EL-0001

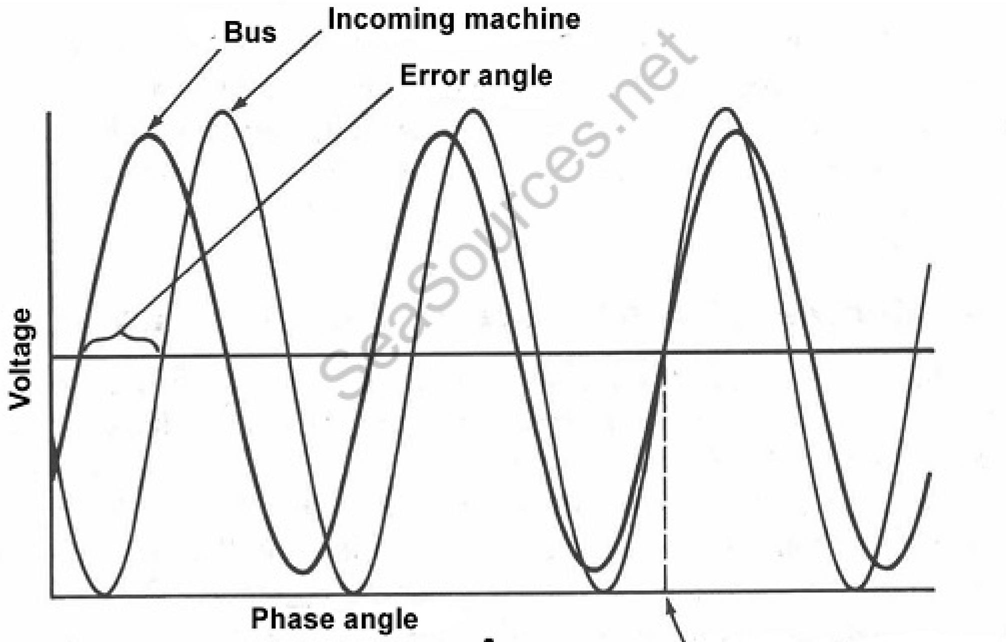
A

B

C

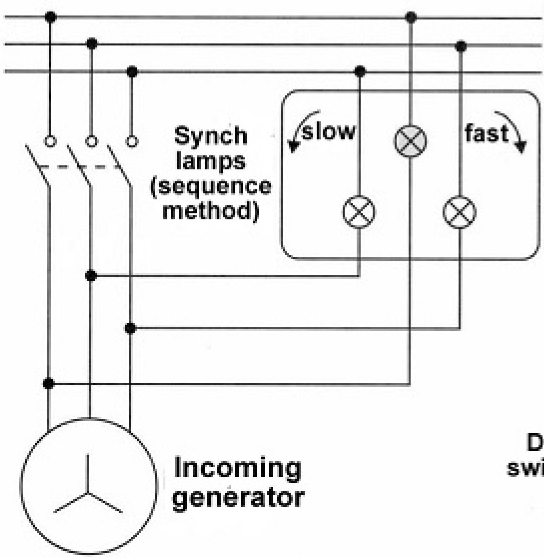
D

EL-0002



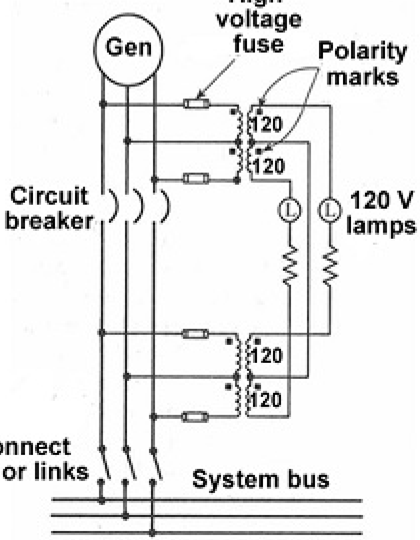
Bus
Incoming machine
Error angle
Voltage
Phase angle
Waves in synchronism

A



Synch
lamps
(sequence
method)
slow
fast
Incoming
generator

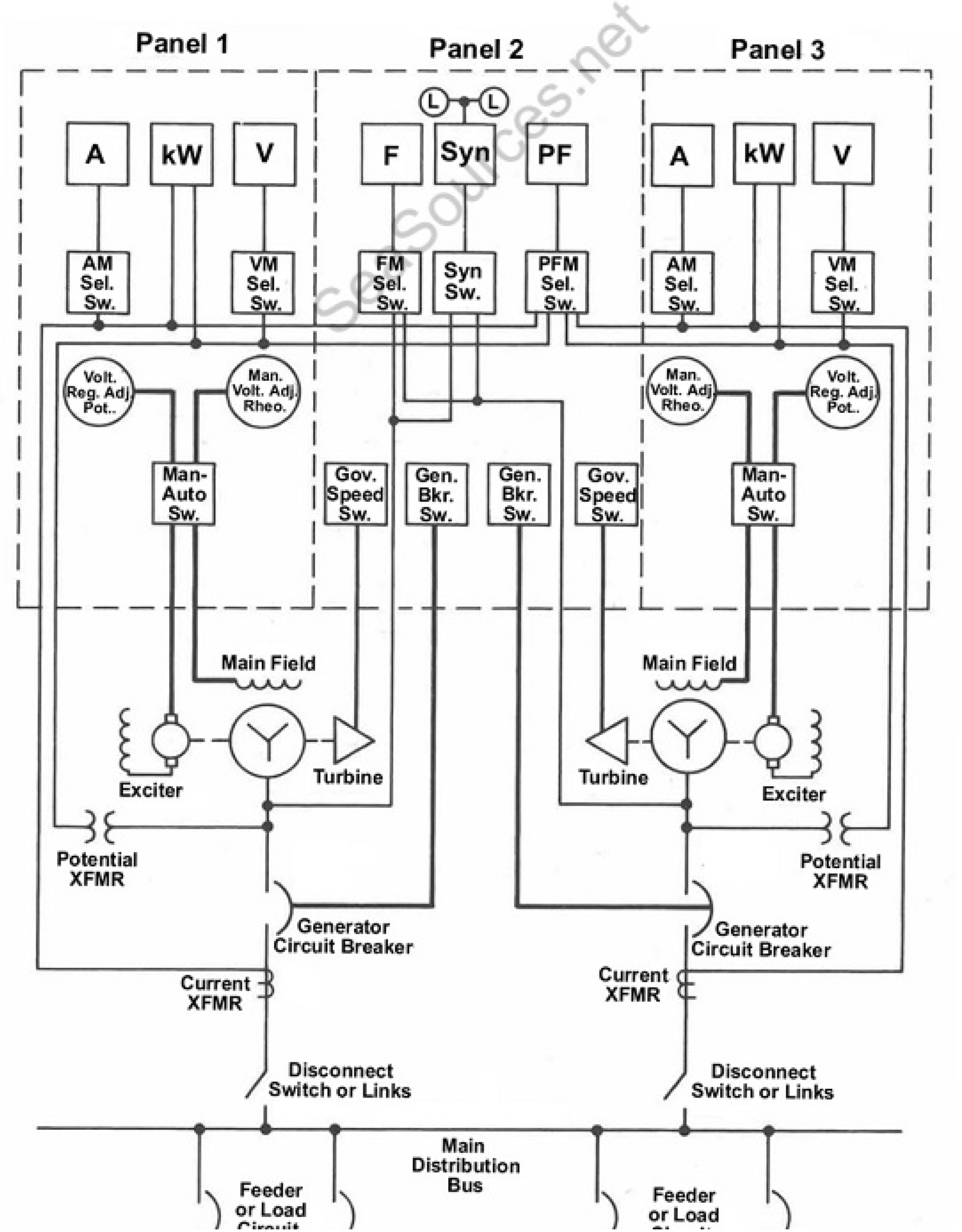
B



High
voltage
fuse
Gen
Polarity
marks
120
120
Circuit
breaker
120 V
lamps
L
L
120
120
Disconnect
switch or links
System bus

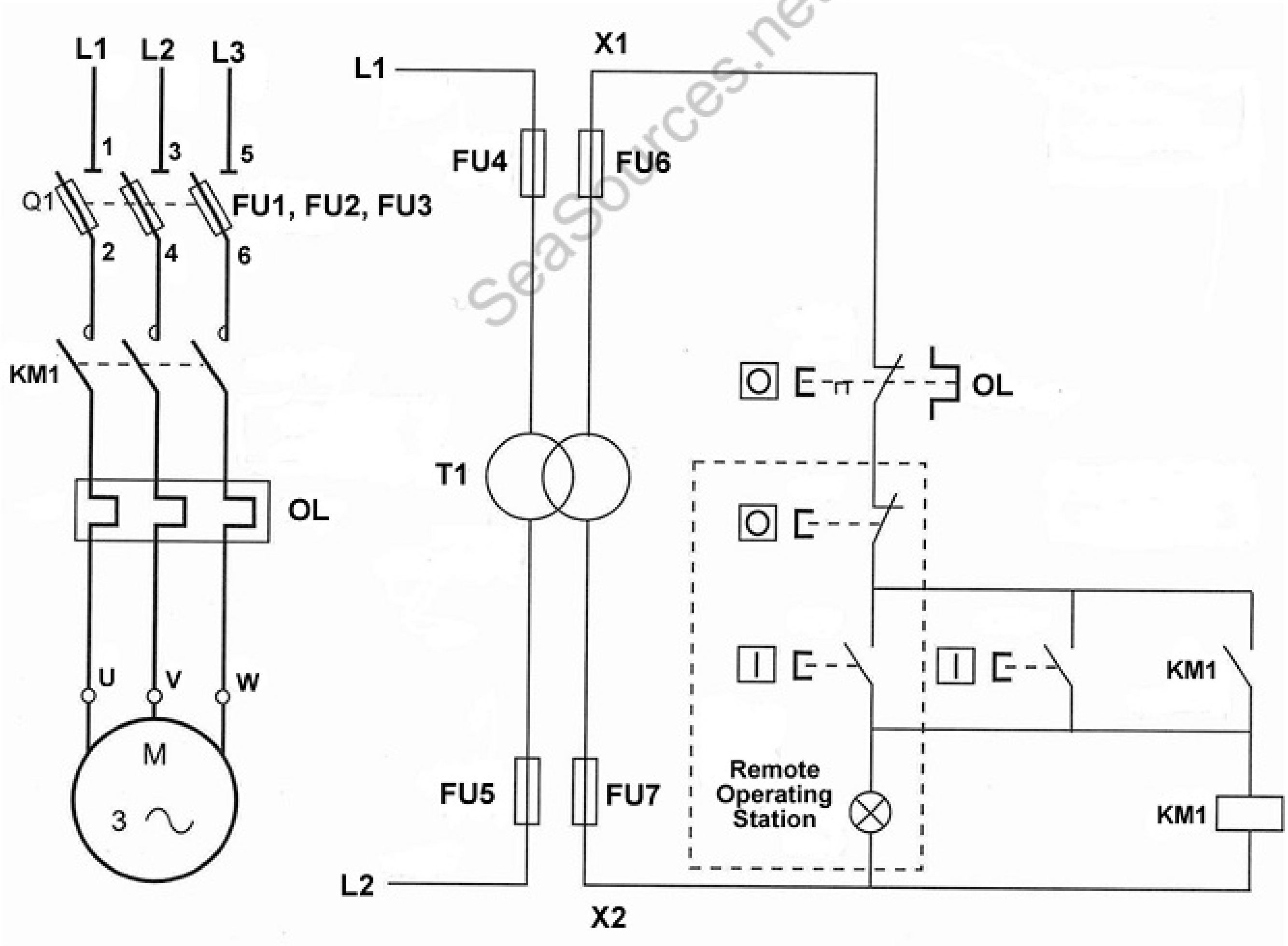
C

EL-0003



Panel 1
Panel 2
Panel 3
L
L
A
kW
V
F
Syn
PF
A
kW
V
AM Sel. Sw.
VM Sel. Sw.
FM Sel. Sw.
Syn Sw.
PFM Sel. Sw.
AM Sel. Sw.
VM Sel. Sw.
Volt. Reg. Adj. Pot..
Man. Volt. Adj. Rheo.
Man. Volt. Adj. Rheo.
Volt. Reg. Adj. Pot..
Man-Auto Sw.
Gov. Speed Sw.
Gen. Bkr. Sw.
Gen. Bkr. Sw.
Gov. Speed Sw.
Man-Auto Sw.
Main Field
Main Field
Exciter
Turbine
Turbine
Exciter
Potential XFMR
Potential XFMR
Generator Circuit Breaker
Generator Circuit Breaker
Current XFMR
Current XFMR
Disconnect Switch or Links
Disconnect Switch or Links
Main Distribution Bus
Feeder or Load
Feeder or Load

EL-0004


L1
L2
L3
1
3
5
Q1
FU1, FU2, FU3
2
4
6
KM1
OL
U
V
W
M
3 ~
L1
X1
FU4
FU6
T1
FU5
FU7
L2
X2
OL
KM1
Remote Operating Station
KM1

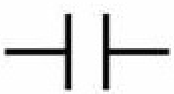
EL-0005

A

B

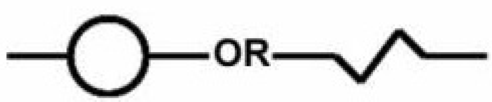
C

D

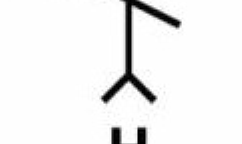


E

F



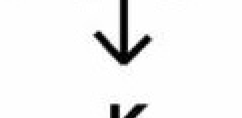
G



H

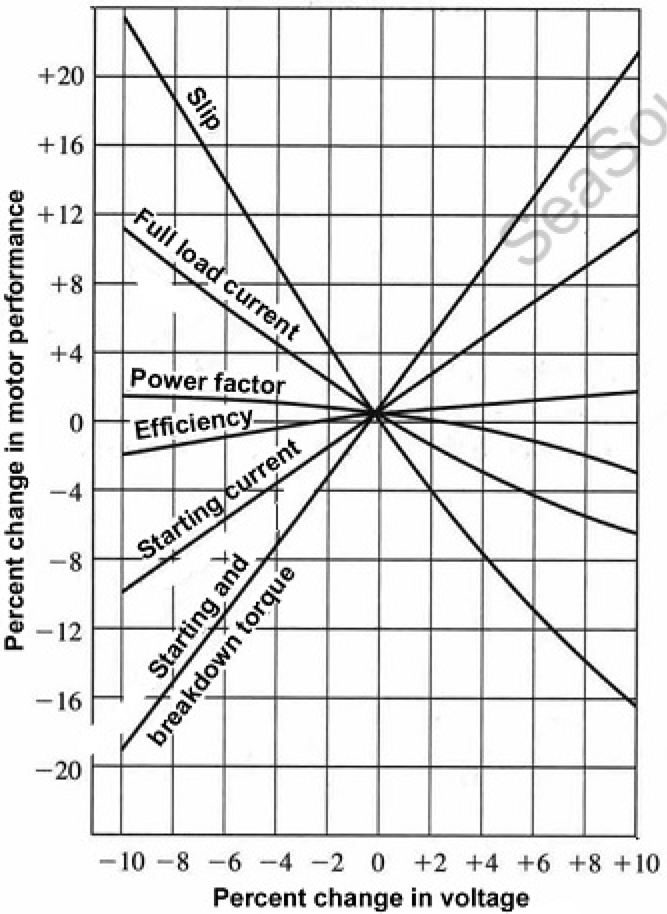
I

J

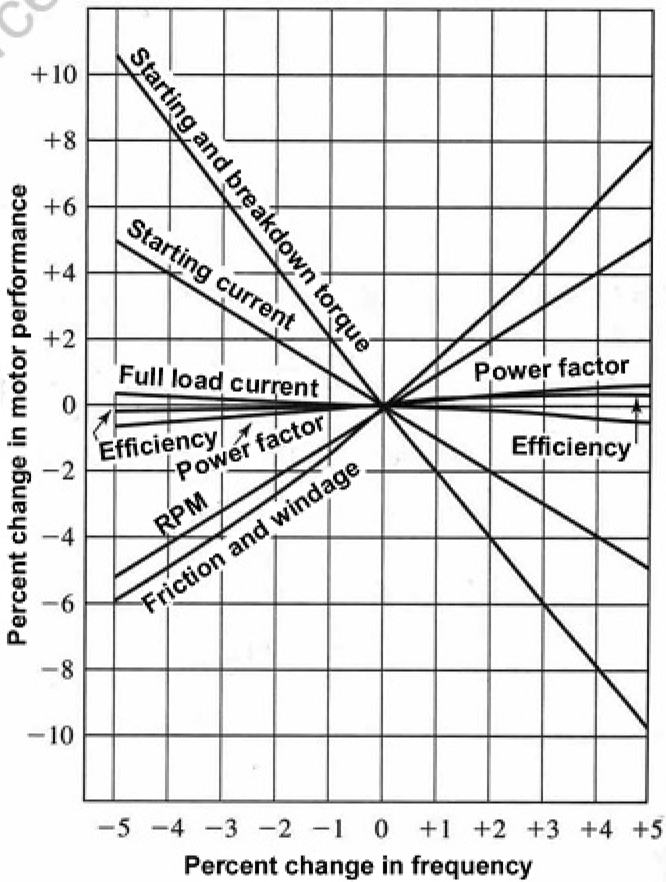


K

EL-0006

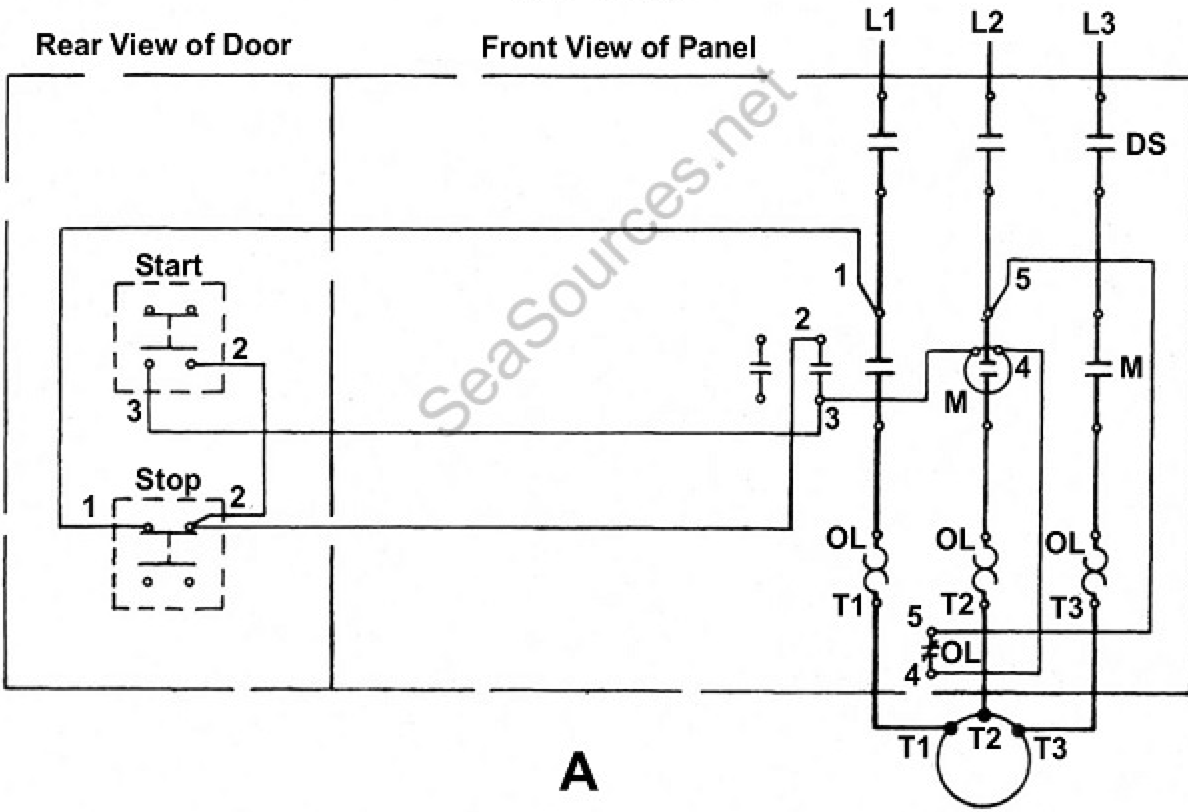


Slip
Full load current
Power factor
Efficiency
Starting current
Starting and breakdown torque
Percent change in motor performance
Percent change in voltage
+20
+16
+12
+8
+4
0
−4
−8
−12
−16
−20
−10 −8 −6 −4 −2 0 +2 +4 +6 +8 +10



