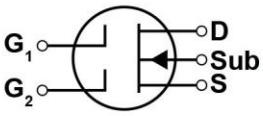

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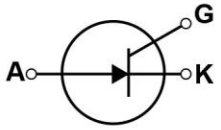

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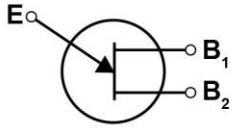

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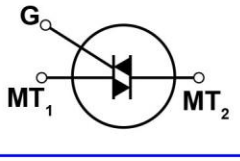

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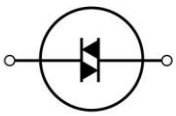

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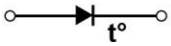

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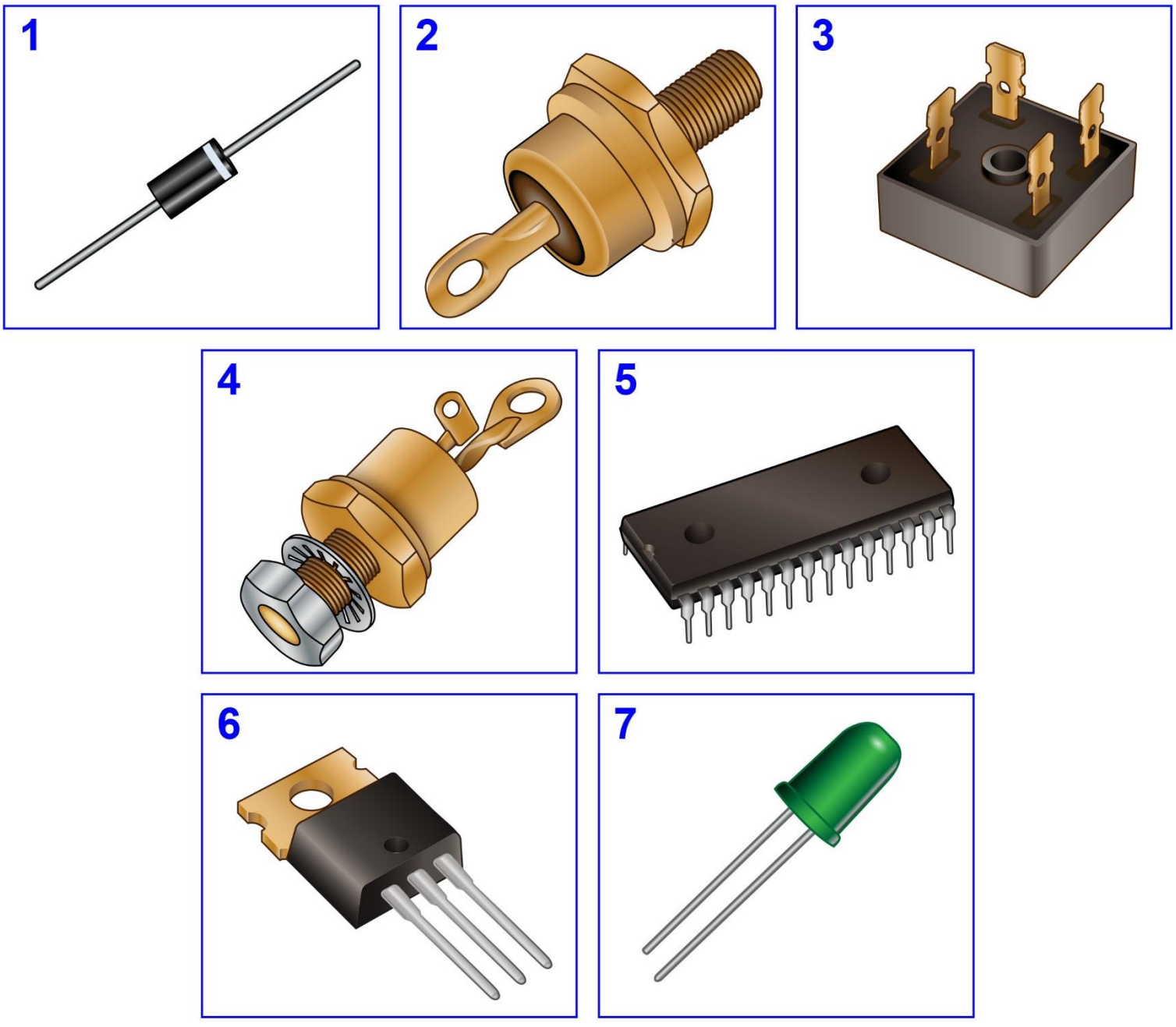
EL-0068



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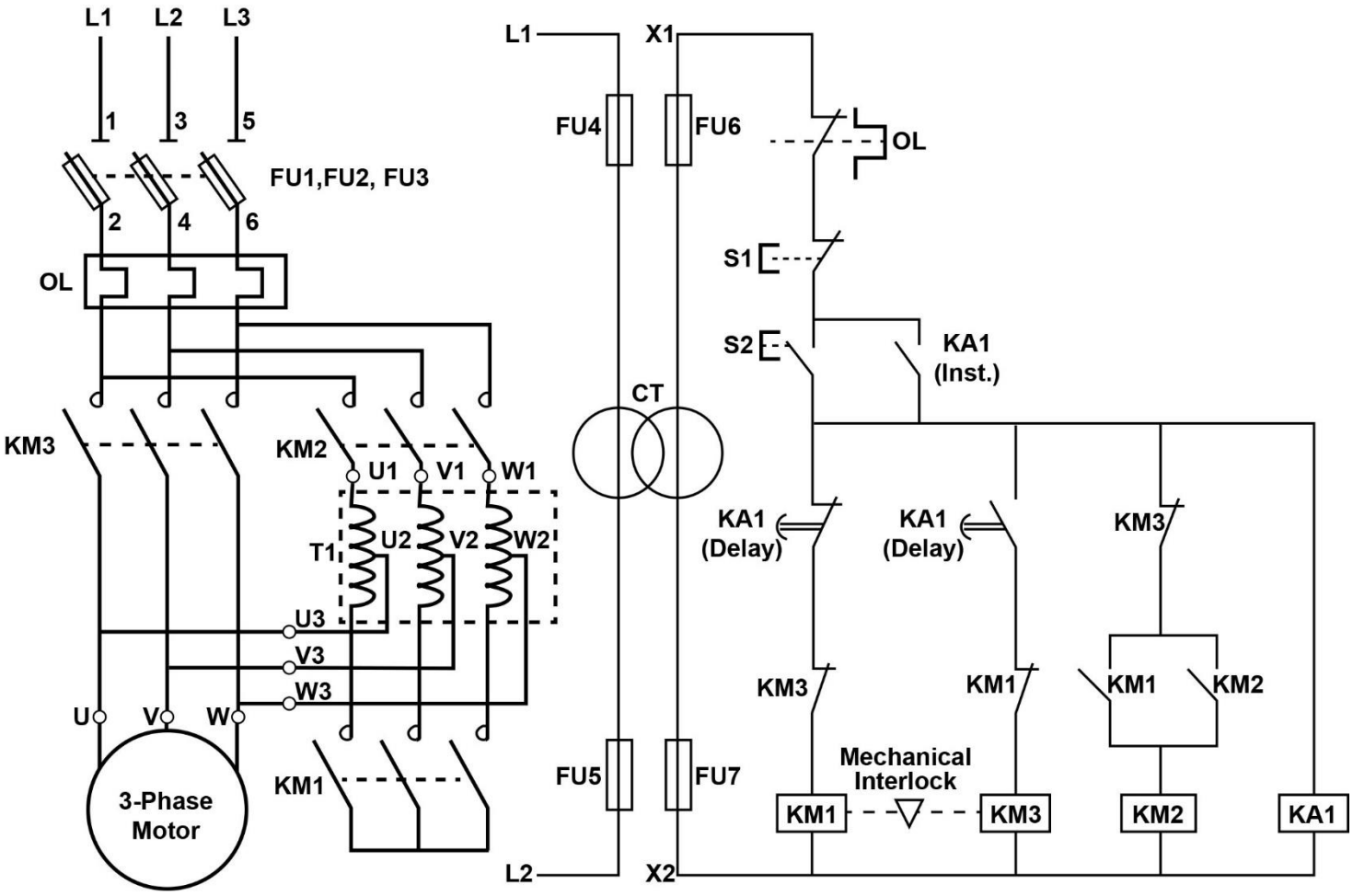