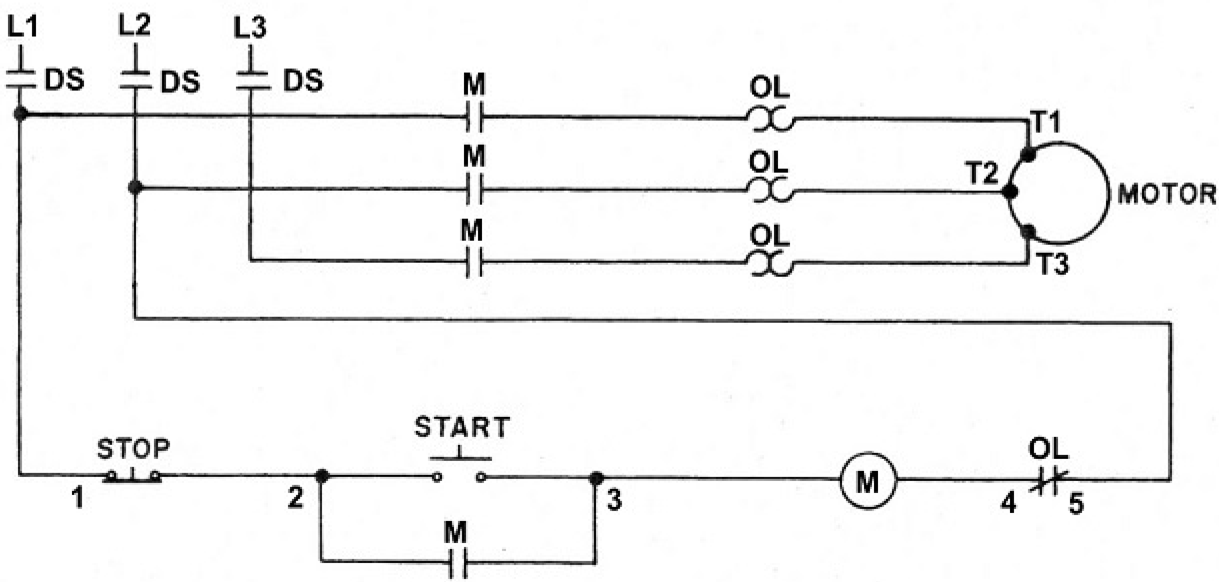
Starting and breakdown torque
Starting current
Full load current
Power factor
Efficiency
Efficiency
Power factor
RPM
Friction and windage
Percent change in motor performance
Percent change in frequency
+10
+8
+6
+4
+2
0
−2
−4
−6
−8
−10
−5 −4 −3 −2 −1 0 +1 +2 +3 +4 +5

EL-0007



Rear View of Door
Front View of Panel
L1
L2
L3
DS
Start
Stop
1
2
3
5
4
M
M
OL
OL
OL
T1
T2
T3
OL
T1
T2
T3

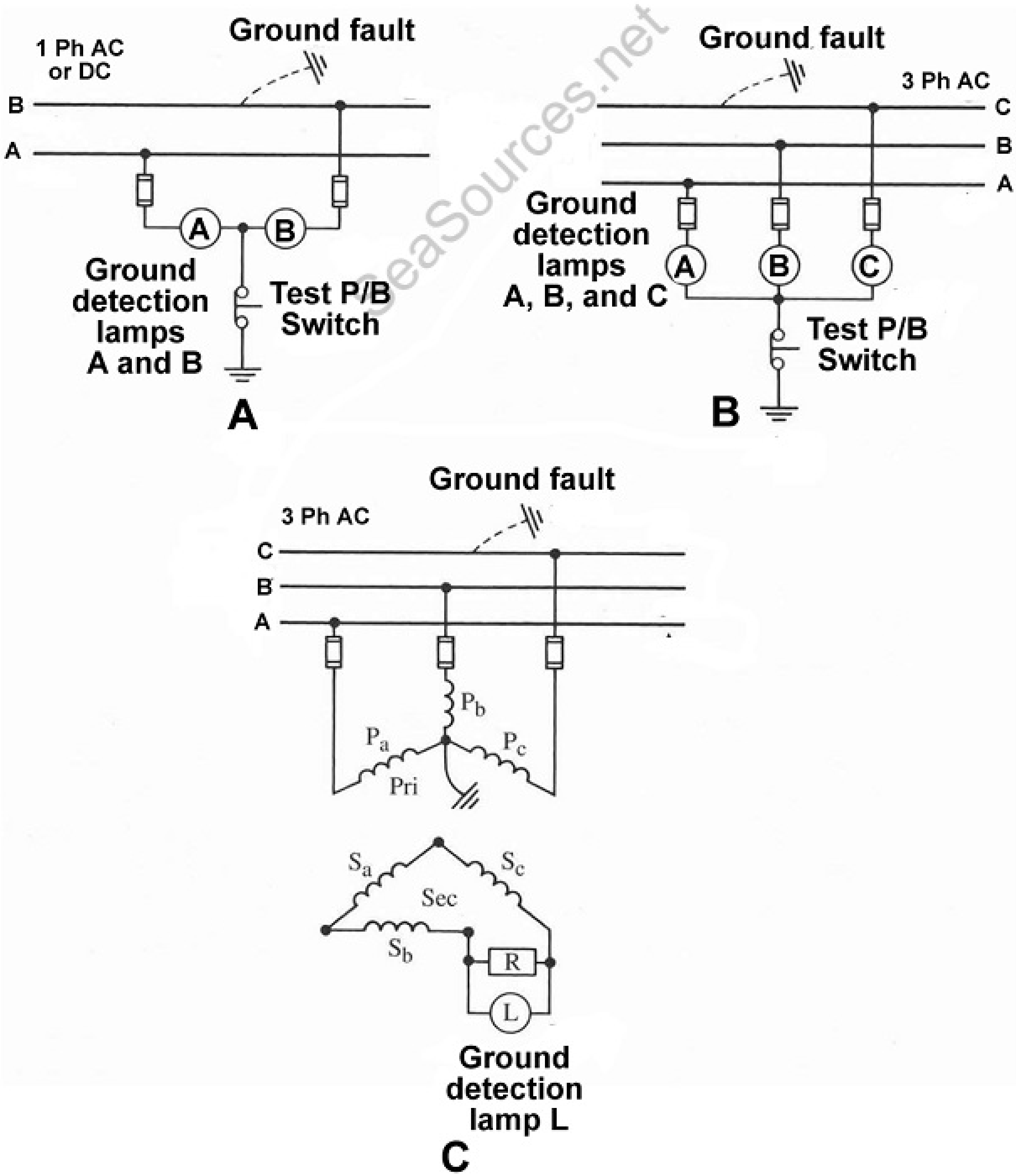
A



L1
L2
L3
DS
DS
DS
M
M
M
OL
OL
OL
T1
T2
T3
MOTOR
STOP
START
M
M
OL
1
2
3
4
5

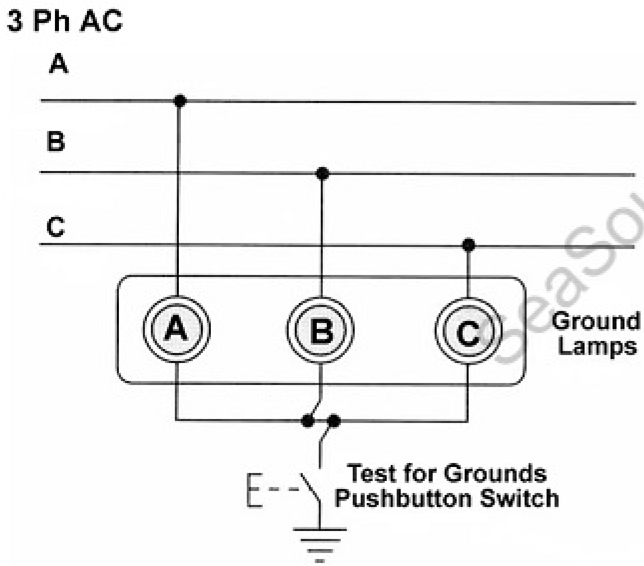
B

EL-0008

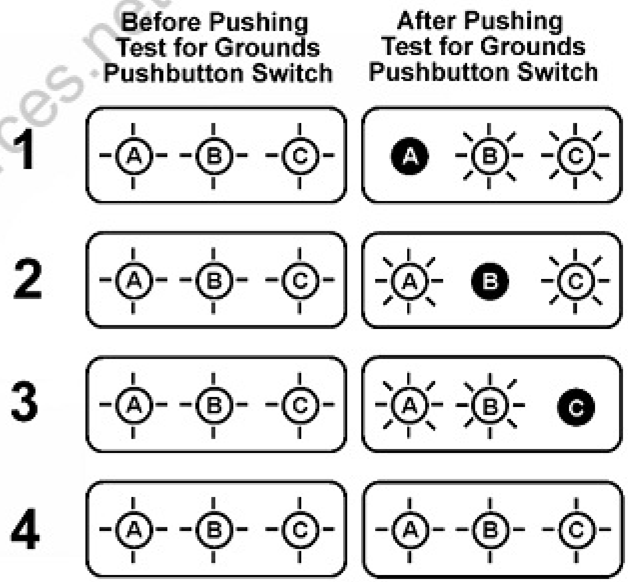


Ground fault
1 Ph AC
or DC
B
A
A
B
Ground
detection
lamps
A and B
Test P/B
Switch
A
Ground fault
3 Ph AC
C
B
A
Ground
detection
lamps
A, B, and C
A
B
C
Test P/B
Switch
B
Ground fault
3 Ph AC
C
B
A
P_b
P_a
P_c
Pri
S_a
S_c
Sec
S_b
R
L
Ground
detection
lamp L
C

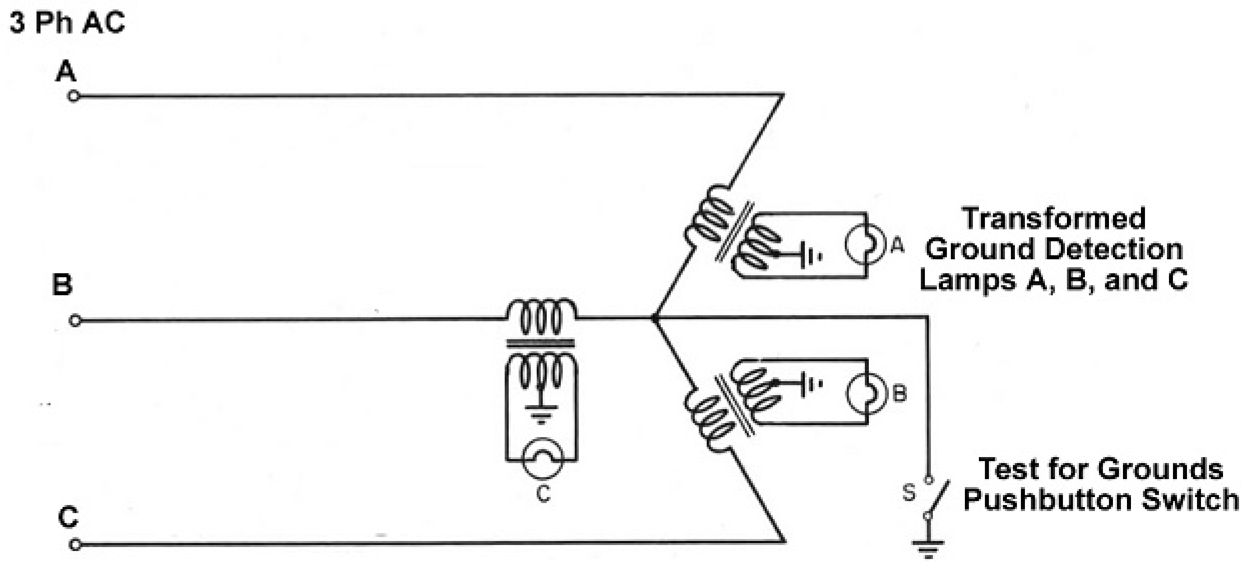
EL-0009



Simplified Ground Detection Circuit



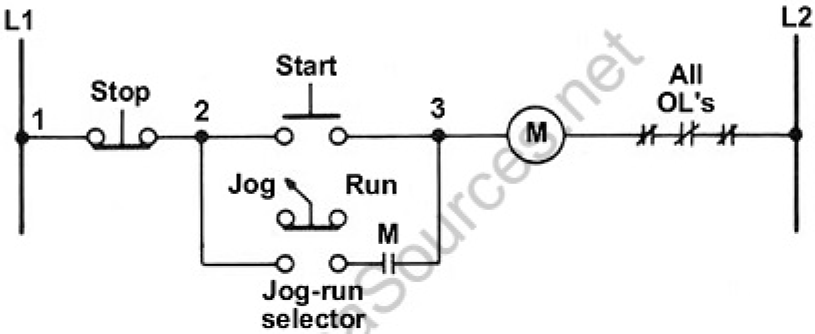
Example Indications



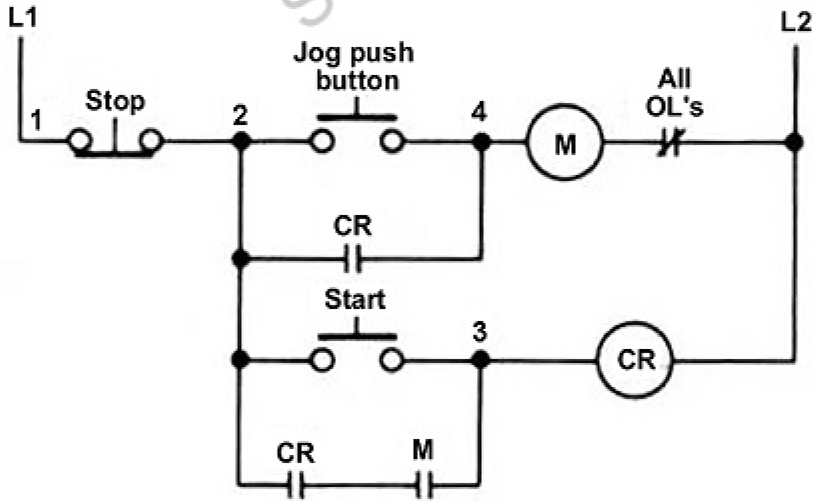
Actual Ground Detection Circuit

EL-0010

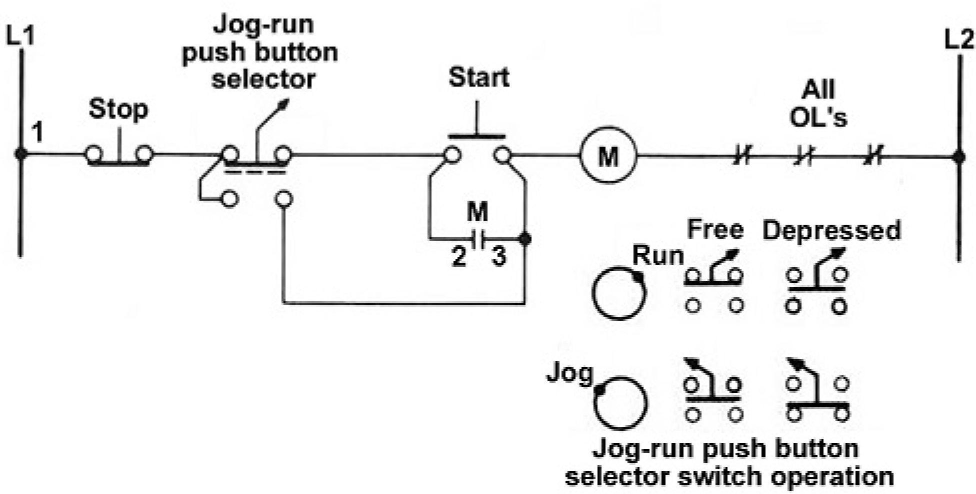
A


L1
L2
Stop
Start
1
2
3
M
All
OL's
Jog
Run
M
Jog-run
selector

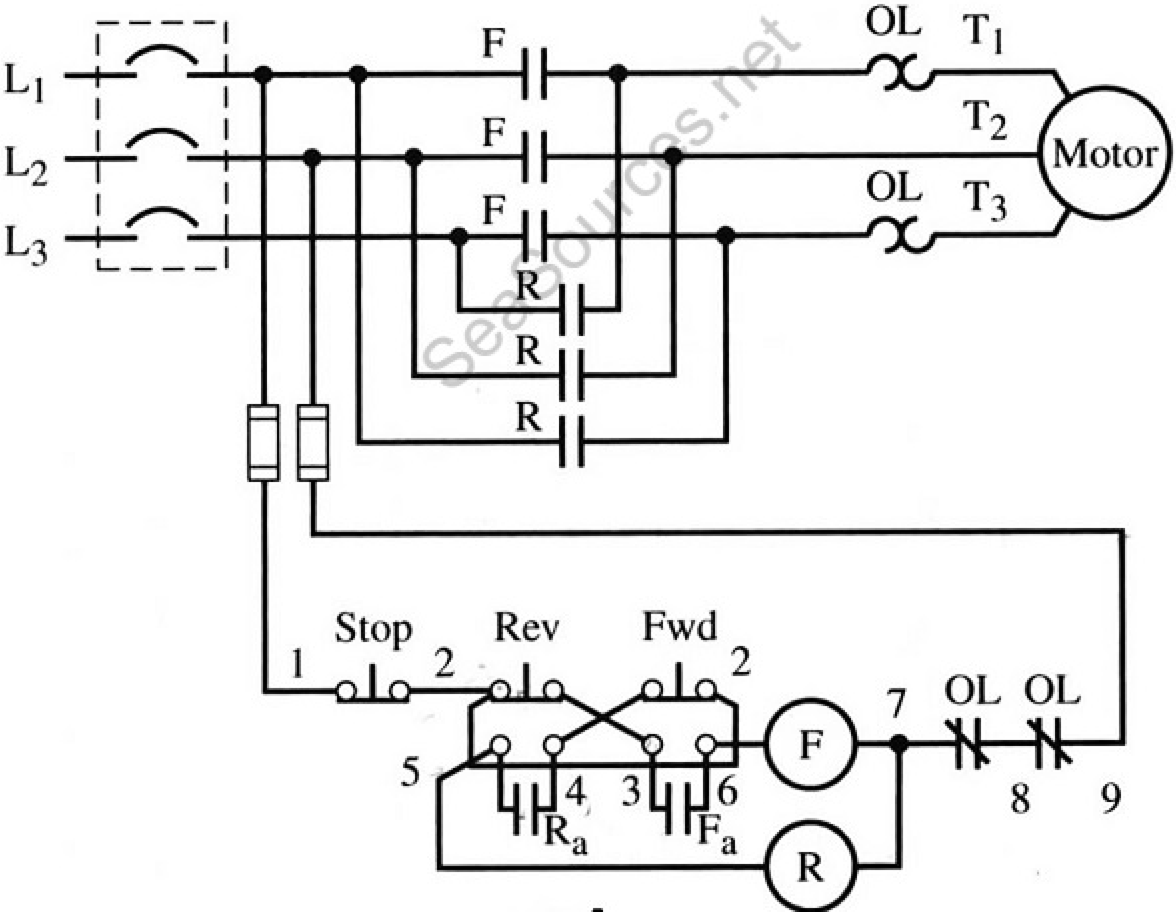
B


L1
L2
Stop
Jog push
button
1
2
4
M
All
OL's
CR
Start
3
CR
CR
M

C

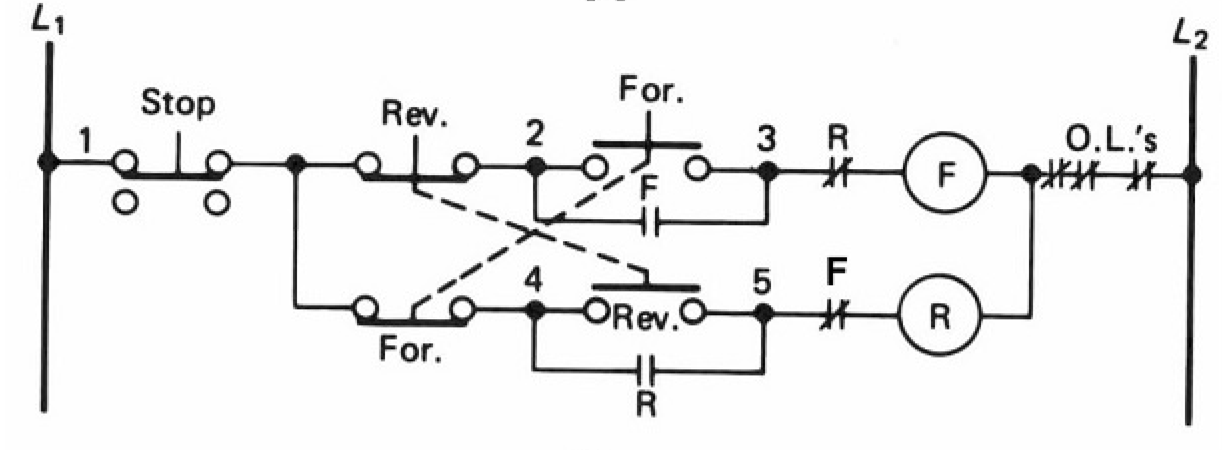

L1
L2
Stop
Jog-run
push button
selector
Start
1
M
All
OL's
M
2
3
Free
Depressed
Run
Jog
Jog-run push button
selector switch operation

EL-0011



L1
L2
L3
F
F
F
R
R
R
OL
OL
T1
T2
T3
Motor
Stop
Rev
Fwd
1
2
2
5
4
3
6
Ra
Fa
F
R
7
OL
OL
8
9

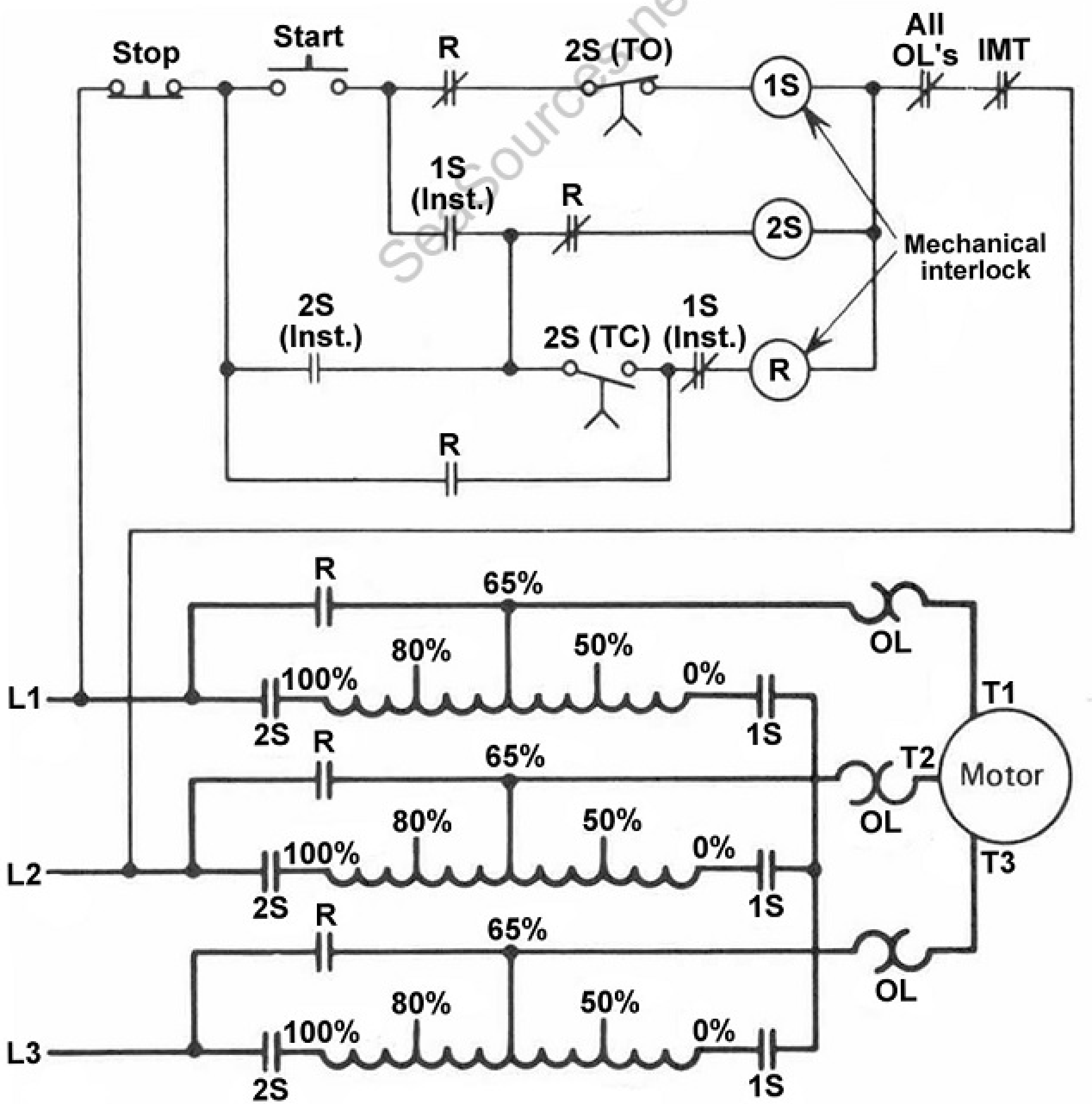
A



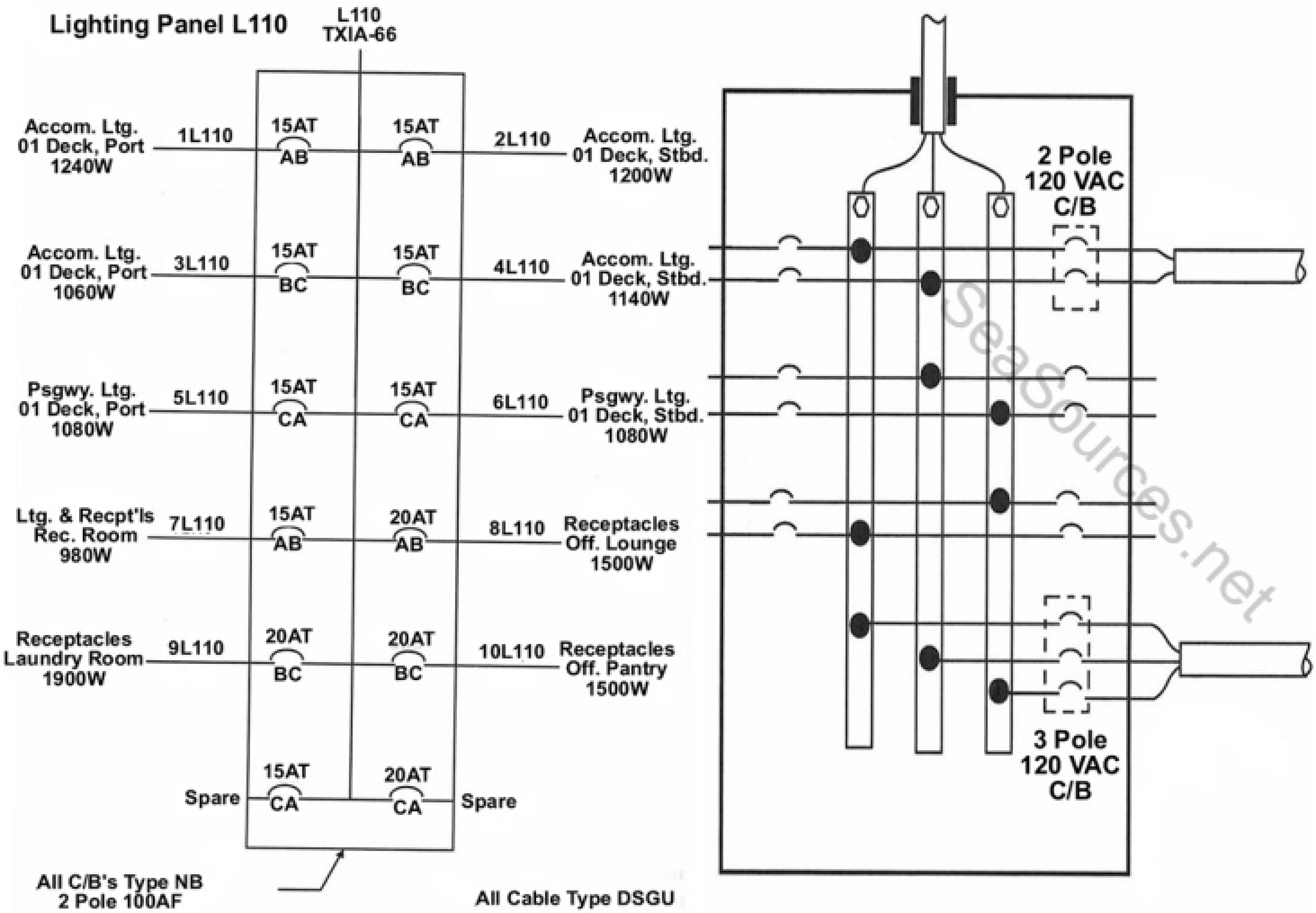
L1
L2
Stop
1
Rev.
2
For.
3
R
F
F
O.L.'s
4
5
F
Rev.
For.
R
R

B

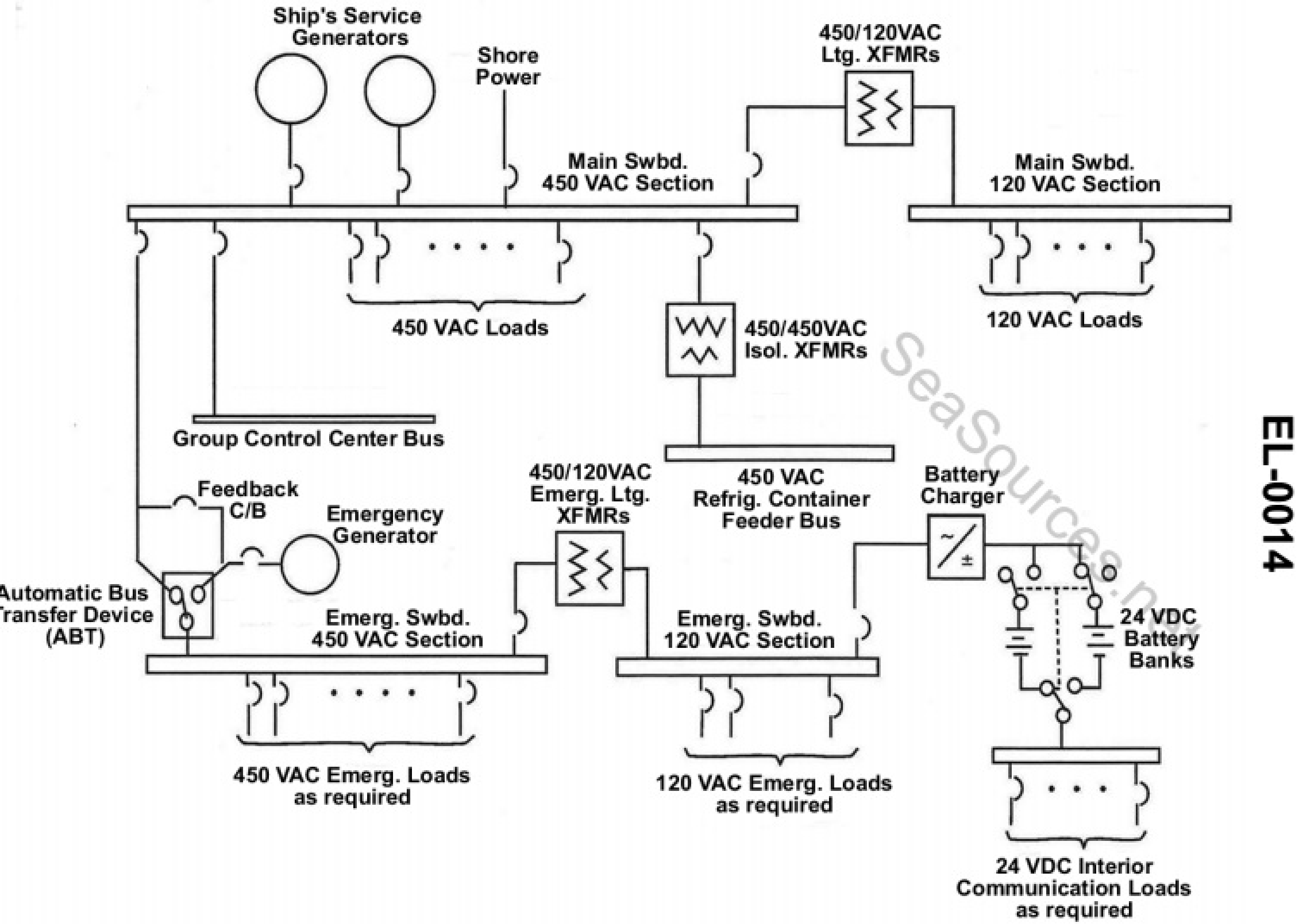
EL-0012



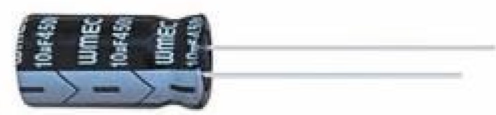
Stop
Start
R
2S (TO)
1S
All
OL's
IMT
1S
(Inst.)
R
2S
Mechanical
interlock
2S
(Inst.)
2S (TC)
1S
(Inst.)
R
R
R
65%
OL
80%
50%
100%
0%
L1
2S
1S
T1
R
65%
T2
Motor
80%
OL
50%
100%
0%
L2
2S
1S
T3
R
65%
OL
80%
50%
100%
0%
L3
2S
1S


Lighting Panel L110
L110
TXIA-66
Accom. Ltg.
01 Deck, Port
1240W
1L110
15AT
AB
15AT
AB
2L110
Accom. Ltg.
01 Deck, Stbd.
1200W
Accom. Ltg.
01 Deck, Port
1060W
3L110
15AT
BC
15AT
BC
4L110
Accom. Ltg.
01 Deck, Stbd.
1140W
Psgwy. Ltg.
01 Deck, Port
1080W
5L110
15AT
CA
15AT
CA
6L110
Psgwy. Ltg.
01 Deck, Stbd.
1080W
Ltg. & Recpt'ls
Rec. Room
980W
7L110
15AT
AB
20AT
AB
8L110
Receptacles
Off. Lounge
1500W
Receptacles
Laundry Room
1900W
9L110
20AT
BC
20AT
BC
10L110
Receptacles
Off. Pantry
1500W
Spare
15AT
CA
20AT
CA
Spare
All C/B's Type NB
2 Pole 100AF
All Cable Type DSGU
2 Pole
120 VAC
C/B
3 Pole
120 VAC
C/B

EL-0013

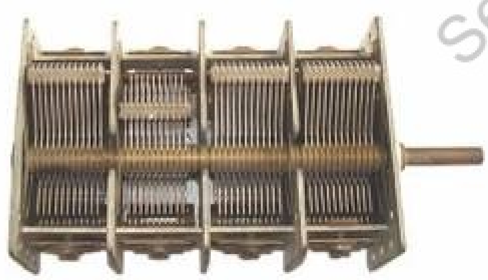

Ship's Service Generators
Shore Power
450/120VAC Ltg. XFMRs
Main Swbd. 450 VAC Section
Main Swbd. 120 VAC Section
450 VAC Loads
450/450VAC Isol. XFMRs
120 VAC Loads
Group Control Center Bus
450 VAC Refrig. Container Feeder Bus
Feedback C/B
Emergency Generator
450/120VAC Emerg. Ltg. XFMRs
Battery Charger
Automatic Bus Transfer Device (ABT)
Emerg. Swbd. 450 VAC Section
Emerg. Swbd. 120 VAC Section
24 VDC Battery Banks
450 VAC Emerg. Loads as required
120 VAC Emerg. Loads as required
24 VDC Interior Communication Loads as required
SeaSources.net
EL-0014