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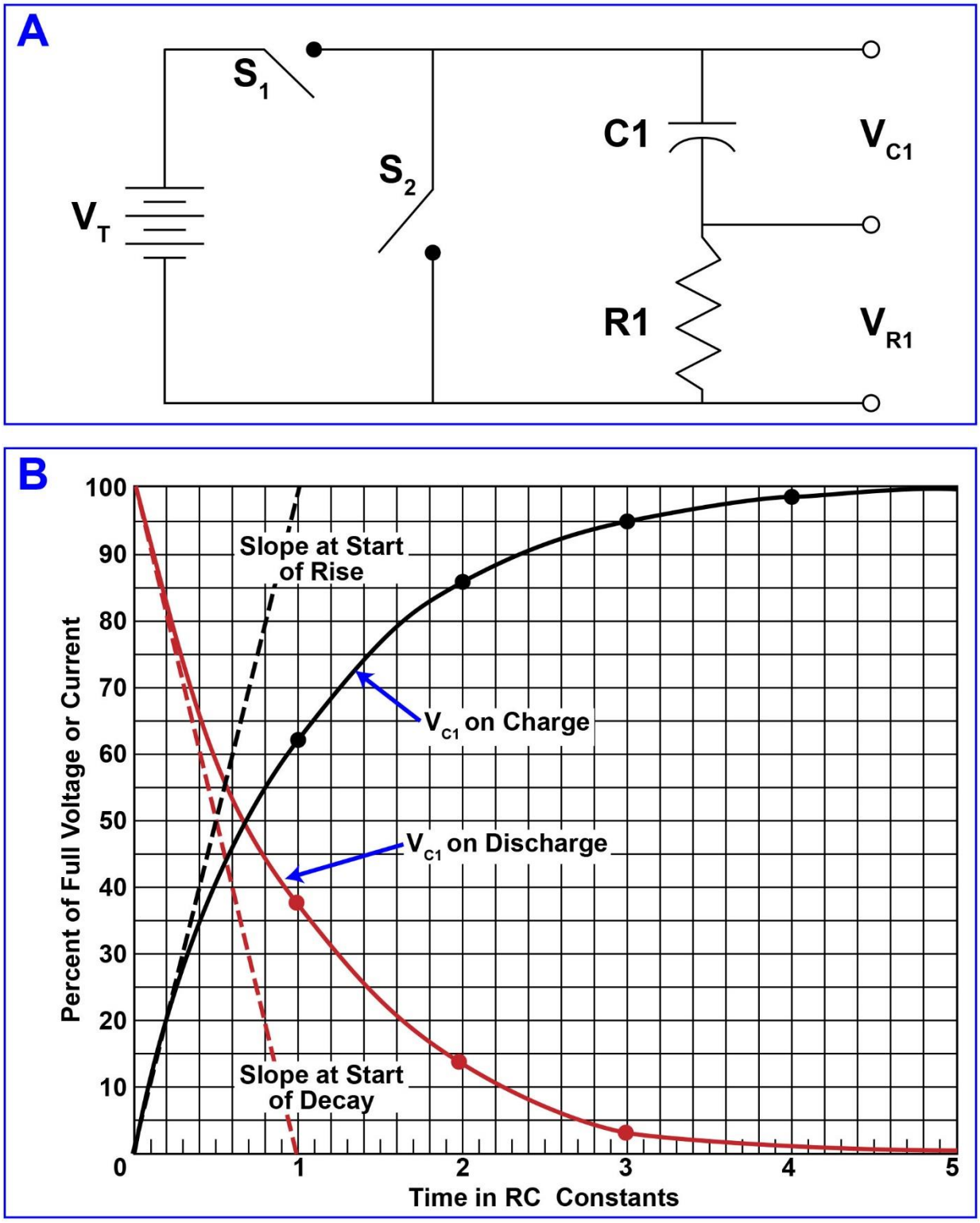

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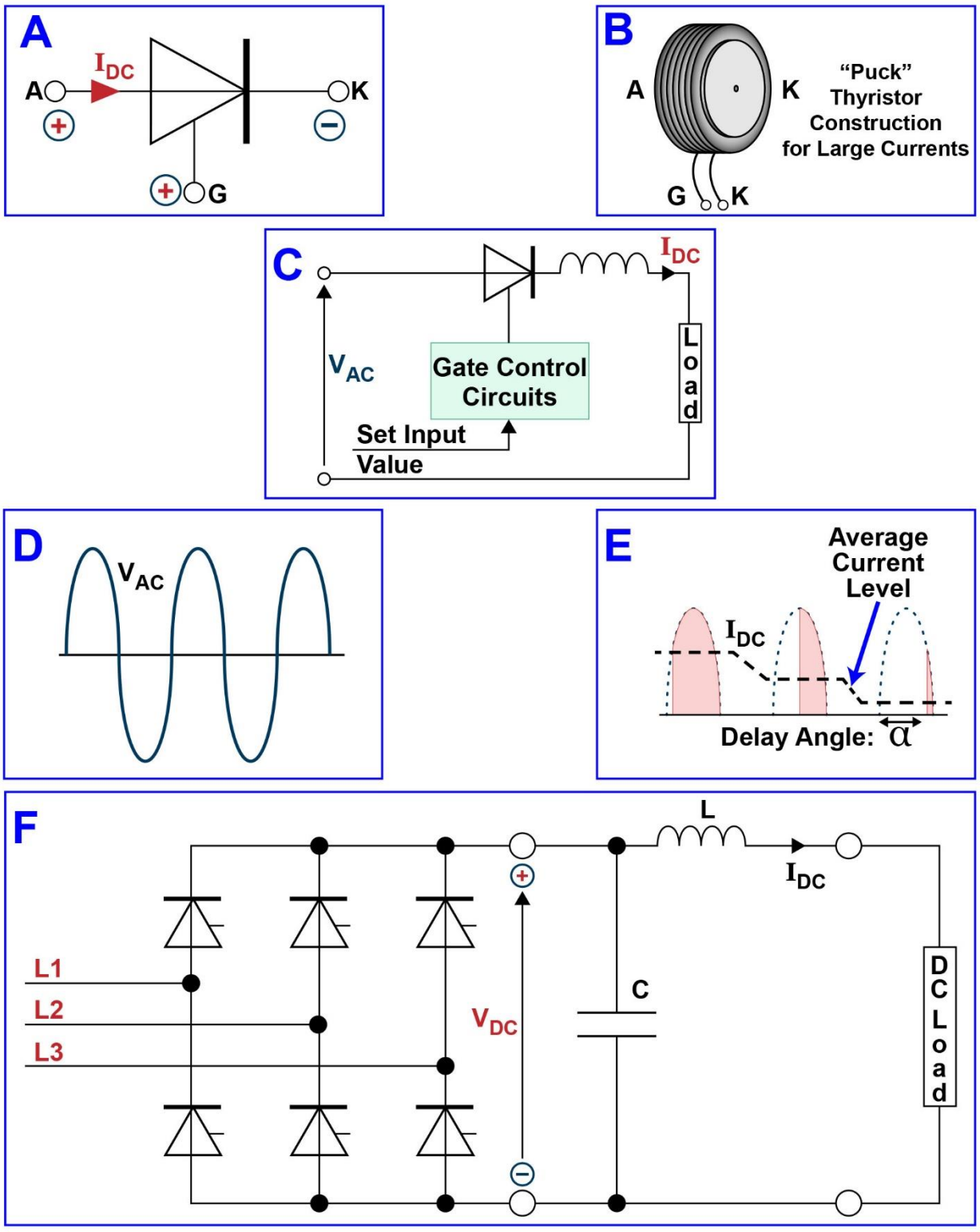