EL-0015

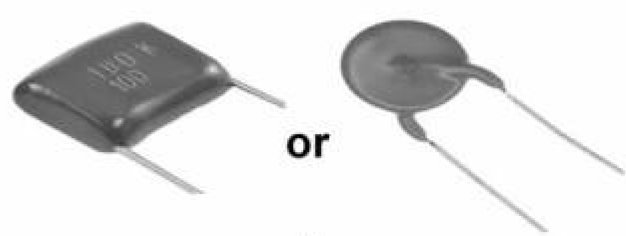


1

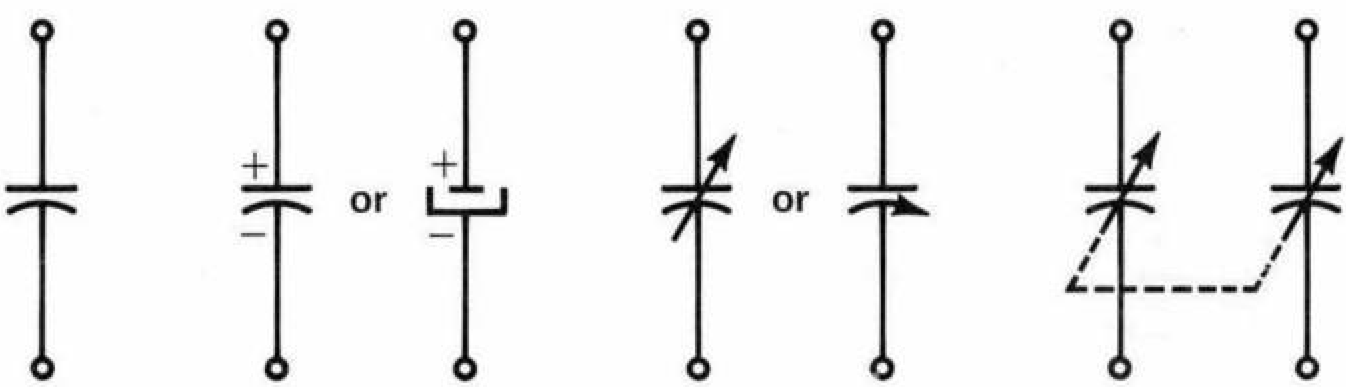
2



3

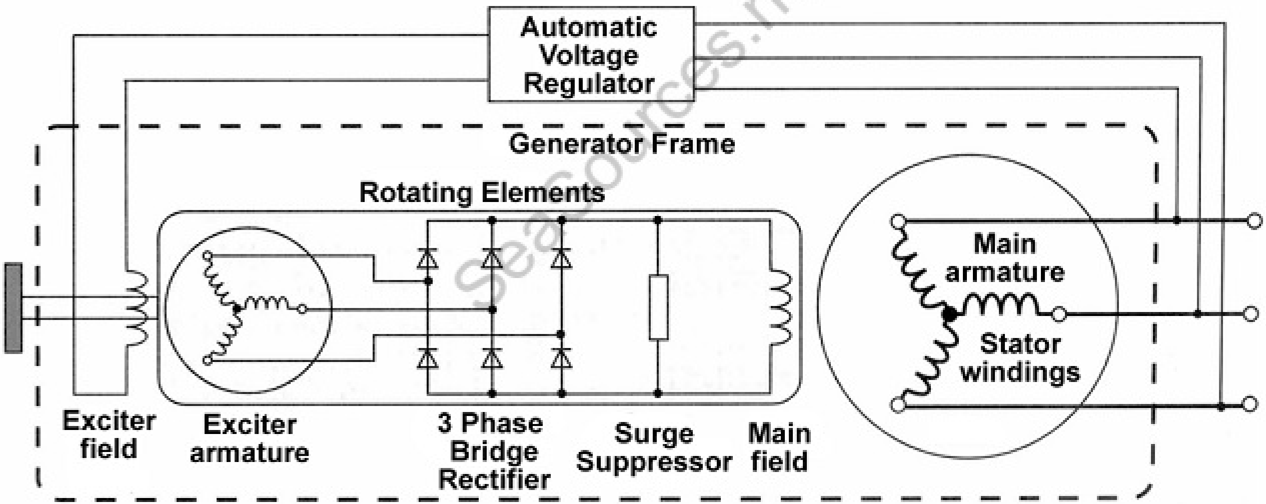


4



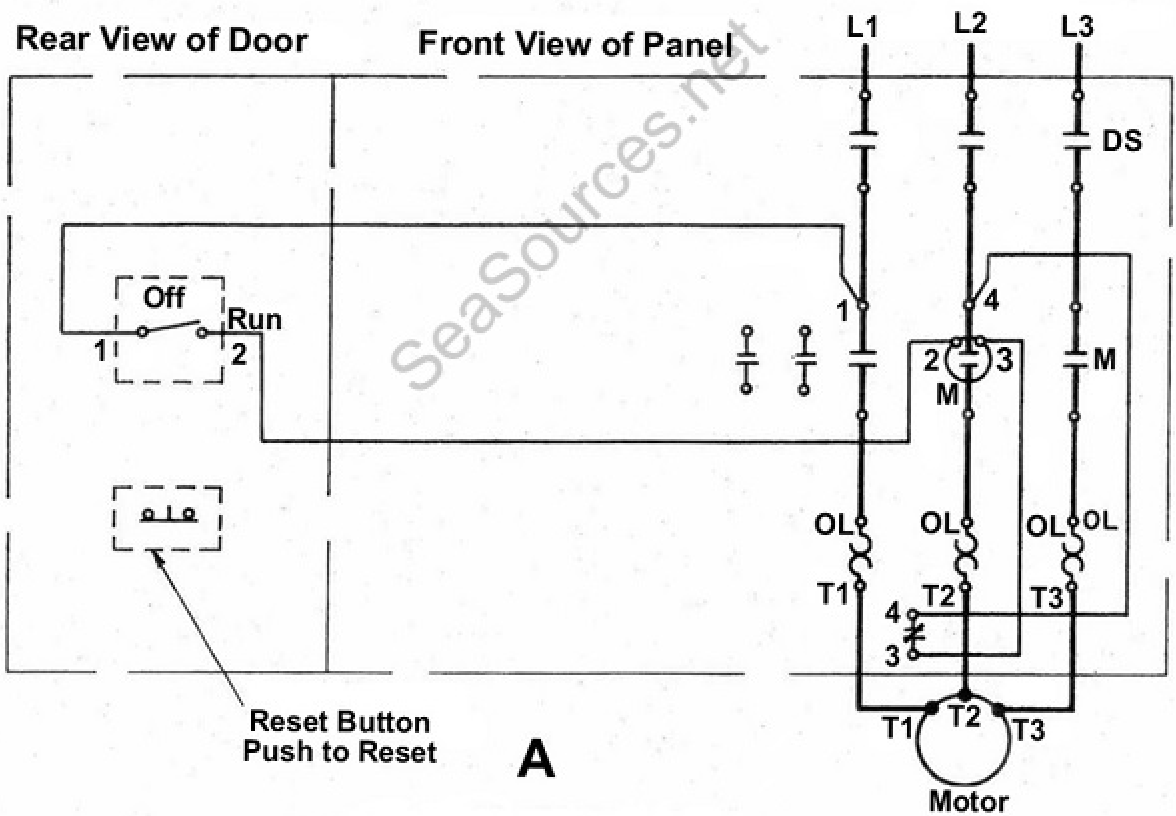
A B C D

EL-0016



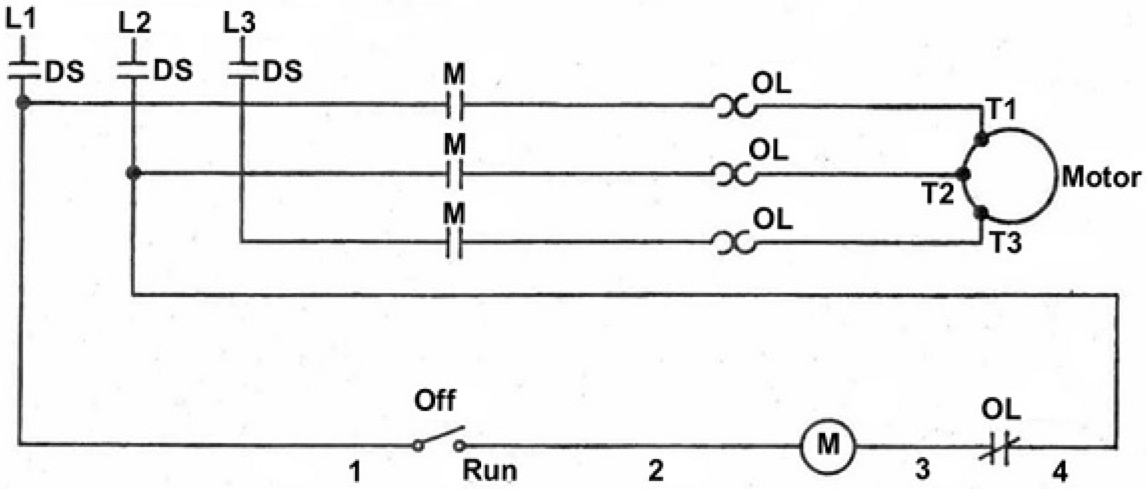
Automatic Voltage Regulator
Generator Frame
Rotating Elements
Main armature
Stator windings
Exciter field
Exciter armature
3 Phase Bridge Rectifier
Surge Suppressor
Main field

EL-0017



Rear View of Door
Front View of Panel
L1
L2
L3
DS
Off
Run
1
2
4
3
M
OL
T1
T2
T3
Reset Button
Push to Reset
Motor

A

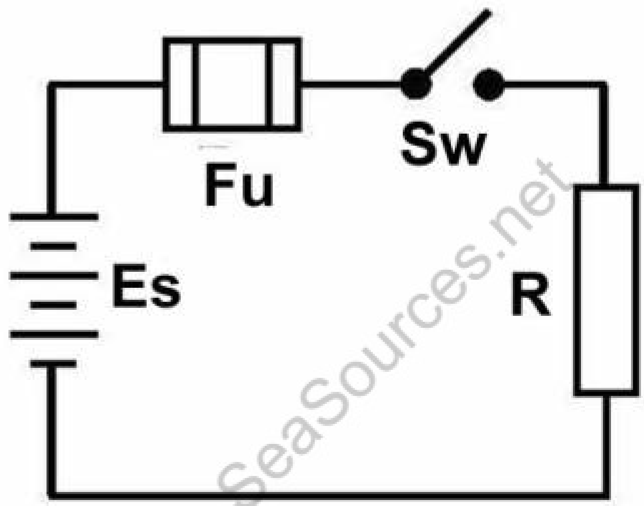


L1
L2
L3
DS
M
OL
T1
T2
T3
Motor
Off
Run
1
2
M
3
4

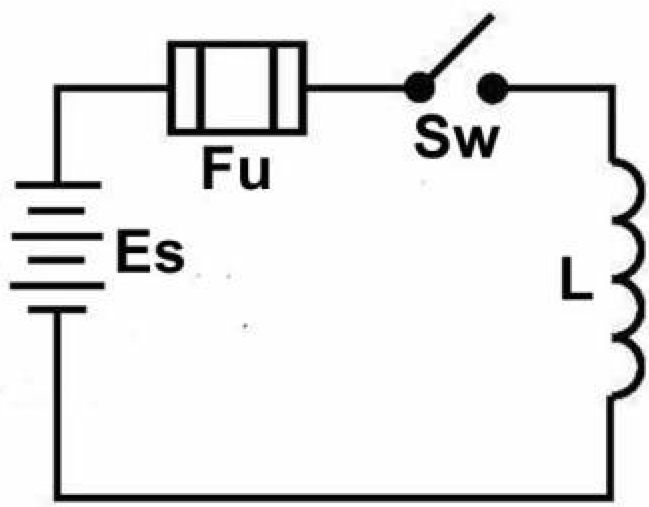
B

EL-0018

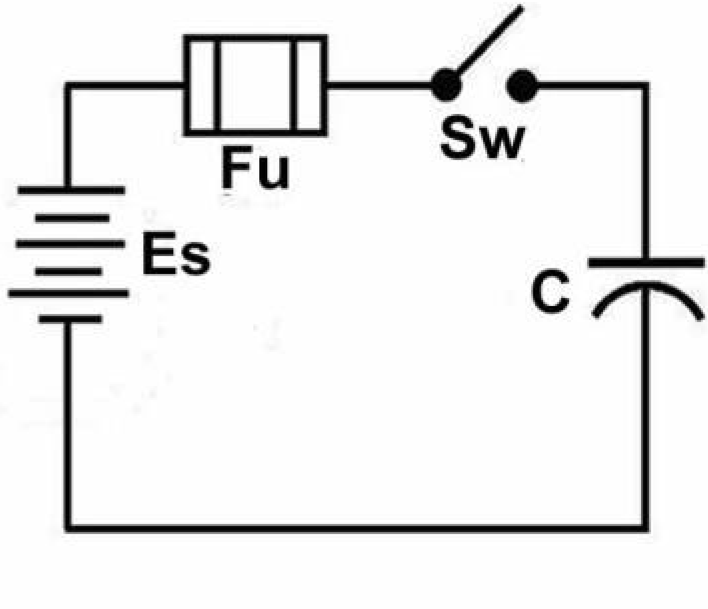
A



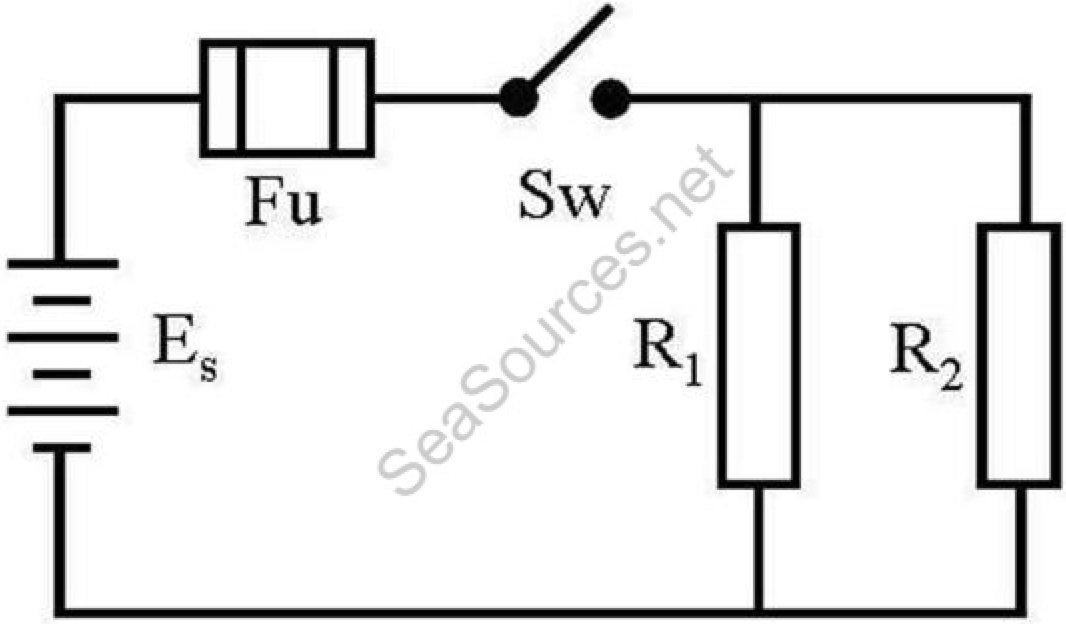
B



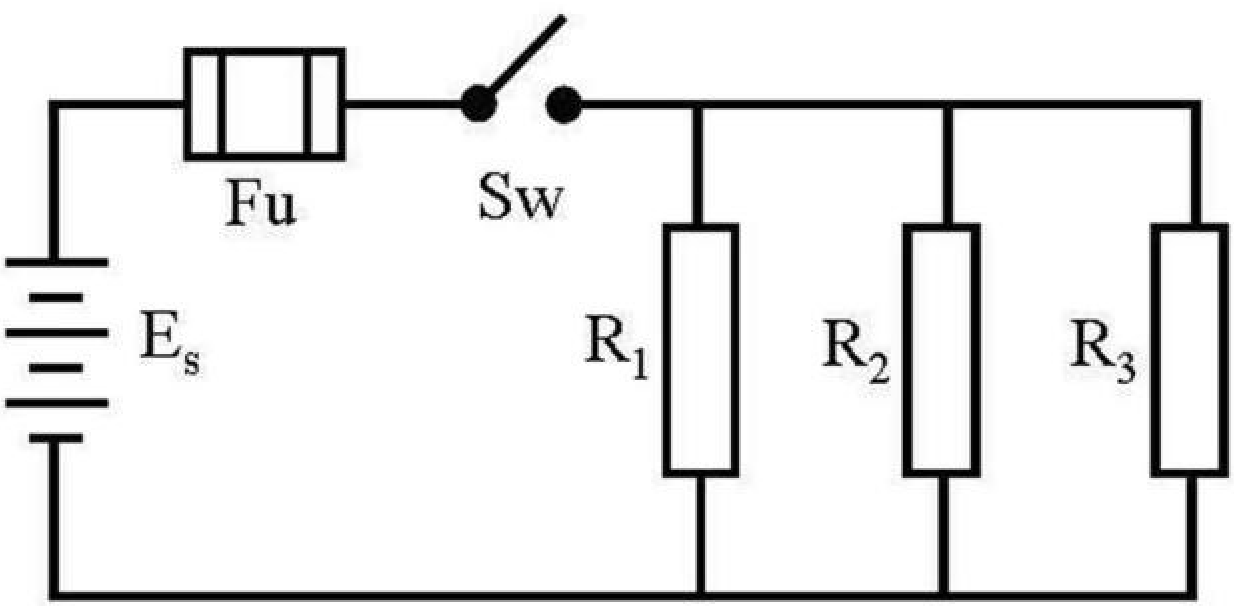
C



EL-0019

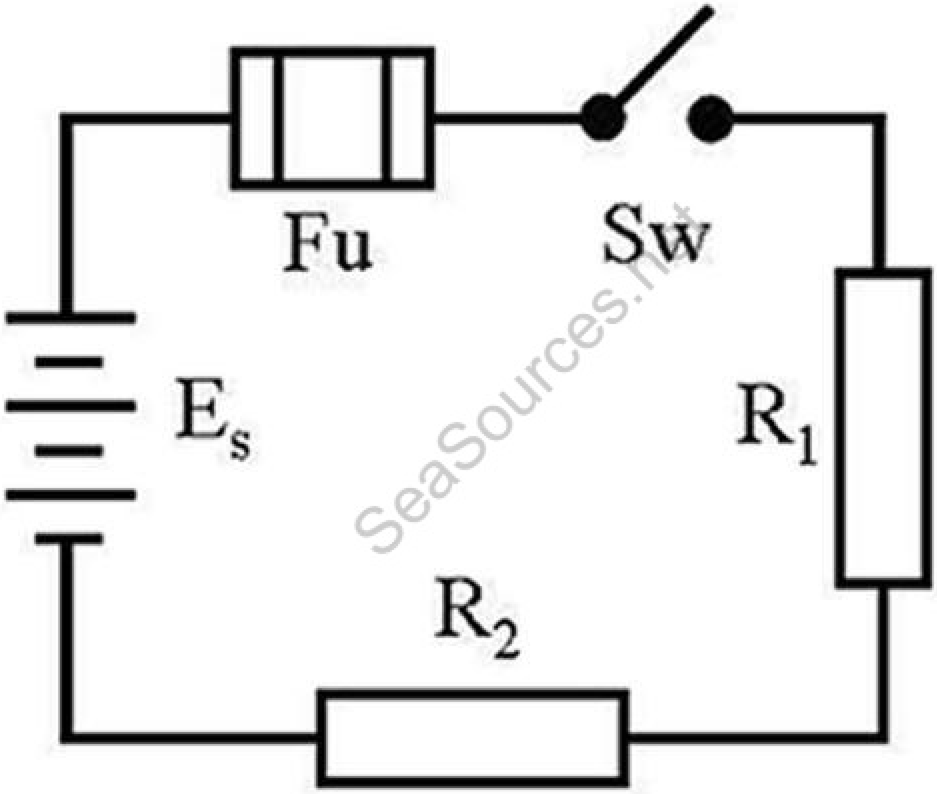


A

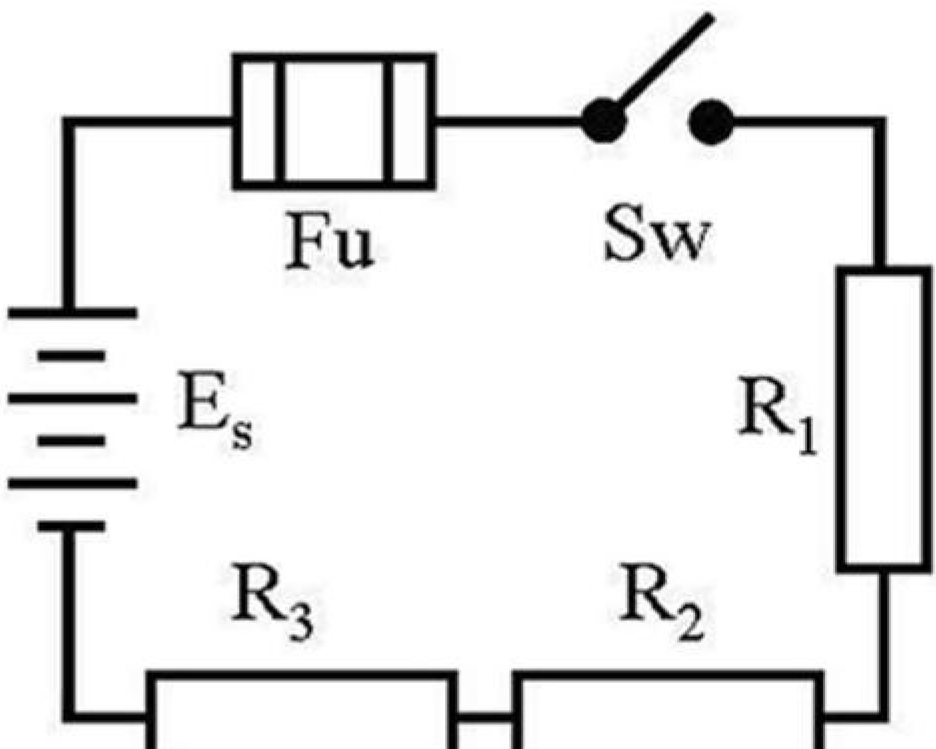


B

EL-0020

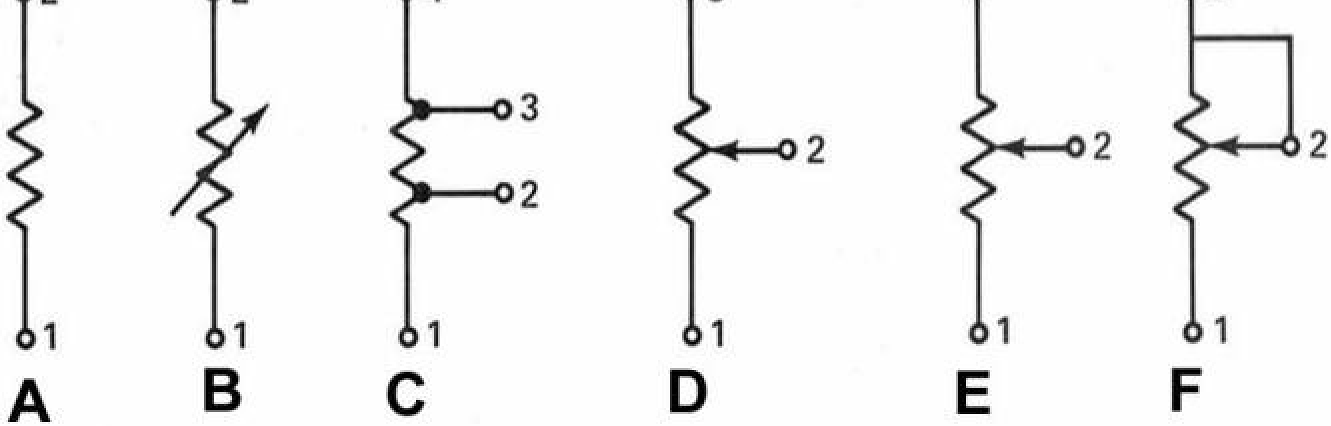


A

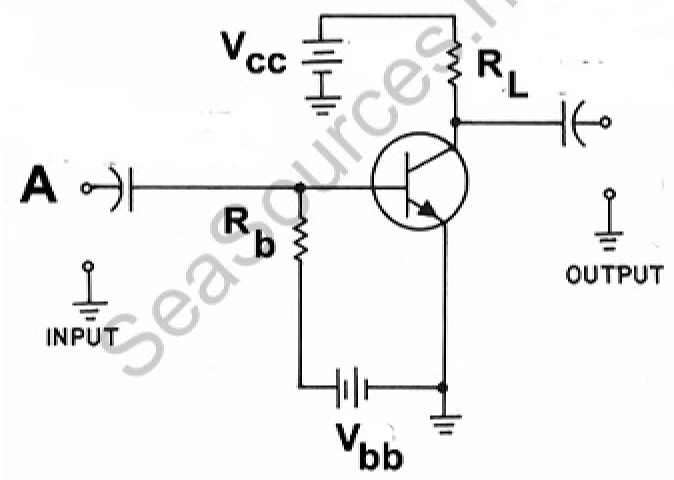


B

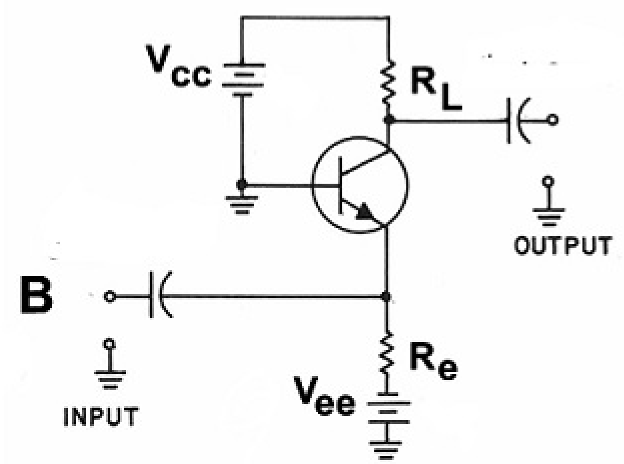
EL-0021



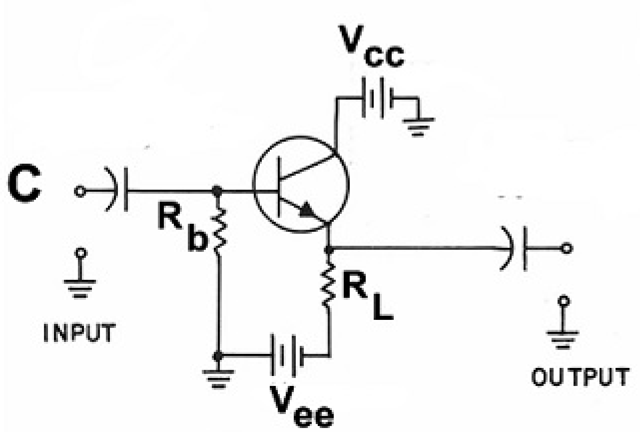
EL-0022



Vcc
RL
A
Rb
OUTPUT
INPUT
Vbb

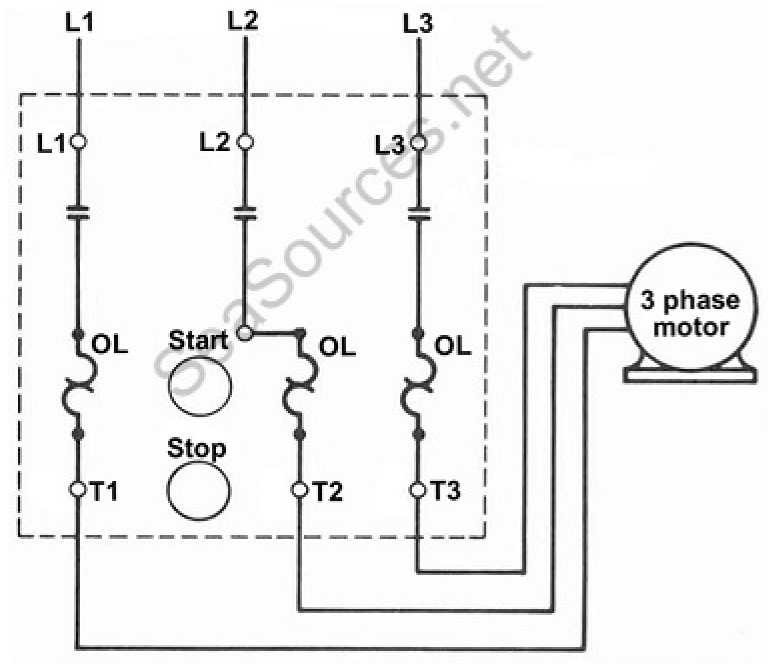


Vcc
RL
OUTPUT
B
Re
Vee
INPUT



Vcc
C
Rb
RL
INPUT
OUTPUT
Vee

EL-0023



A

1

2

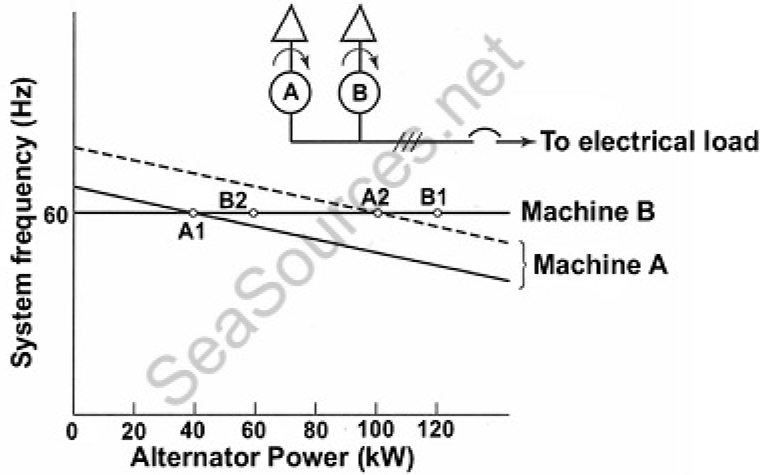
3

4

El-0024: The new Illustration associated with this question has not yet been made available to the public from the National Maritime Center even though they are already using them in the exam room. We hope to have them posted soon.

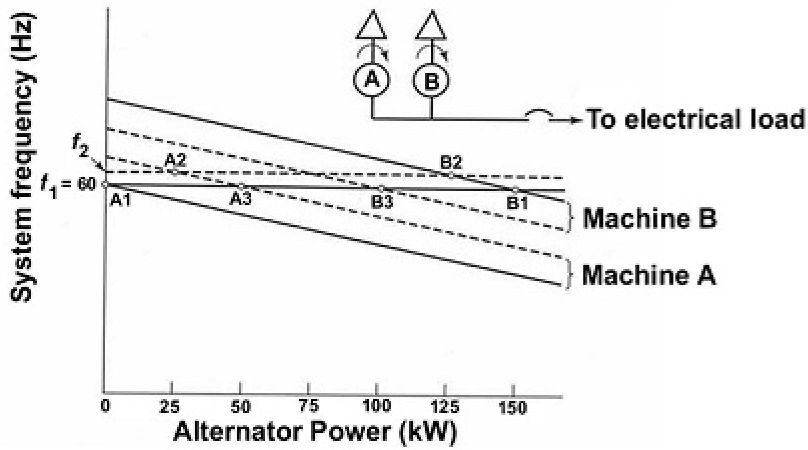
EL-0025

A



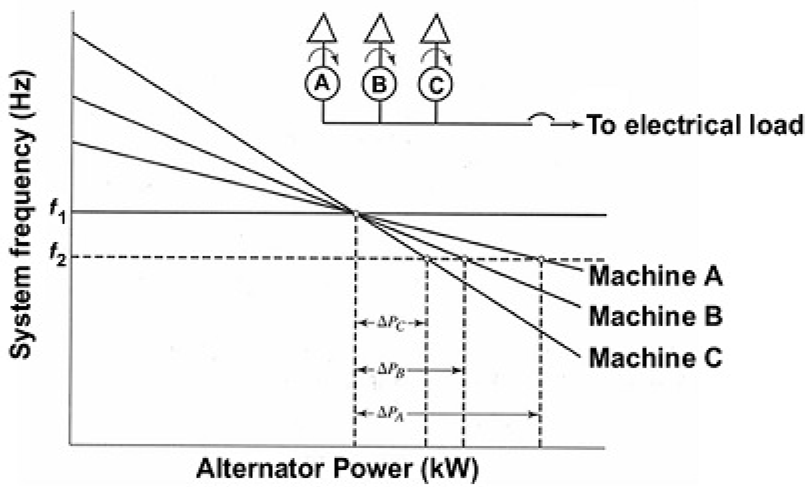
A
B
To electrical load
System frequency (Hz)
60
B2
A2
B1
A1
Machine B
Machine A
0
20
40
60
80
100
120
Alternator Power (kW)

B



A
B
To electrical load
System frequency (Hz)
f_2
f_1 = 60
A2
B2
A1
A3
B3
B1
Machine B
Machine A
0
25
50
75
100
125
150
Alternator Power (kW)

C



A
B
C
To electrical load
System frequency (Hz)
f_1
f_2
Machine A
Machine B
Machine C
ΔP_C
ΔP_B
ΔP_A
Alternator Power (kW)

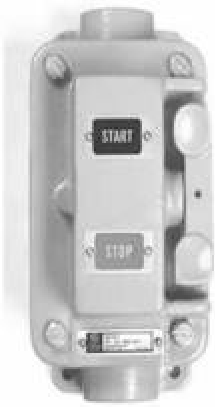
EL-0026

A

B

C

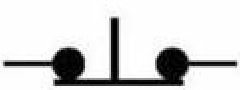
D



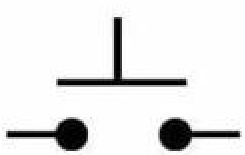
E

F

G

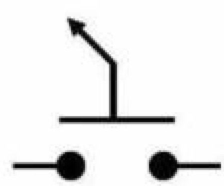


1

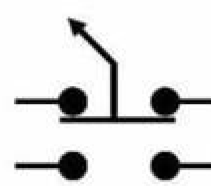


2

3

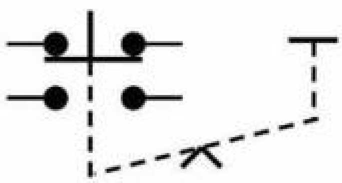


4

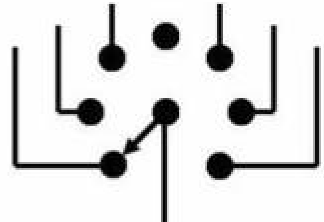


5

6

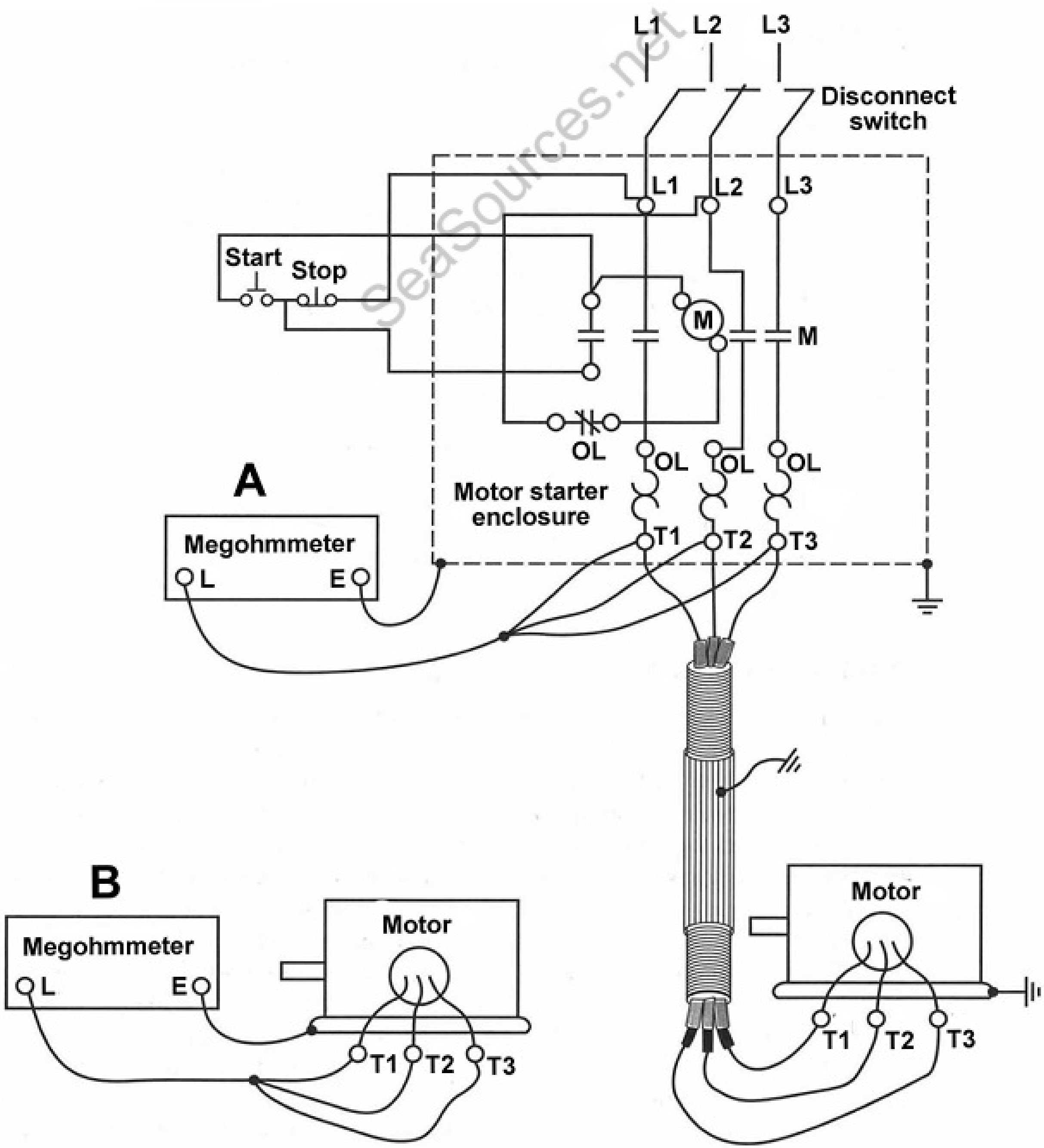


7

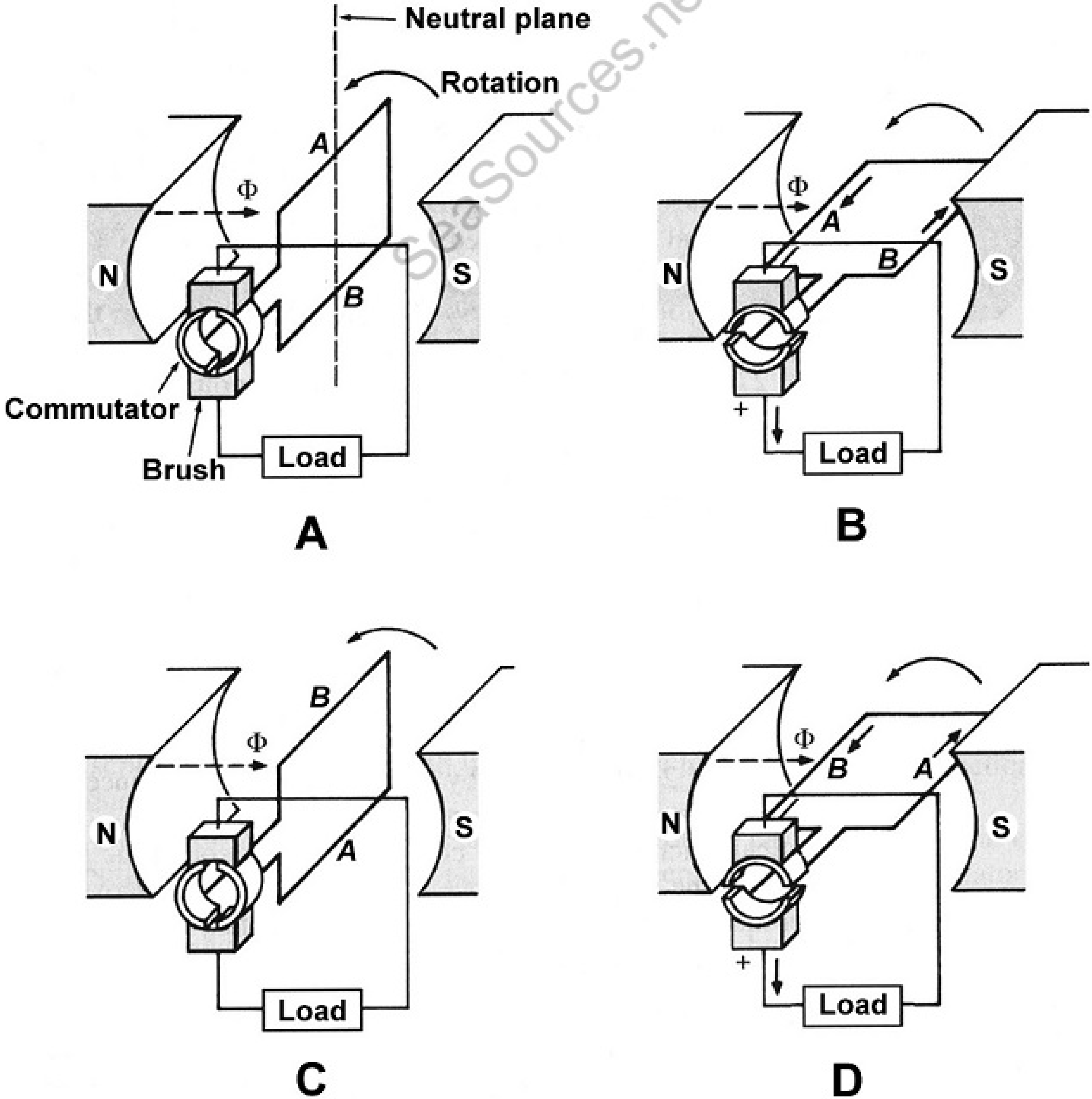


8

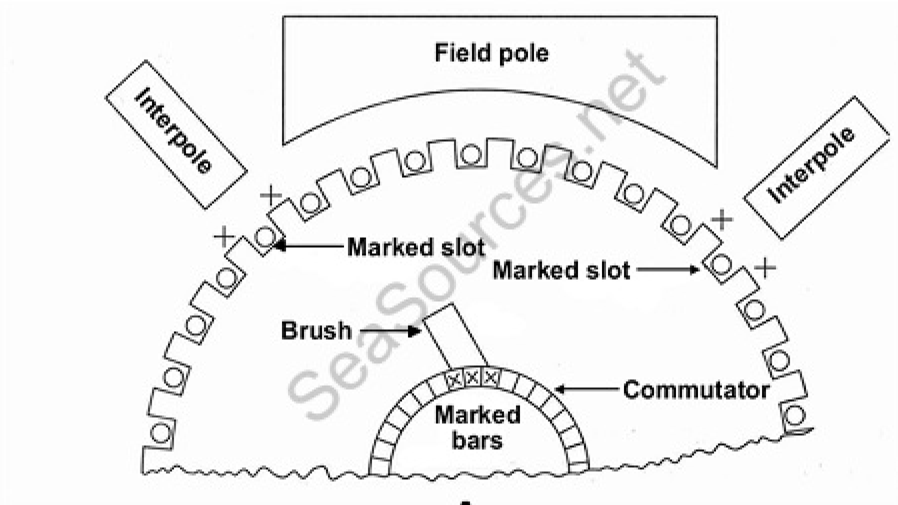
EL-0027


L1
L2
L3
Disconnect switch
L1
L2
L3
Start
Stop
M
M
OL
OL
OL
OL
Motor starter enclosure
T1
T2
T3
A
Megohmmeter
L
E
SeaSources.net
B
Megohmmeter
L
E
Motor
T1
T2
T3
Motor
T1
T2
T3