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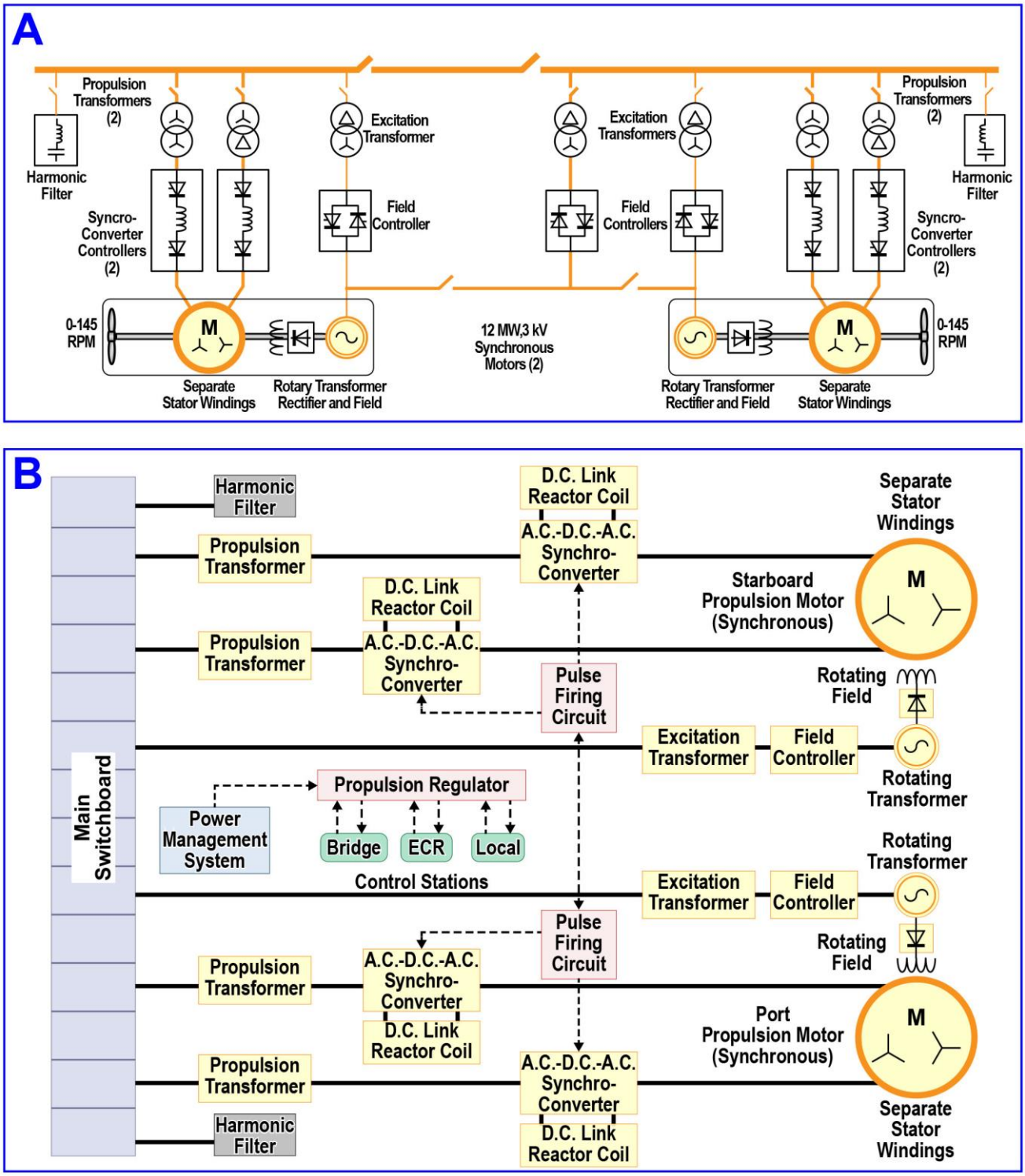