EL-0028

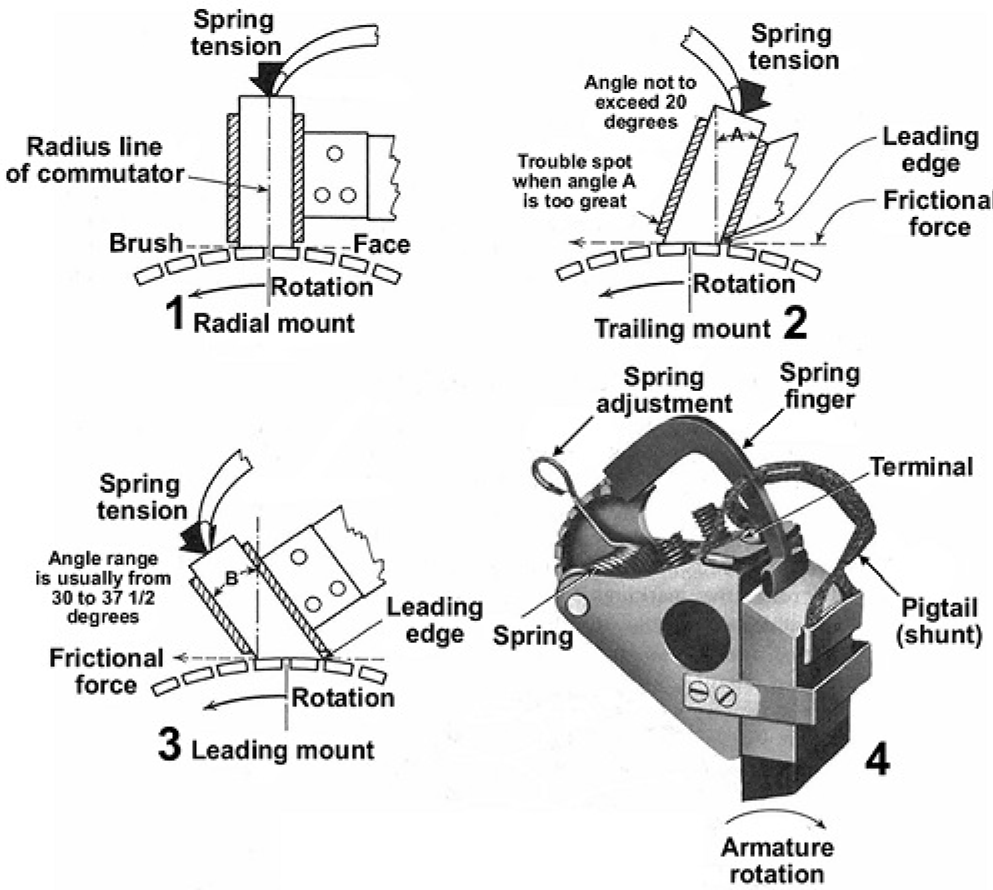

Neutral plane
Rotation
A
Φ
N
S
B
Commutator
Brush
Load
A
Φ
A
B
N
S
+
Load
B
B
Φ
N
S
A
Load
C
Φ
B
A
N
S
+
Load
D

EL-0029



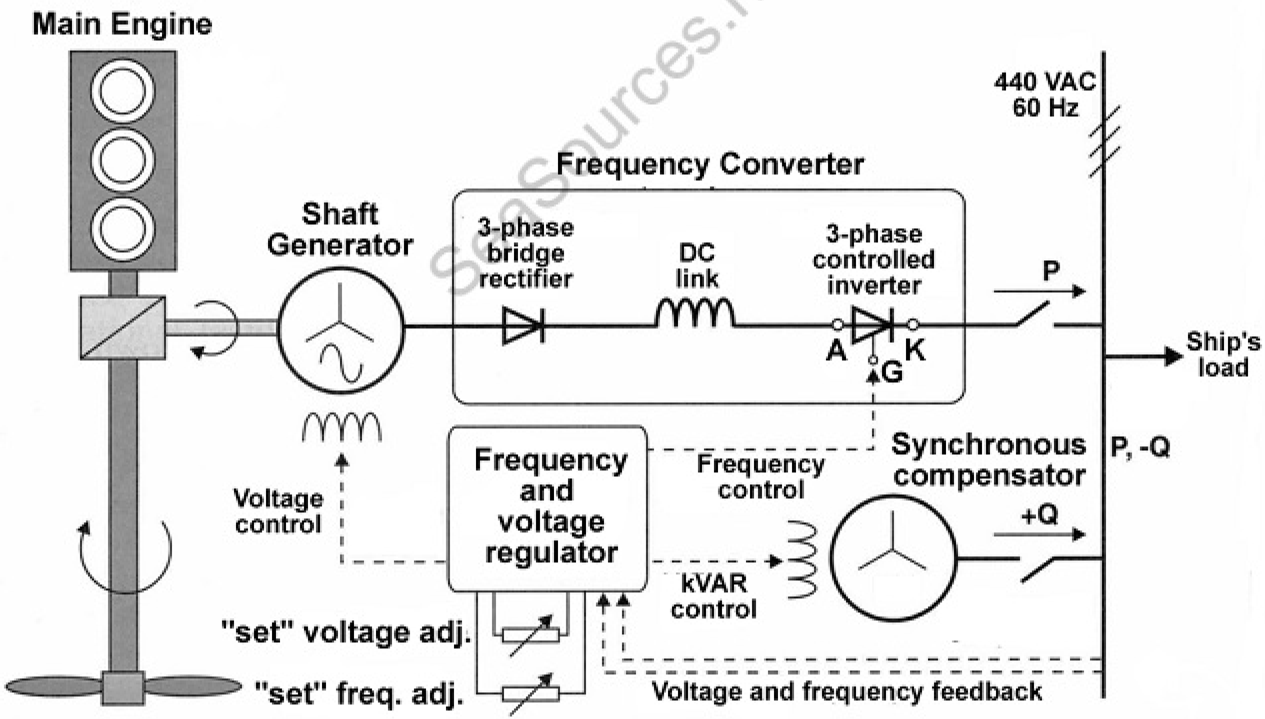
Field pole
Interpole
Interpole
Marked slot
Marked slot
Brush
Commutator
Marked bars

A



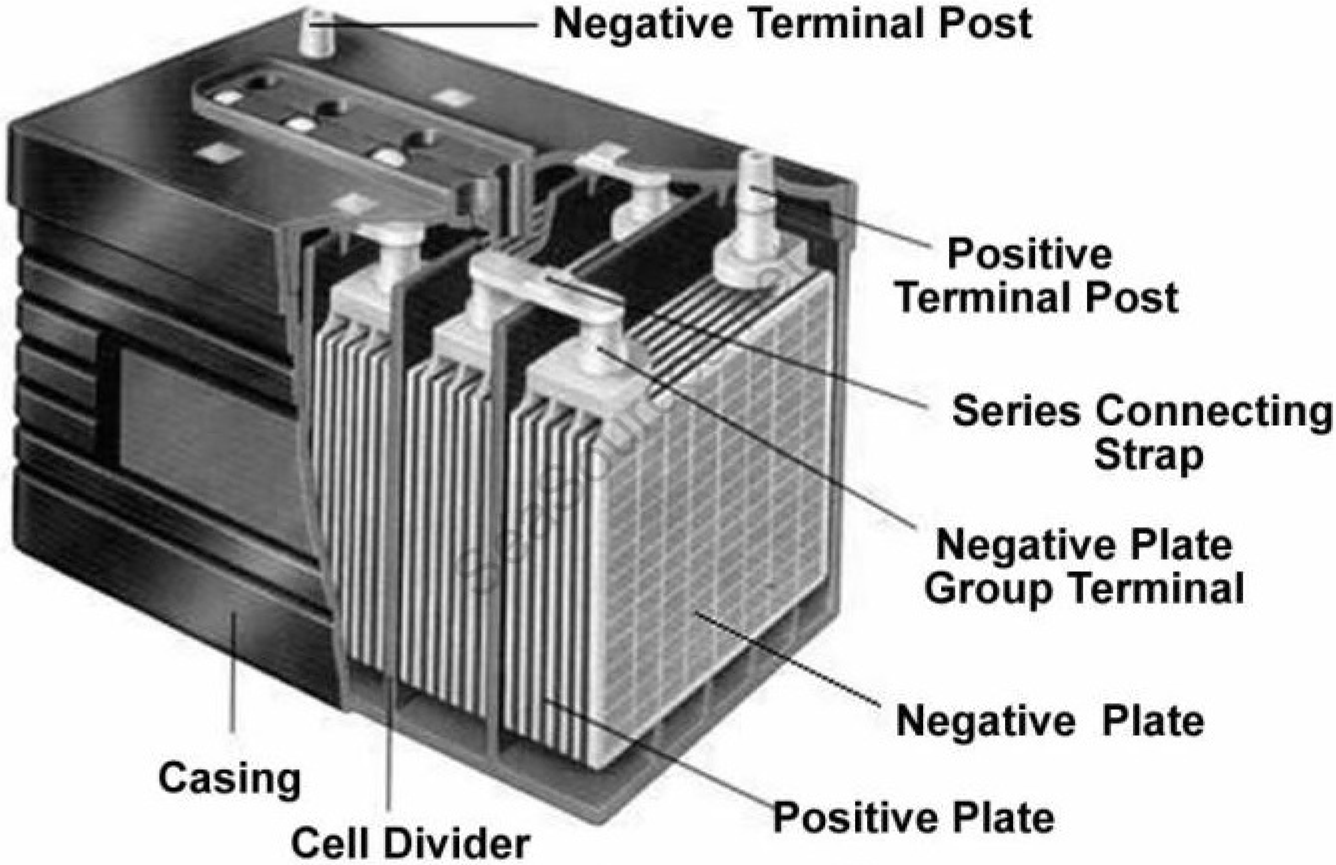
Spring tension
Radius line of commutator
Brush
Face
Rotation
1 Radial mount
Spring tension
Angle not to exceed 20 degrees
A
Trouble spot when angle A is too great
Leading edge
Frictional force
Rotation
Trailing mount 2
Spring tension
Angle range is usually from 30 to 37 1/2 degrees
B
Leading edge
Frictional force
Rotation
3 Leading mount
Spring adjustment
Spring finger
Terminal
Spring
Pigtail (shunt)
4
Armature rotation

EL-0030

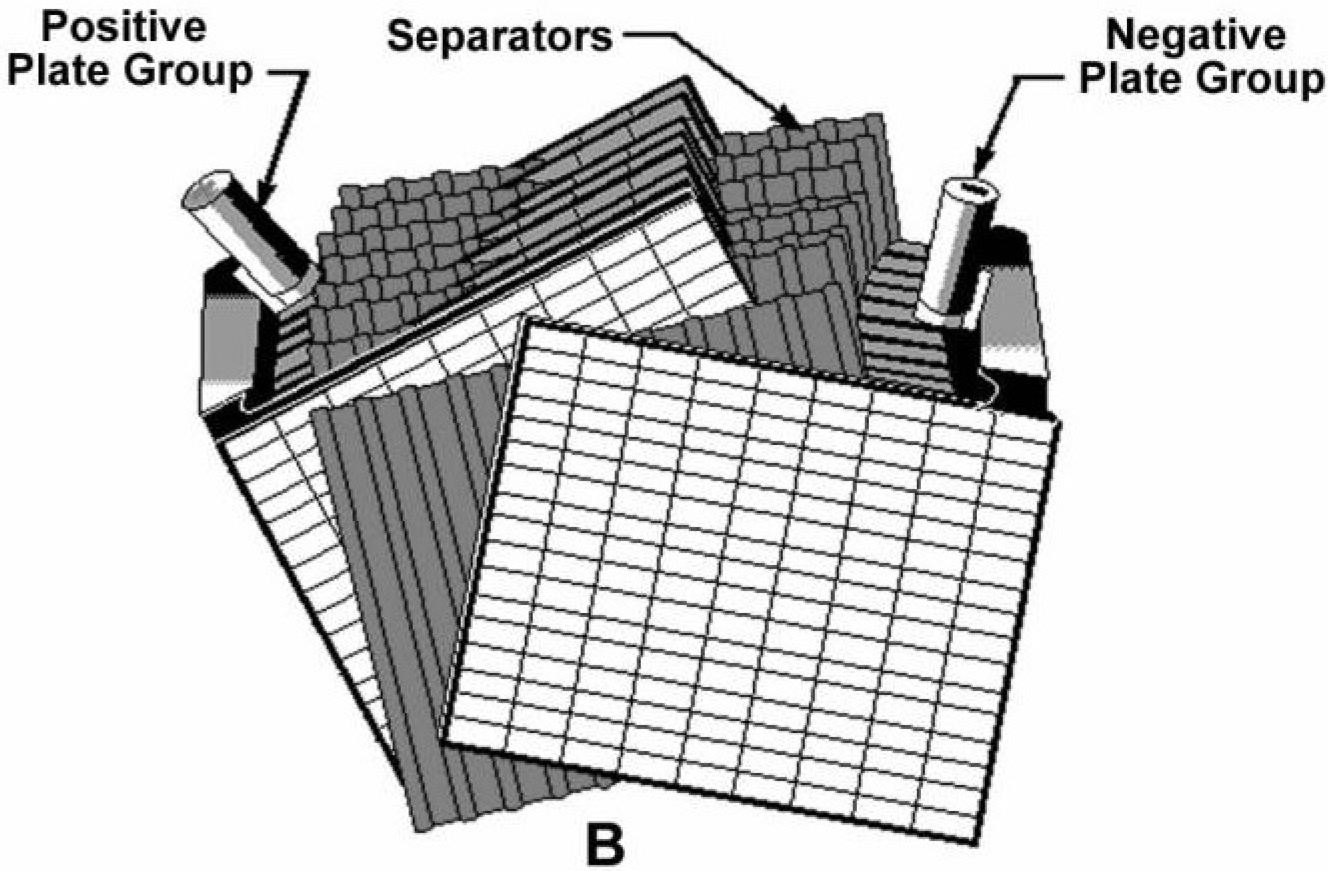


Main Engine
Shaft Generator
Frequency Converter
3-phase bridge rectifier
DC link
3-phase controlled inverter
A
K
G
440 VAC
60 Hz
P
Ship's load
P, -Q
Synchronous compensator
+Q
Frequency and voltage regulator
Frequency control
Voltage control
kVAR control
"set" voltage adj.
"set" freq. adj.
Voltage and frequency feedback

EL-0031

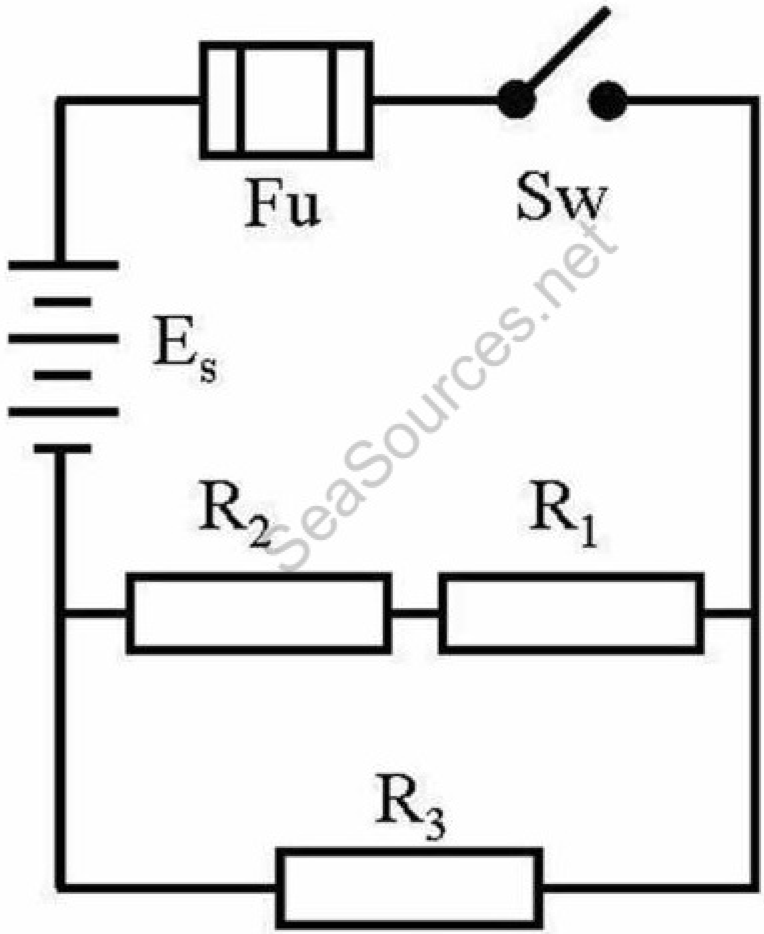

Negative Terminal Post
Positive
Terminal Post
Series Connecting
Strap
Negative Plate
Group Terminal
Negative Plate
Positive Plate
Casing
Cell Divider