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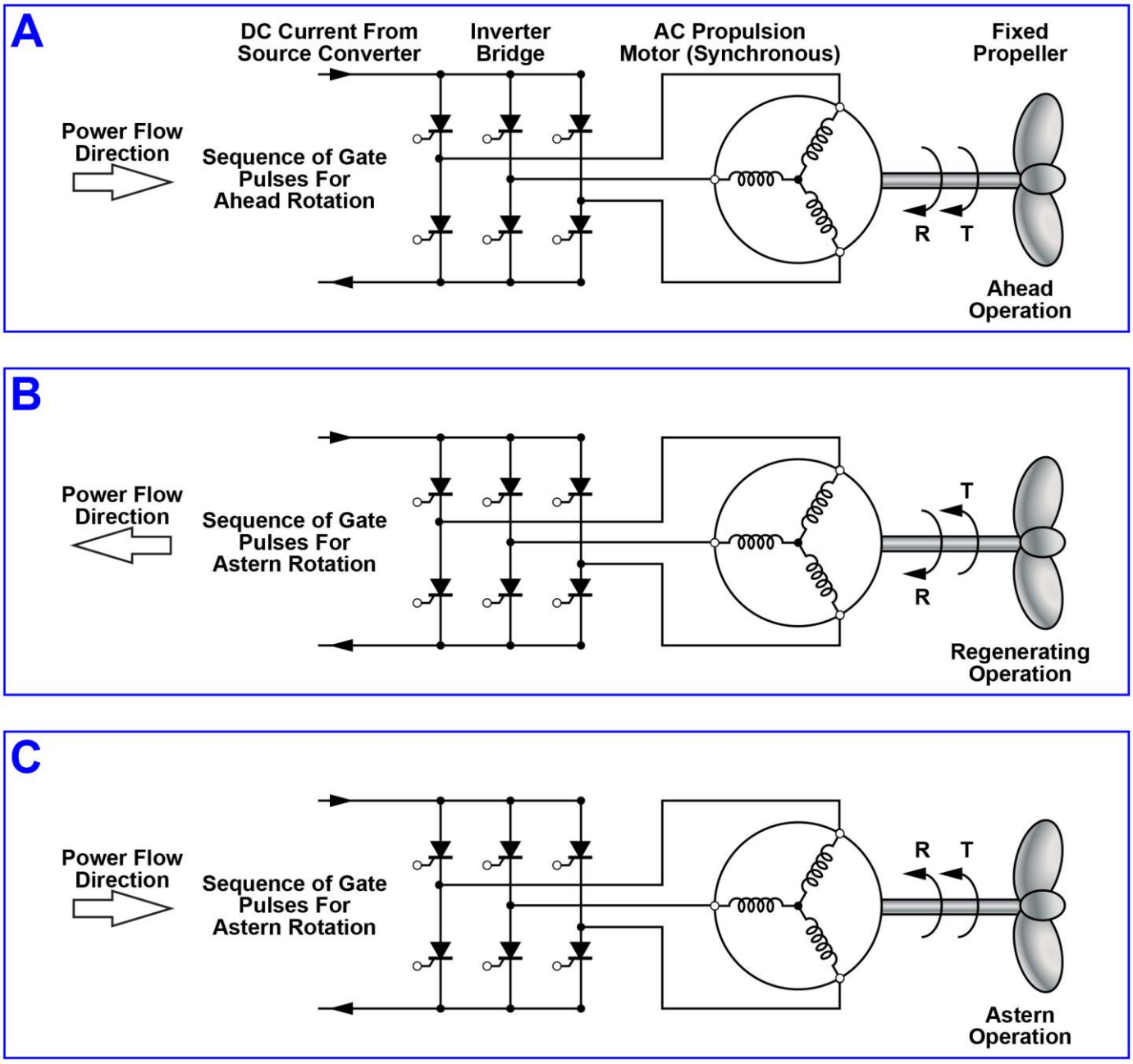
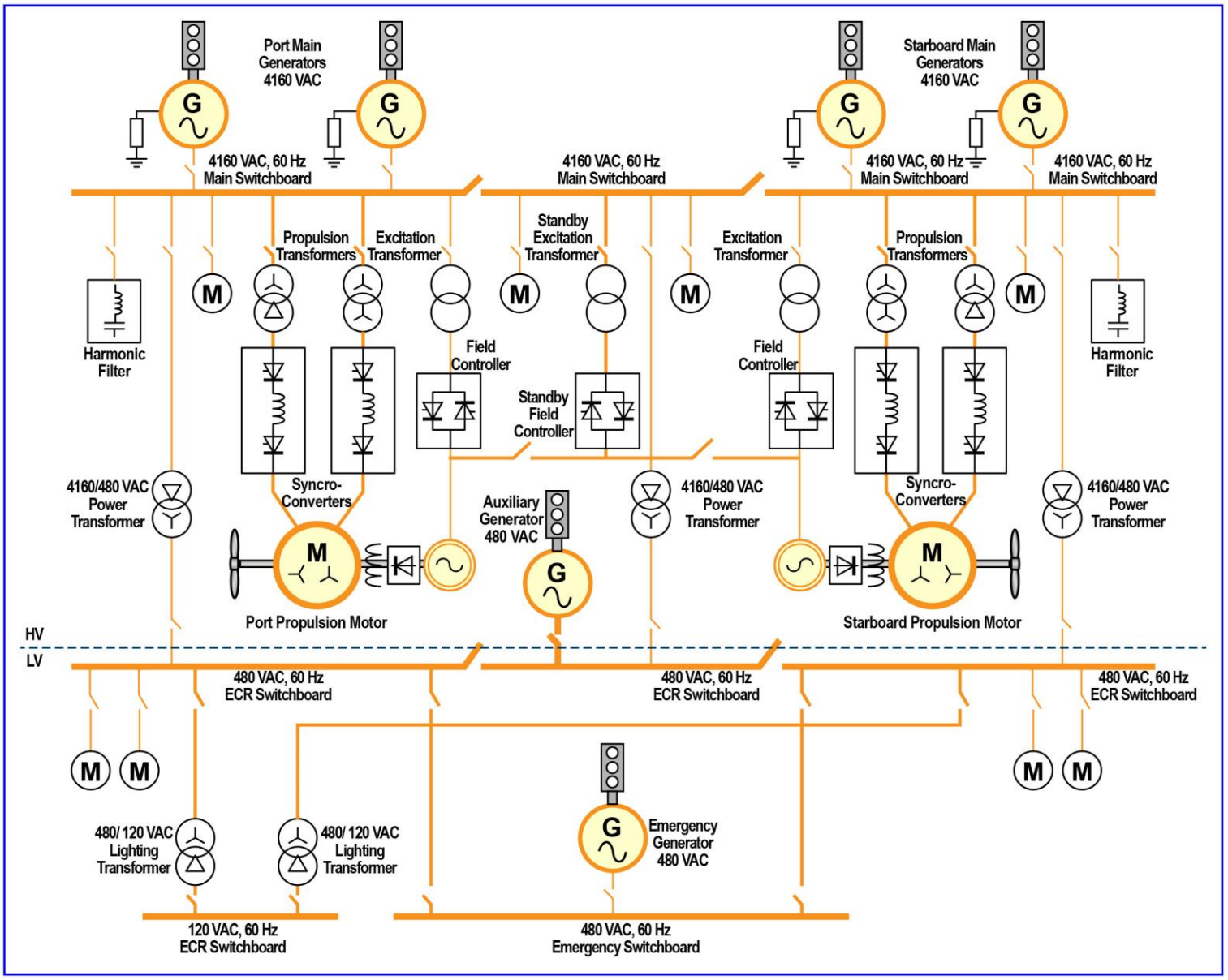


Where R = Direction of Actual Rotation
T = Direction of Applied Torque

EL-0164



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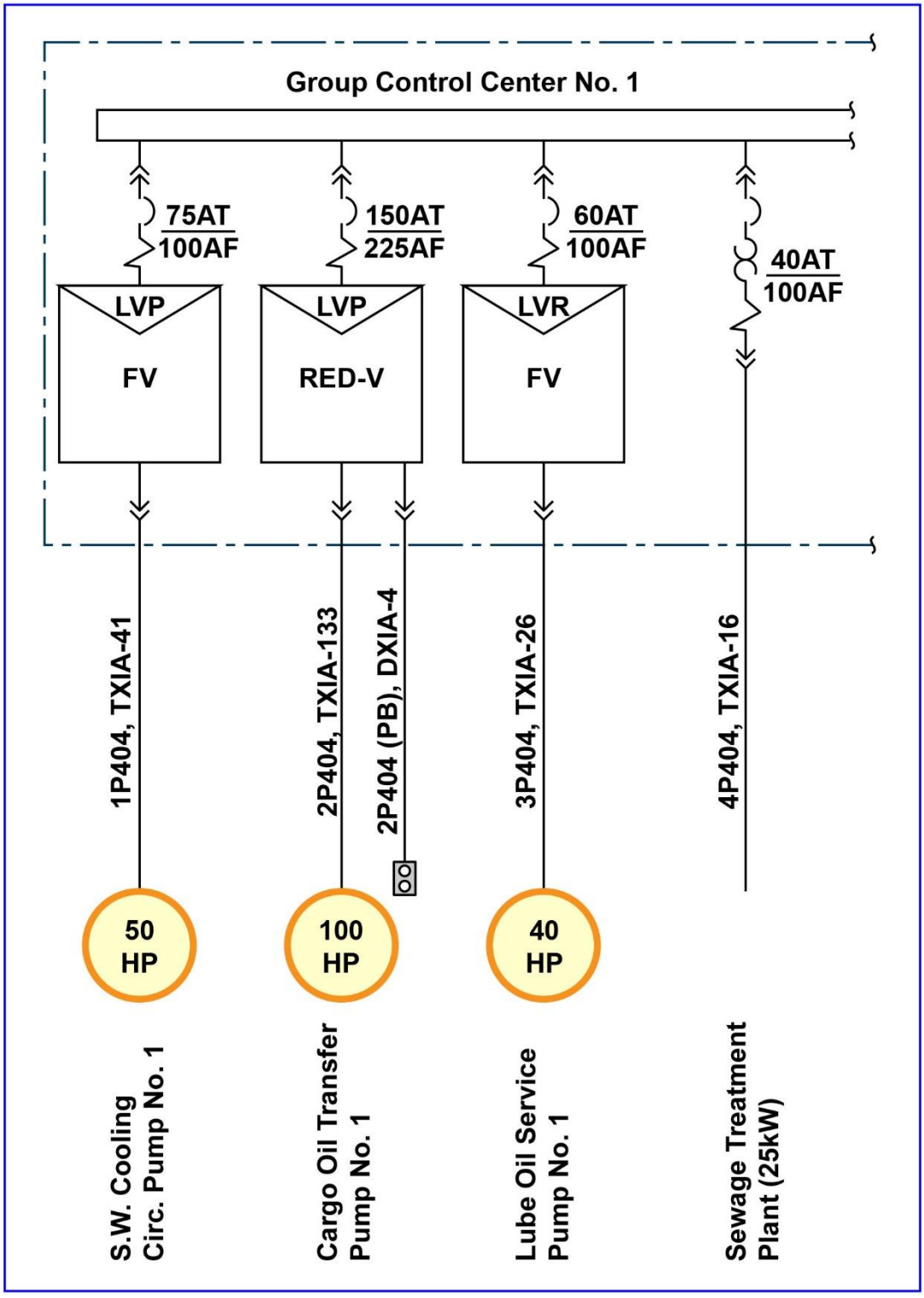

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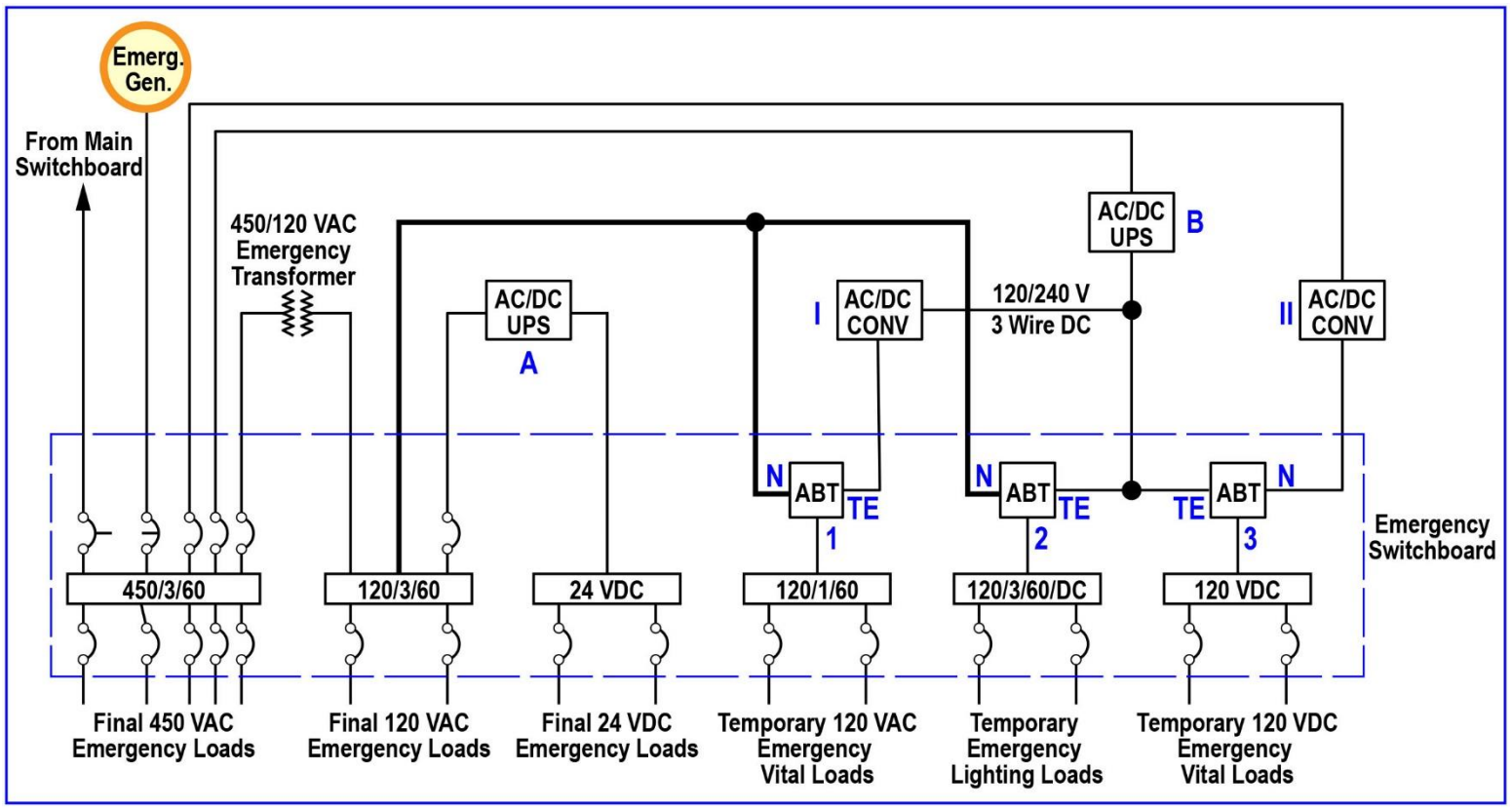


Legend:

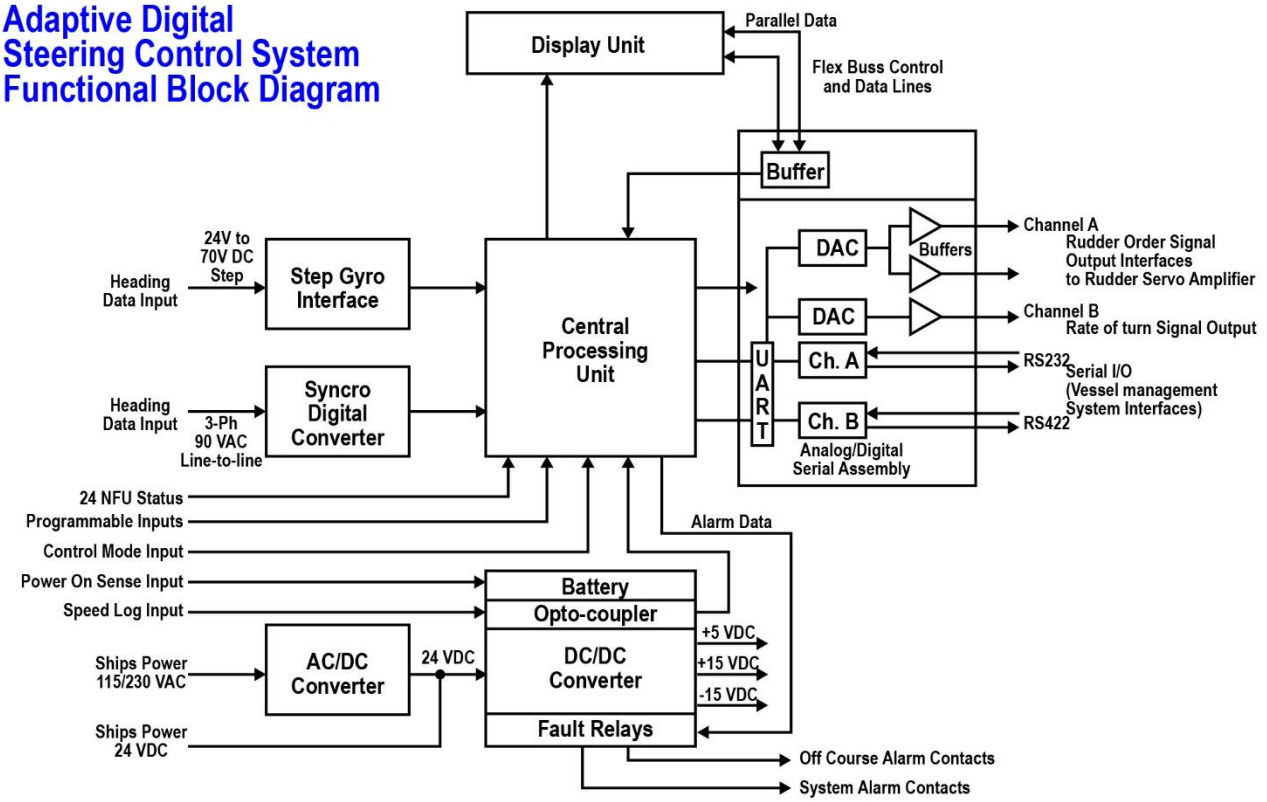
UPS: Uninterruptible Power Supply (Including Battery)
- A - 120 VAC to 24 VDC
- B - 450 VAC to 120/240 VDC