A

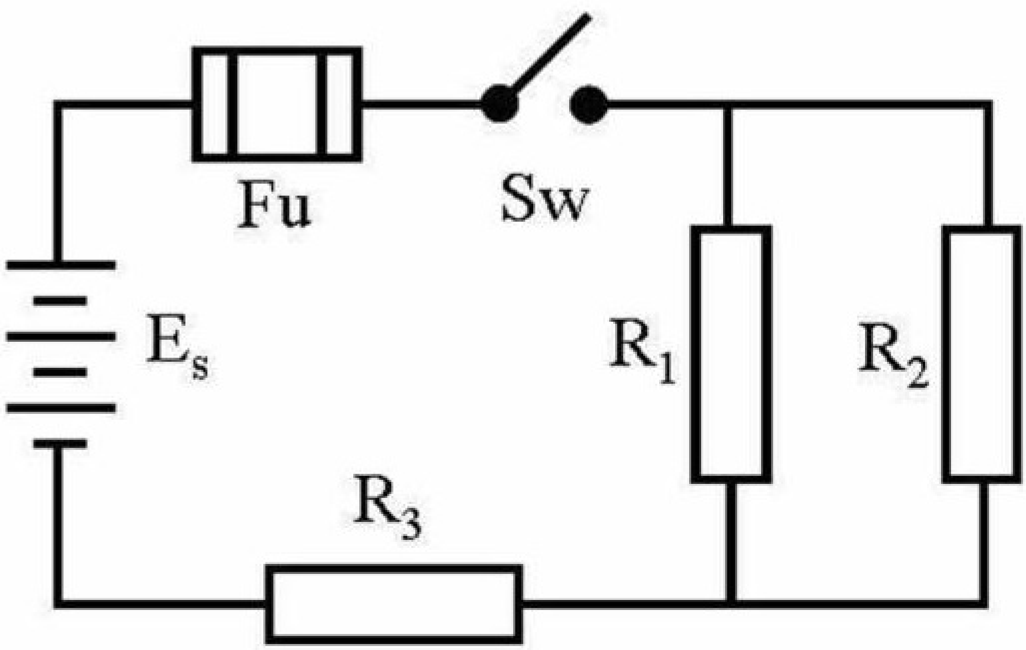

Positive
Plate Group
Separators
Negative
Plate Group

B

EL-0032



A



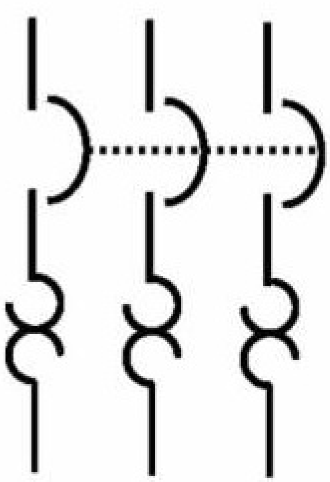
B

EL-0033

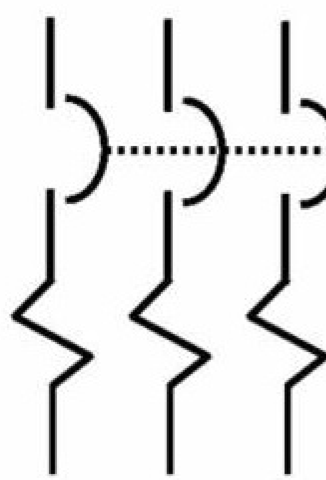
A

B

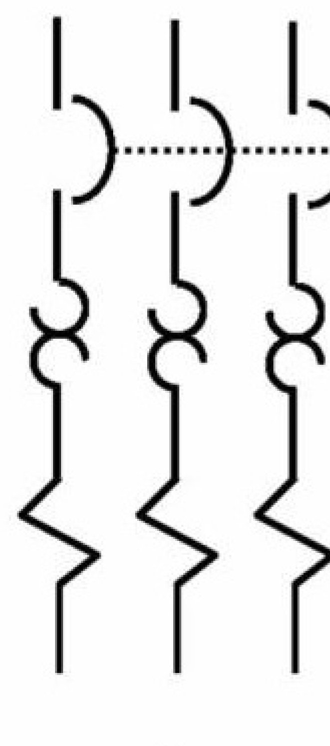
C



1



2



3

EL-0034

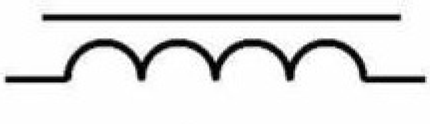
A

B

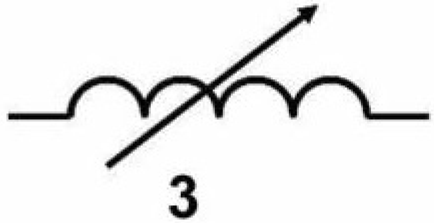
C

D

1

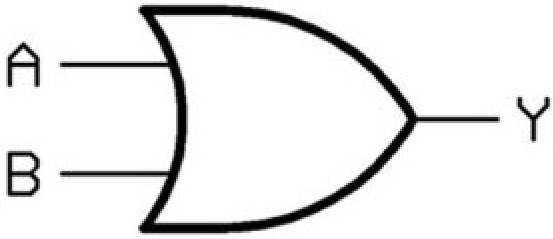


2

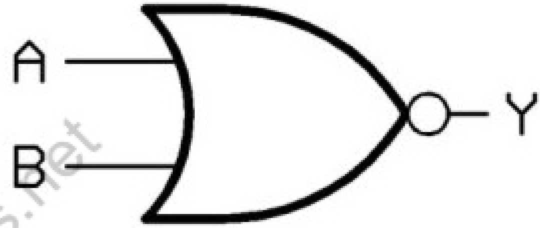


3

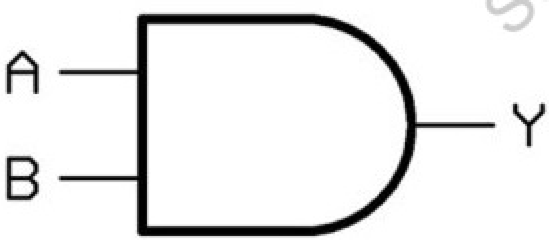
EL-0035



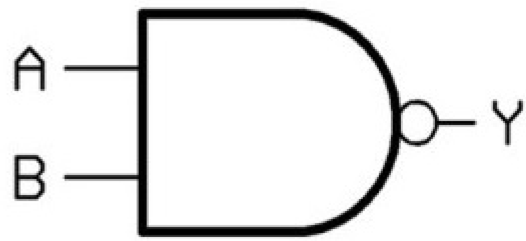
1



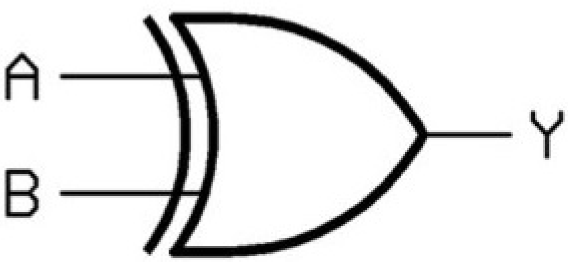
2



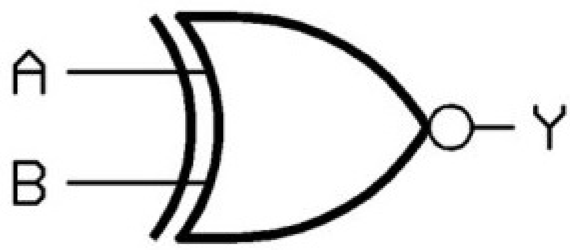
3



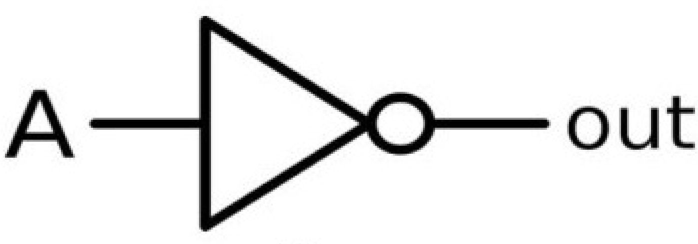
4



5

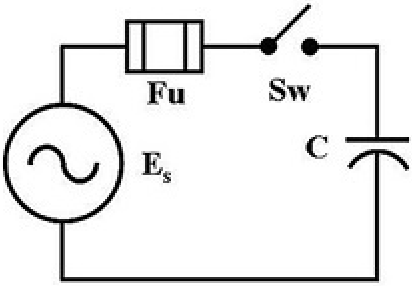


6

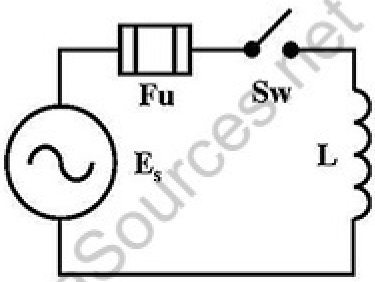


7

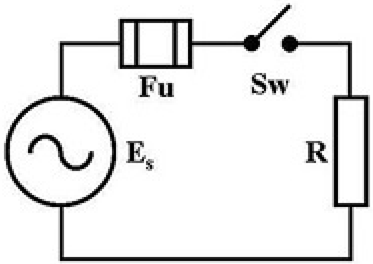
EL-0036


Fu
Sw
C
E_s

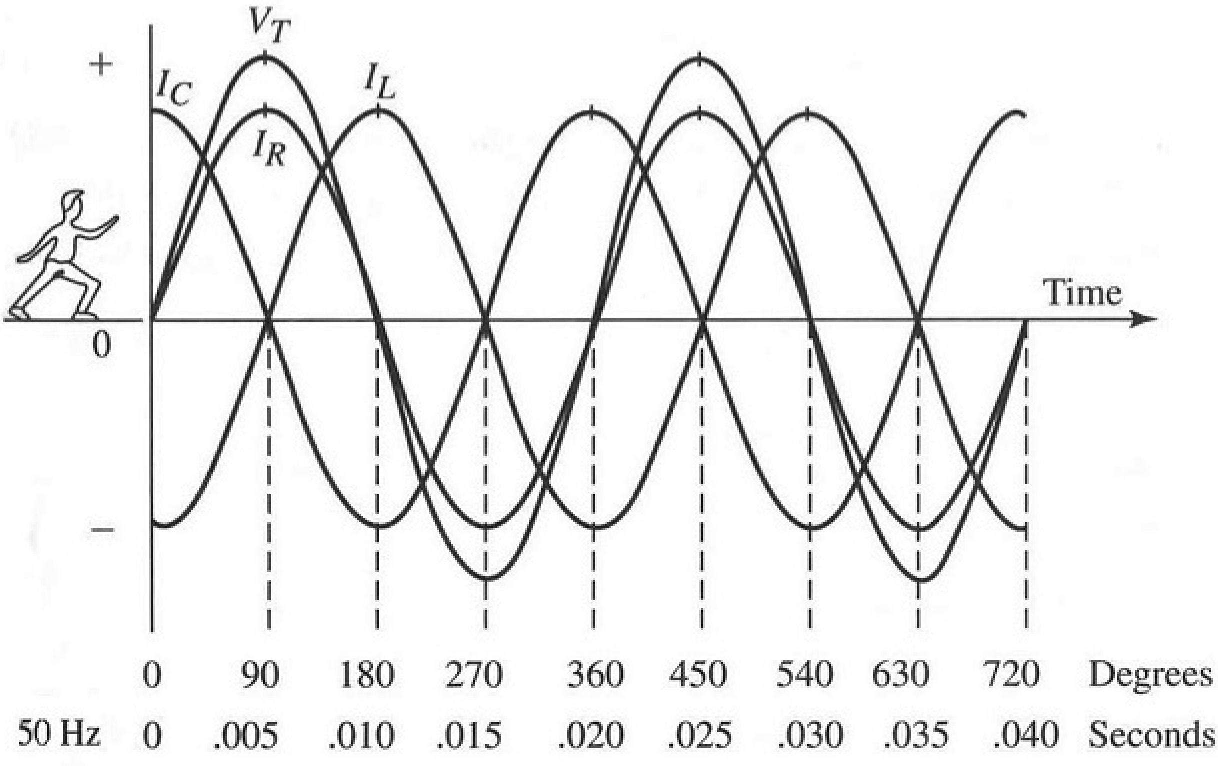
A


Fu
Sw
L
E_s

B

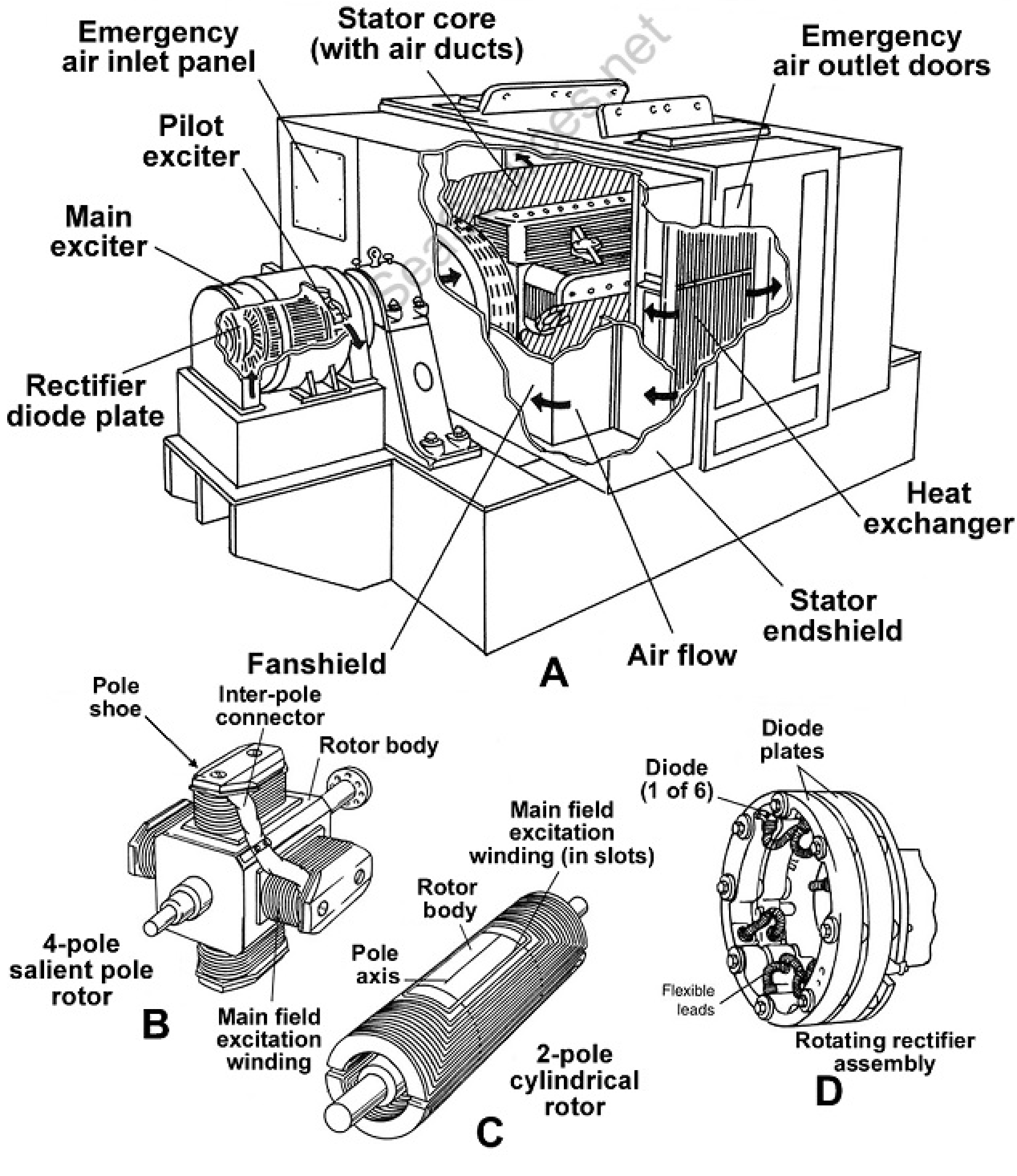

Fu
Sw
R
E_s

C

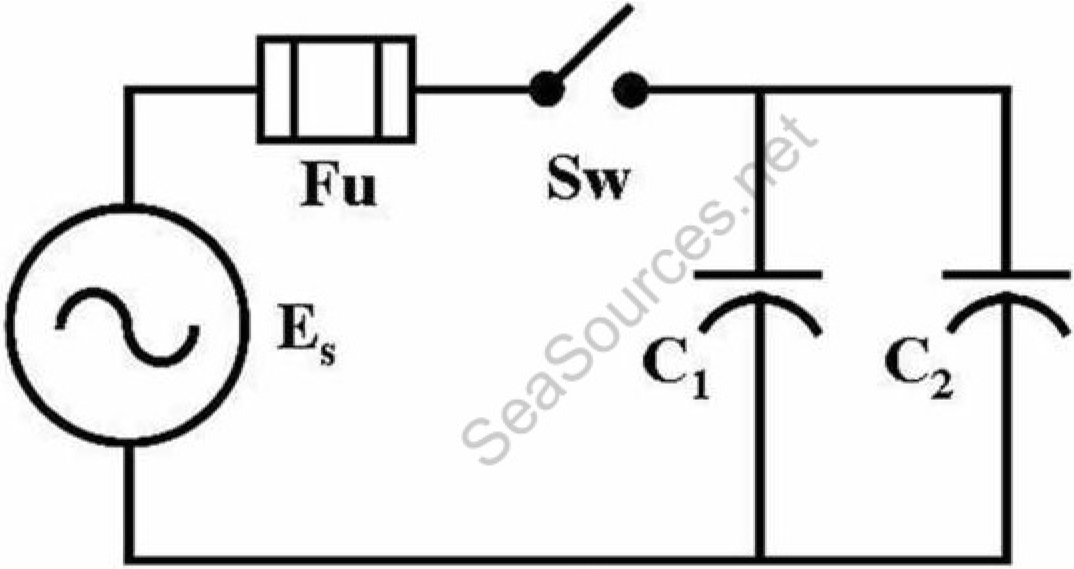

V_T
I_C
I_L
I_R
+
0
–
Time
0 90 180 270 360 450 540 630 720 Degrees
50 Hz 0 .005 .010 .015 .020 .025 .030 .035 .040 Seconds

D

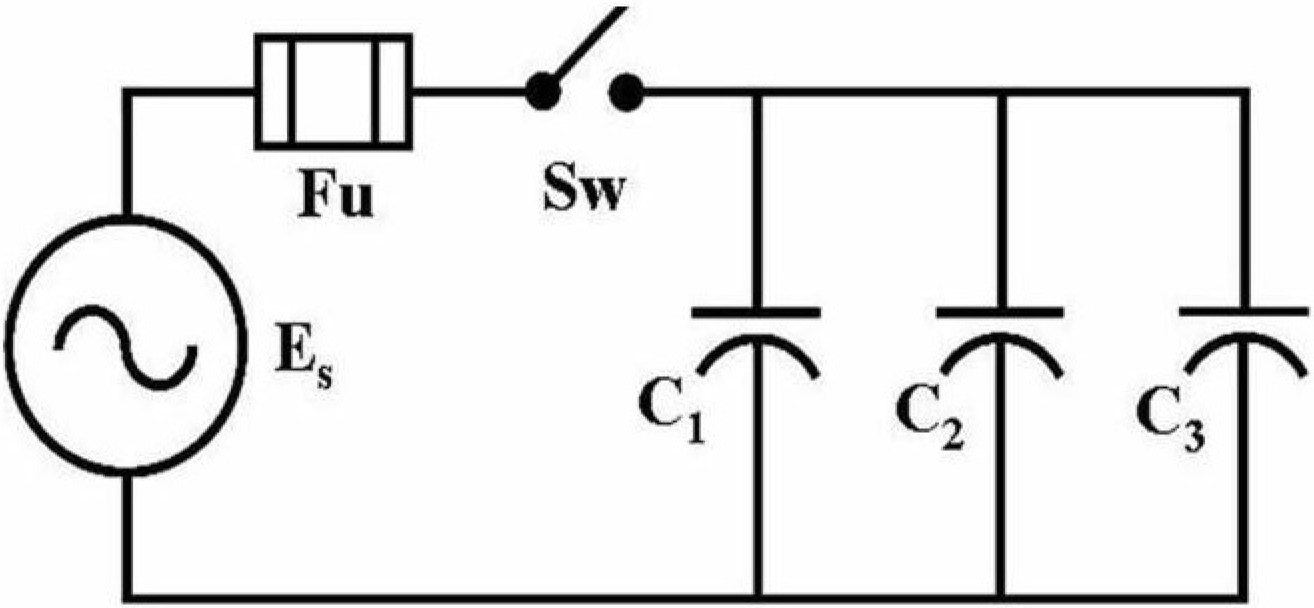
EL-0037


Emergency
air inlet panel
Stator core
(with air ducts)
Emergency
air outlet doors
Pilot
exciter
Main
exciter
Rectifier
diode plate
Heat
exchanger
Stator
endshield
Fanshield
Air flow
A
Pole
shoe
Inter-pole
connector
Rotor body
4-pole
salient pole
rotor
B
Main field
excitation
winding
Main field
excitation
winding (in slots)
Rotor
body
Pole
axis
2-pole
cylindrical
rotor
C
Diode
(1 of 6)
Diode
plates
Flexible
leads
Rotating rectifier
assembly
D