ABT: Automatic Bus Transfer Switch
- 1 - Transfers Vital AC Loads to UPS (B) via DC/AC Converter (I)
- 2 - Transfers Temporary Emergency Lighting to UPS (B)
- 3 - Transfers Vital DC Loads to UPS (B)

CONV: Converters
- I - 240 VDC to 120 VAC
- II - 450 VAC to 120 VAC
- N - Normal & Final Emergency Power Source
- TE - Temporary Emergency Power Source

EL-0191

Adaptive Digital Steering Control System Functional Block Diagram

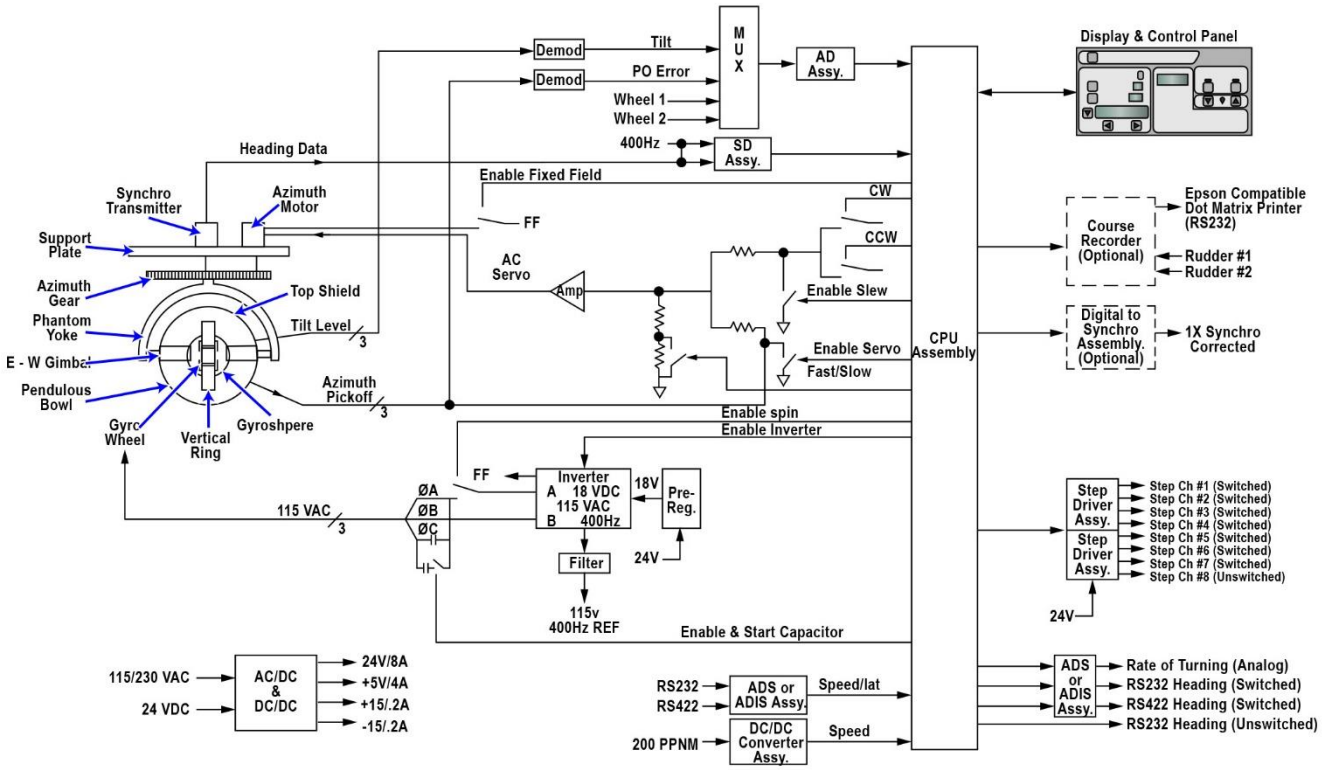


Adaptive Digital Steering System Interface Signals

Inputs	
Speed log input Pulsed Serial	 200 pulse nautical mile (PPNMI) format (contact closure) RS-232 (channel A or C) or RS-422 (channel B) communications in NMEA 0183 format, $VBW, $VHW
Navigator (vessel management system) input	Serial data for heading order, rate order, and cross track error information in RS-232 or RS-422 communication on channel A, B or C, in NMEA format $APB, $HSC, $HTR, $HTC or $XTE
Compass Step data Syncro	Positive or negative step data (24 or 70 V) 1X, 90X or 360X
Data Serial data	$HDT (on channels A, B or C)
Mode switch sense contact	External switched opened or closed to inform autopilot to change from Standby mode to an automatic mode
NFU sense contacts Power failure circuits	External contacts to indicate when the NFU Controller is active Closed contacts on external power switch to activate power failure alarm
Outputs	
Interface to external rudder Servo control amplifiers	Bipolar analogue voltage proportional to the rudder order. ± 11.25 V (maximum limit) equal to ± 45° or rudder
Rate of turn interface	Bipolar analogue voltage proportional to a turn rate indicator. ± 4.5 V (Max) equal to ± 90° turn/min. Resolution equal to 0.5°/min.

EL-0194

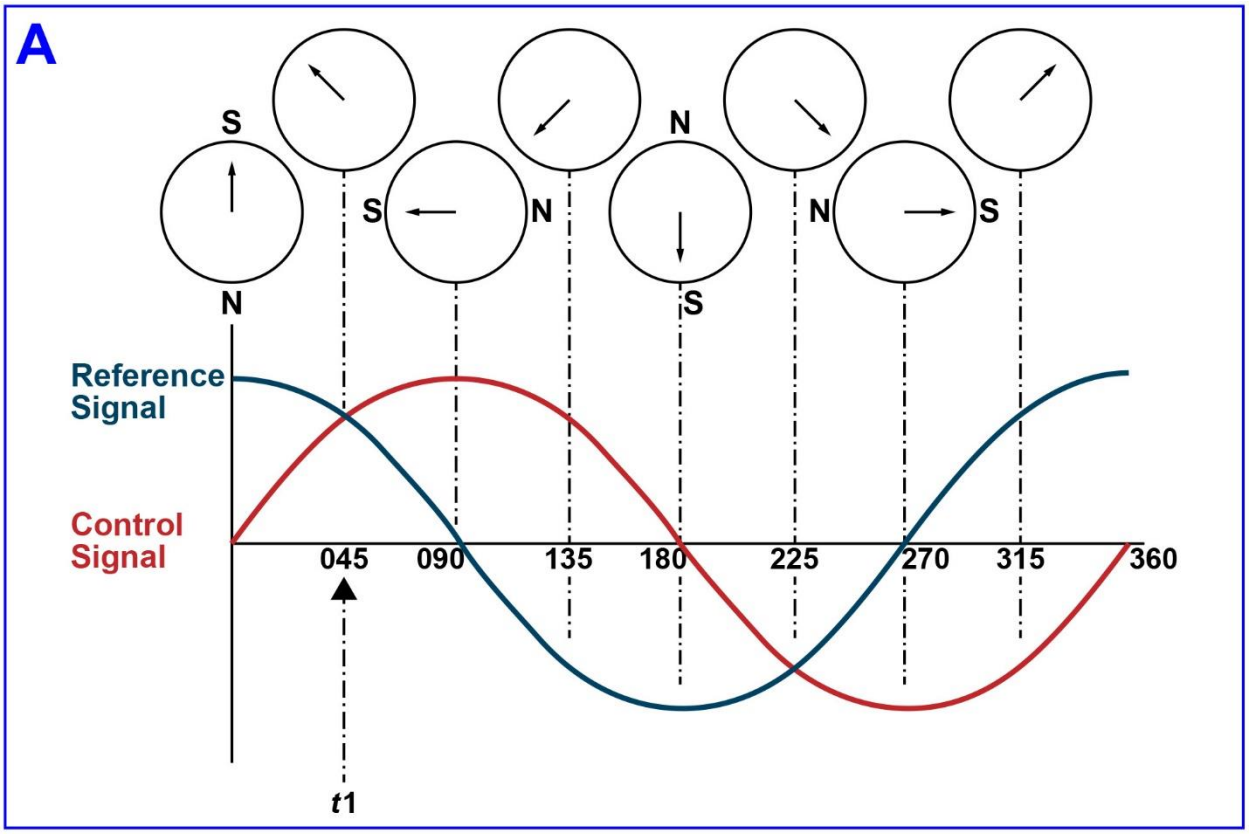
Digital Gyrocompass Functional Block Diagram

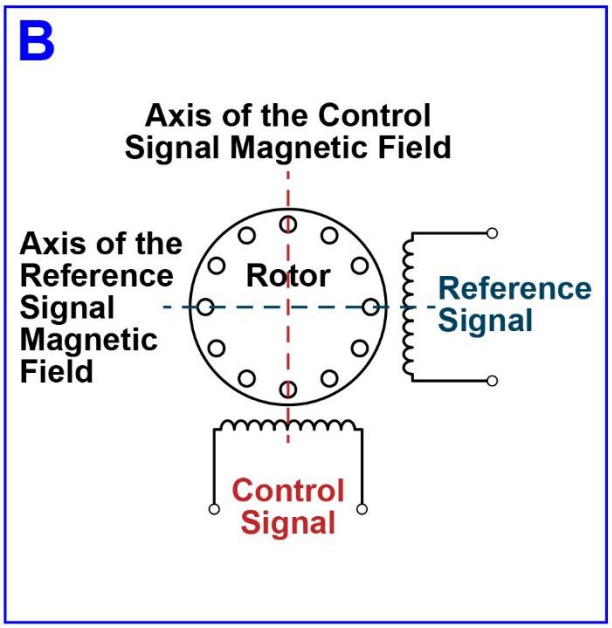


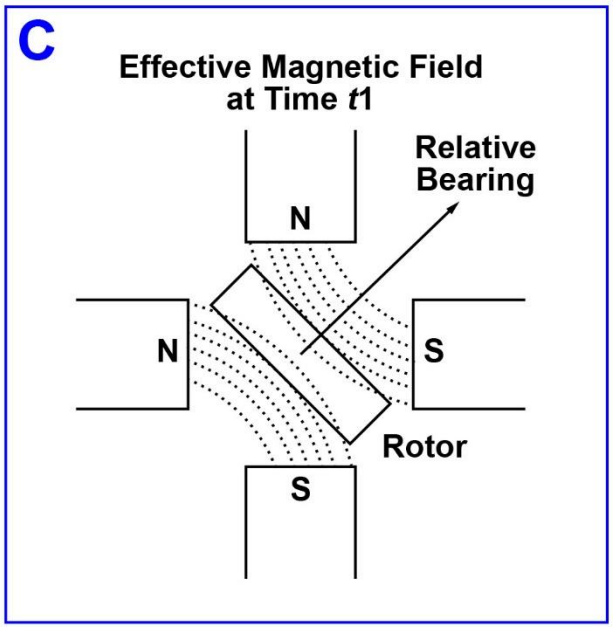
Digital Gyrocompass Communication Protocols

Inputs	
Speed: Pulsed Serial Manual	Automatic: 200 ppnm Automatic from digital sources, RS-232/422 in NMEA 0183 format $VBW, $VHW, $VTG Manually via the control panel
Latitude	Automatic from the GPS via RS-232/422 in NMEA format $GLL, $GGA Automatic from digital sources via RS-232/422 in NMEA 0183 format $GLL Manually via the control panel
Outputs	
Rate of Turn	50 mV per deg/min (± 4.5 VDC full scale = ± 90°/min) NMEA 0183 format $HEROT, X.XXXX, A*hh<CR><LF> 1 Hz, 4800 baud
Step Repeaters	Eight 24 VDC step data outputs. (An additional 12-step data output at 35 VDC or 70 VDC from the optional transmission unit) 7 — switched, 1 — unswitched
Heading Data	One RS-422, capable of driving up to 10 loads in NMEA 0183 format $HEHDT, XXX.XXX, T*hh<CR><LF> Two RS-232, each capable of driving one load in NMEA 0183 format $HEHDT, XXX>XXX, T*hh<CR><LF> 10 Hz, 4800 baud 1 — 232 switched, 1 — 232 unswitched, 1 — 422 switched
Alarm Outputs	A relay and a battery-powered circuit activates a fault indicator and audible alarm during a power loss. Compass alarm NO/NC contacts. Power alarm — NO/NC contacts
Course Recorder	(If fitted) RS-232 to dot matrix printer
Synchro Output	(If fitted) 90 V line-to-line with a 115 VAC 400 Hz reference. Can be switched or unswitched

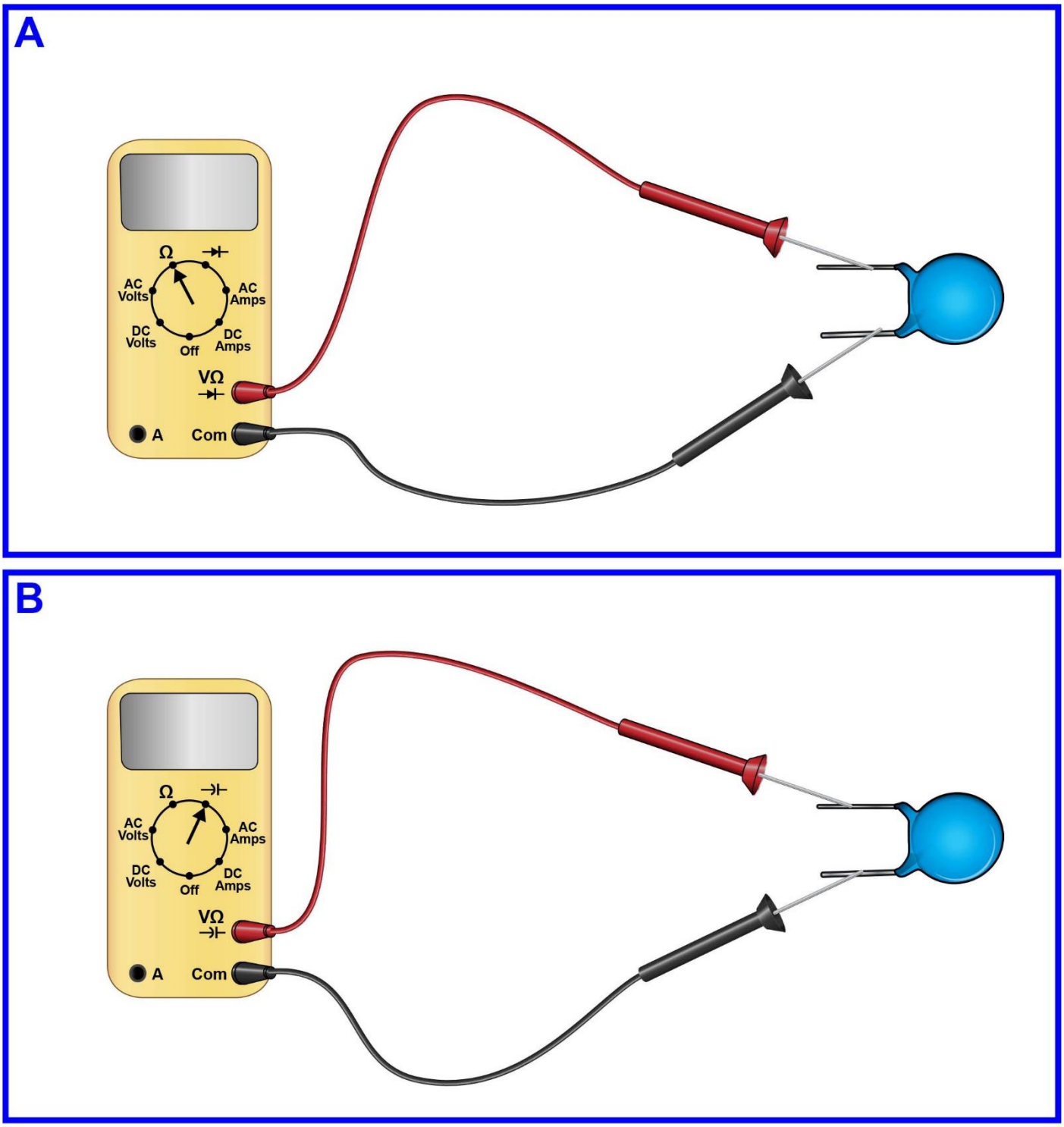
EL-0196







EL-0213



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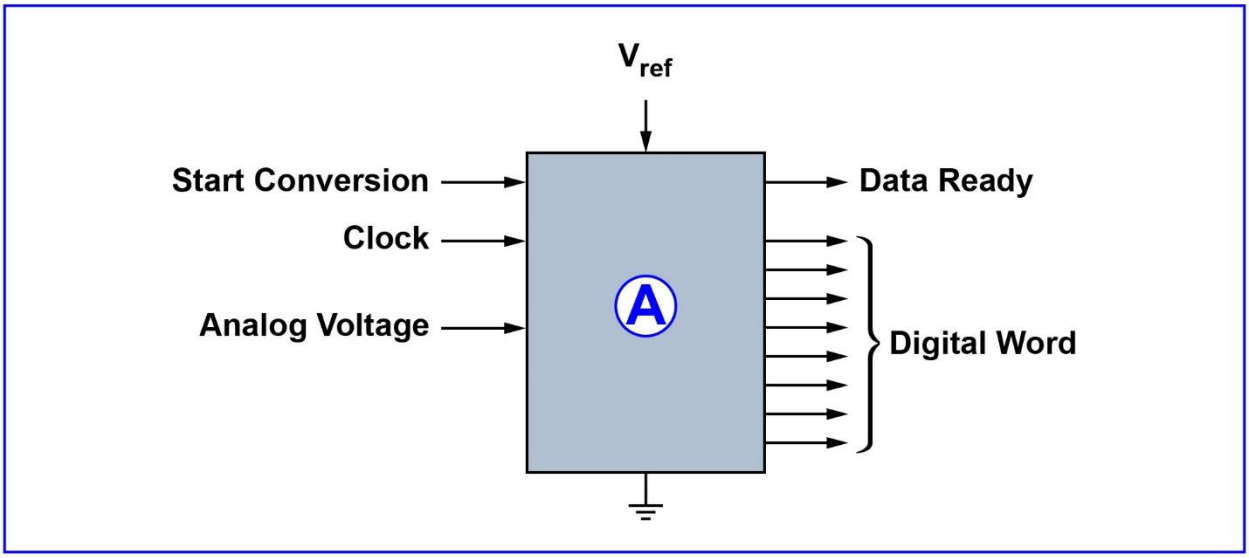

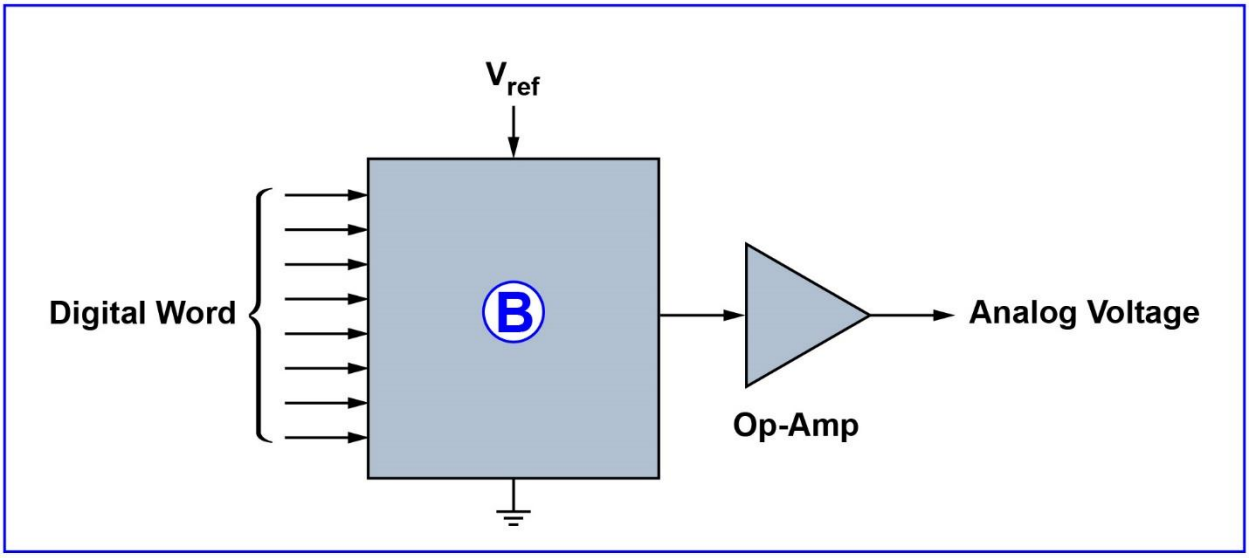

EL-0256

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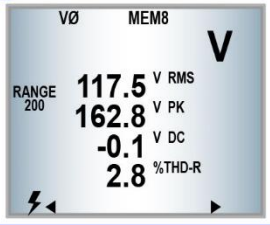

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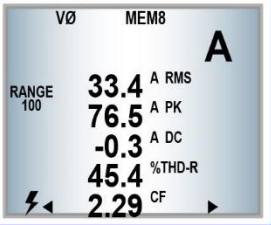

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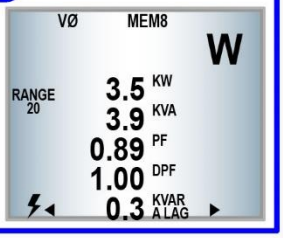

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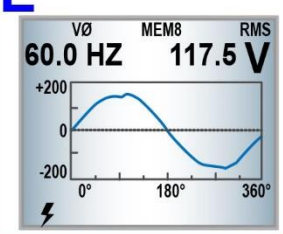

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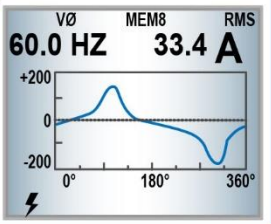

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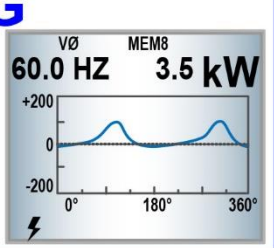

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