EL-0038

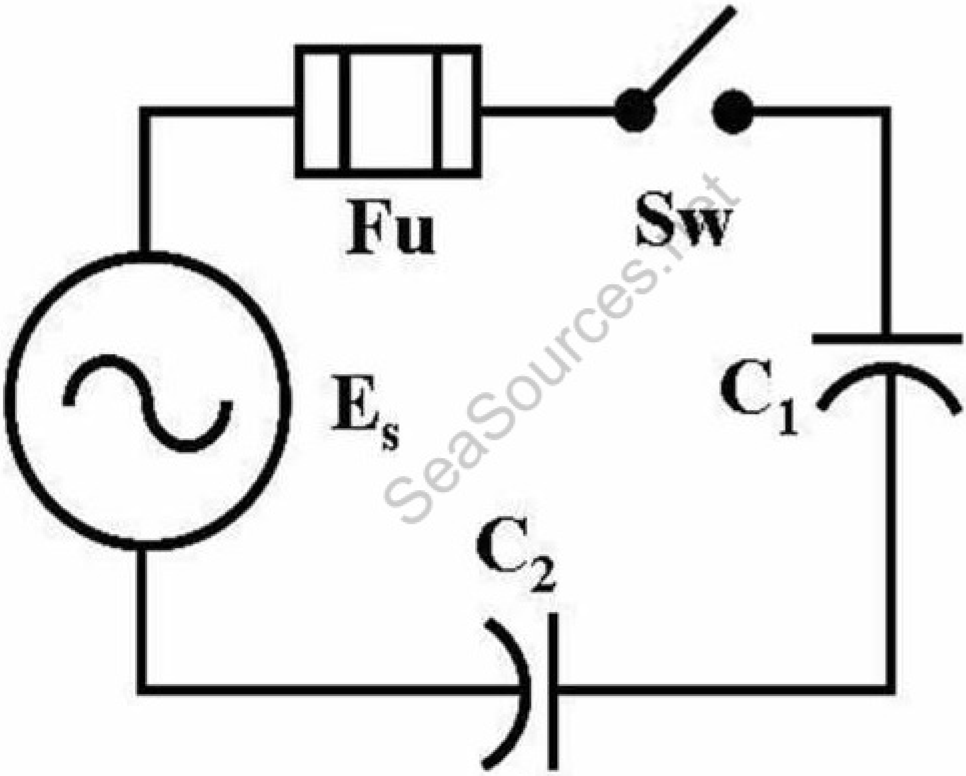


A

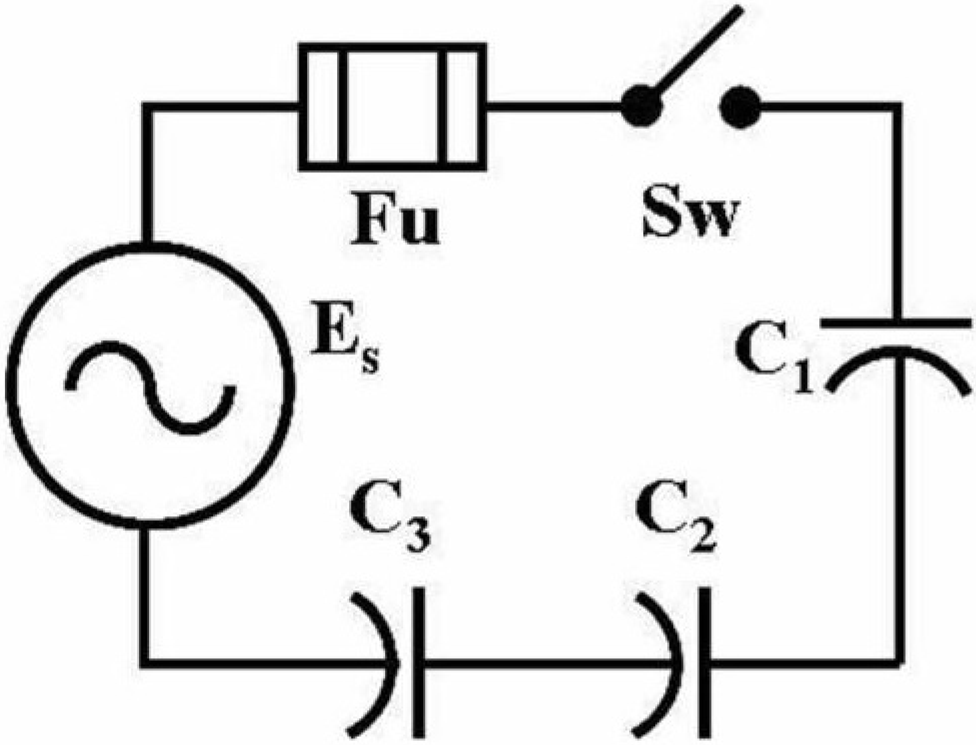


B

EL-0039

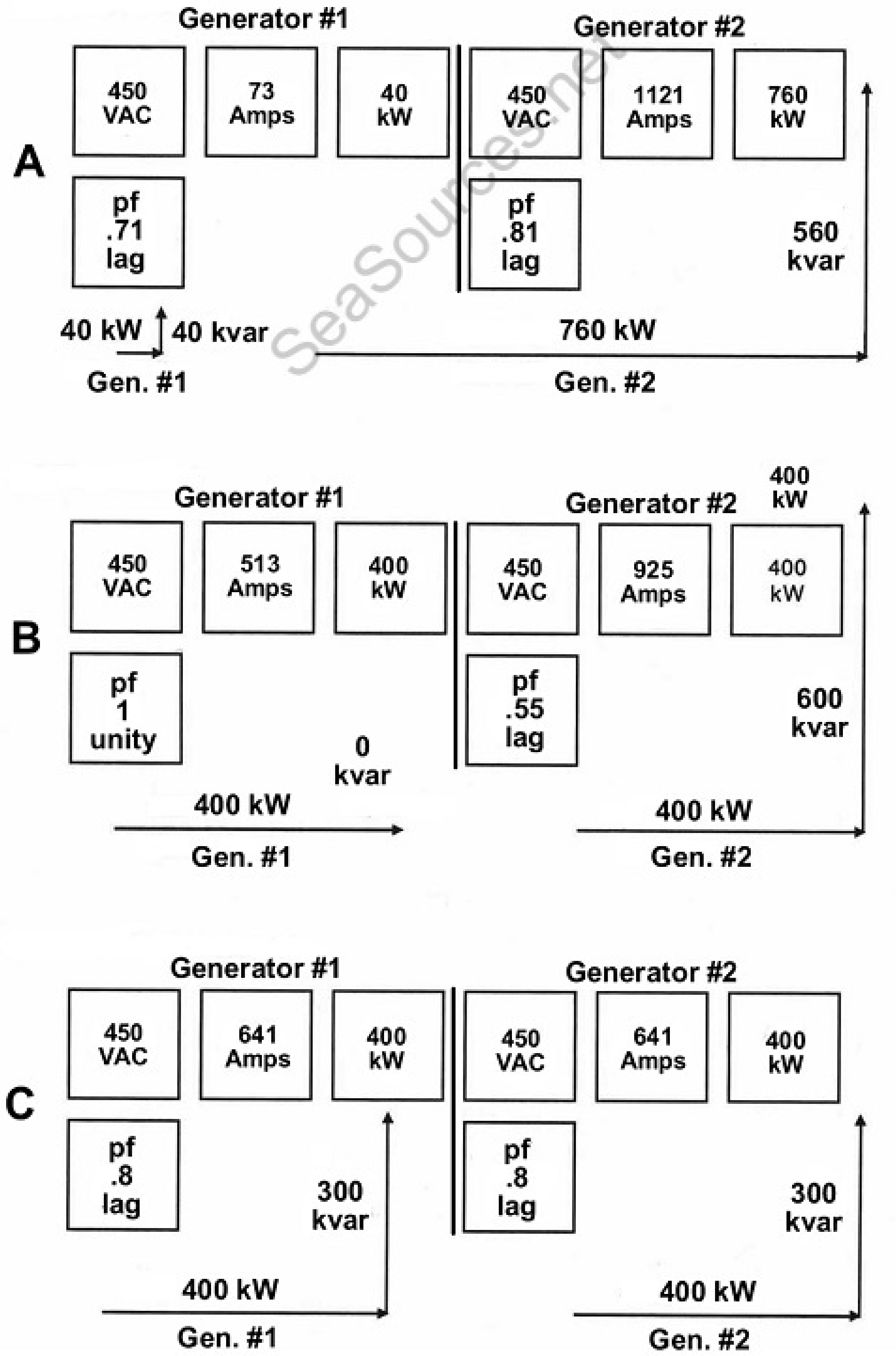


A

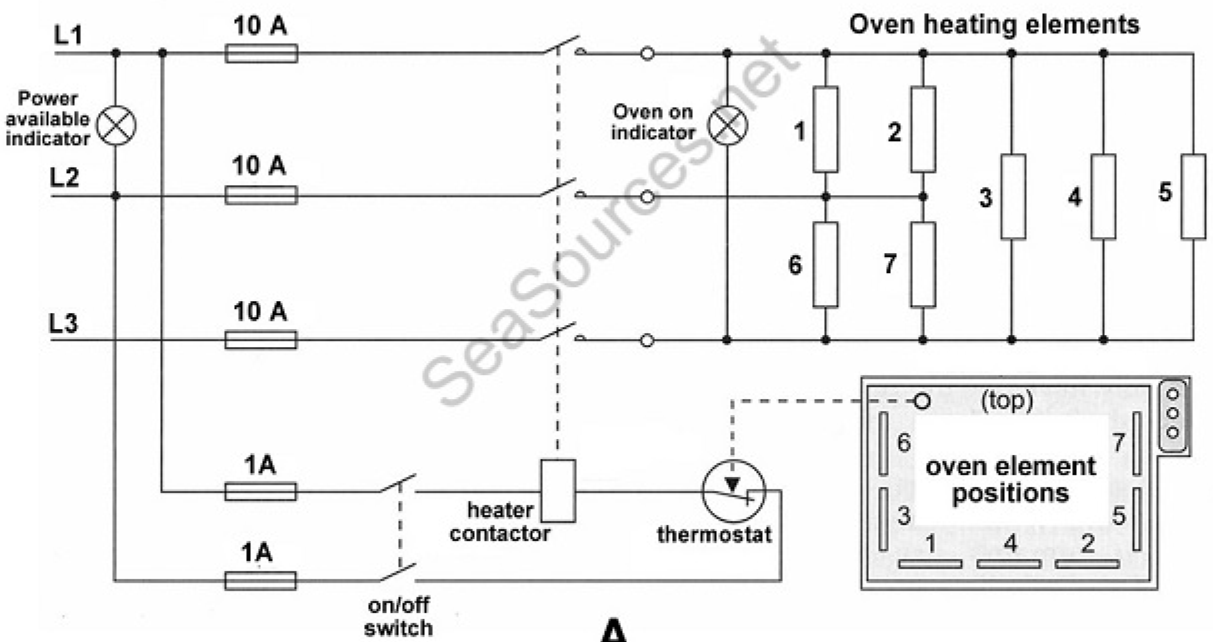


B

EL-0040

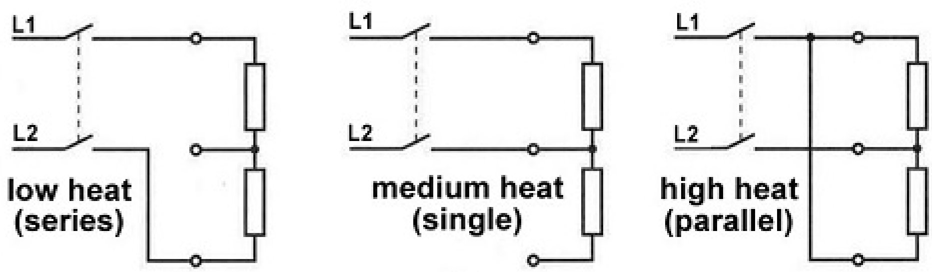

A
Generator #1
450 VAC
73 Amps
40 kW
pf .71 lag
Generator #2
450 VAC
1121 Amps
760 kW
pf .81 lag
560 kvar
40 kW
40 kvar
Gen. #1
760 kW
Gen. #2
B
Generator #1
450 VAC
513 Amps
400 kW
pf 1 unity
0 kvar
400 kW
Gen. #1
Generator #2
400 kW
450 VAC
925 Amps
400 kW
pf .55 lag
600 kvar
400 kW
Gen. #2
C
Generator #1
450 VAC
641 Amps
400 kW
pf .8 lag
300 kvar
400 kW
Gen. #1
Generator #2
450 VAC
641 Amps
400 kW
pf .8 lag
300 kvar
400 kW
Gen. #2

EL-0041



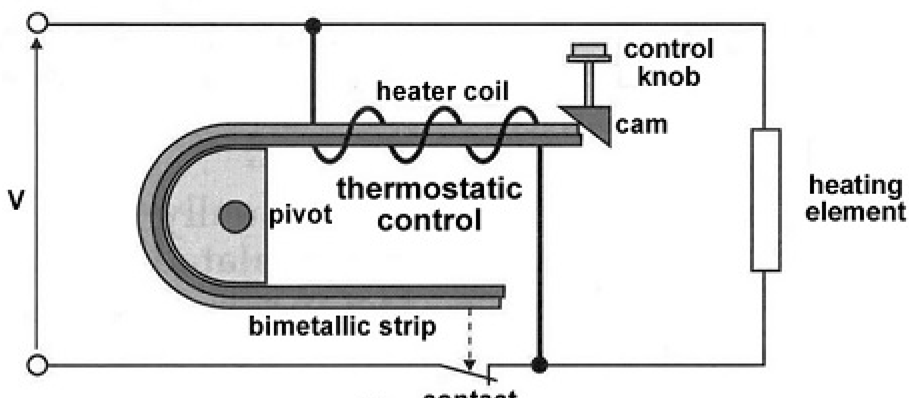
L1
L2
L3
10 A
10 A
10 A
1A
1A
Power available indicator
Oven on indicator
Oven heating elements
1
2
3
4
5
6
7
heater contactor
thermostat
on/off switch
(top)
6
7
oven element positions
3
5
1
4
2

A



L1
L2
low heat (series)
L1
L2
medium heat (single)
L1
L2
high heat (parallel)

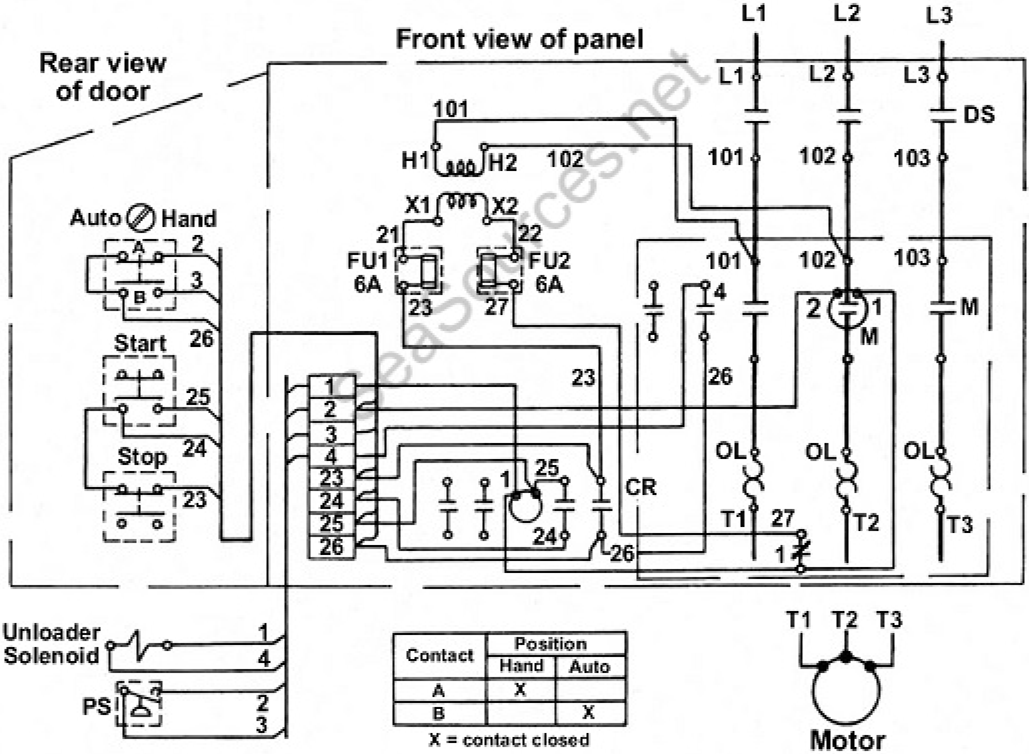
B



V
control knob
heater coil
cam
thermostatic control
pivot
heating element
bimetallic strip
contact

C

EL-0042

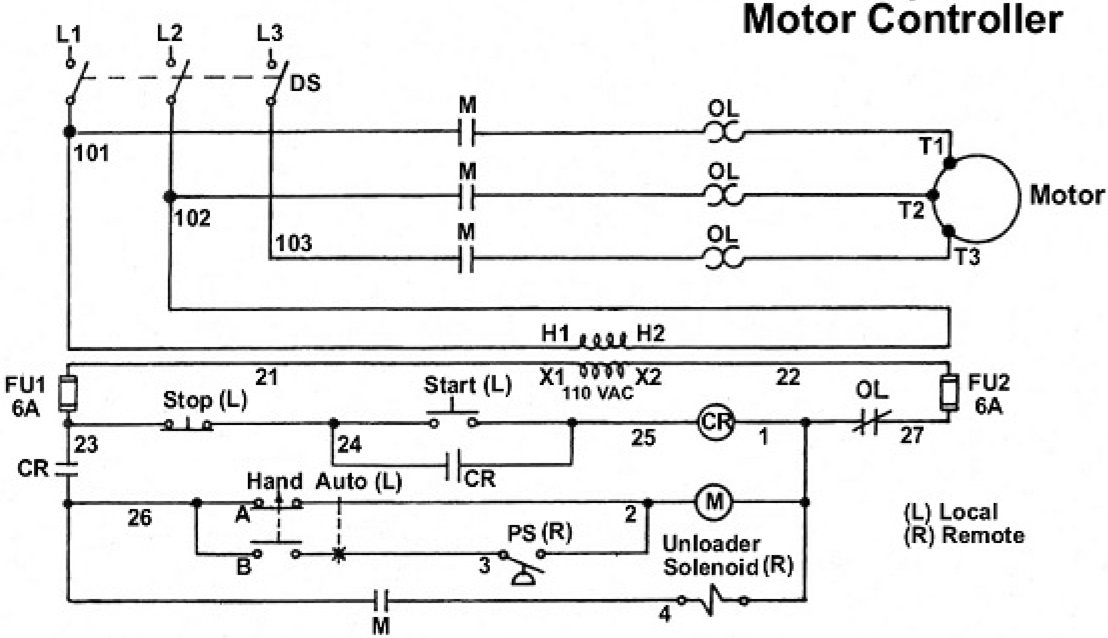


Contact	Position	
	Hand	Auto
A	X	
B		X

X = contact closed

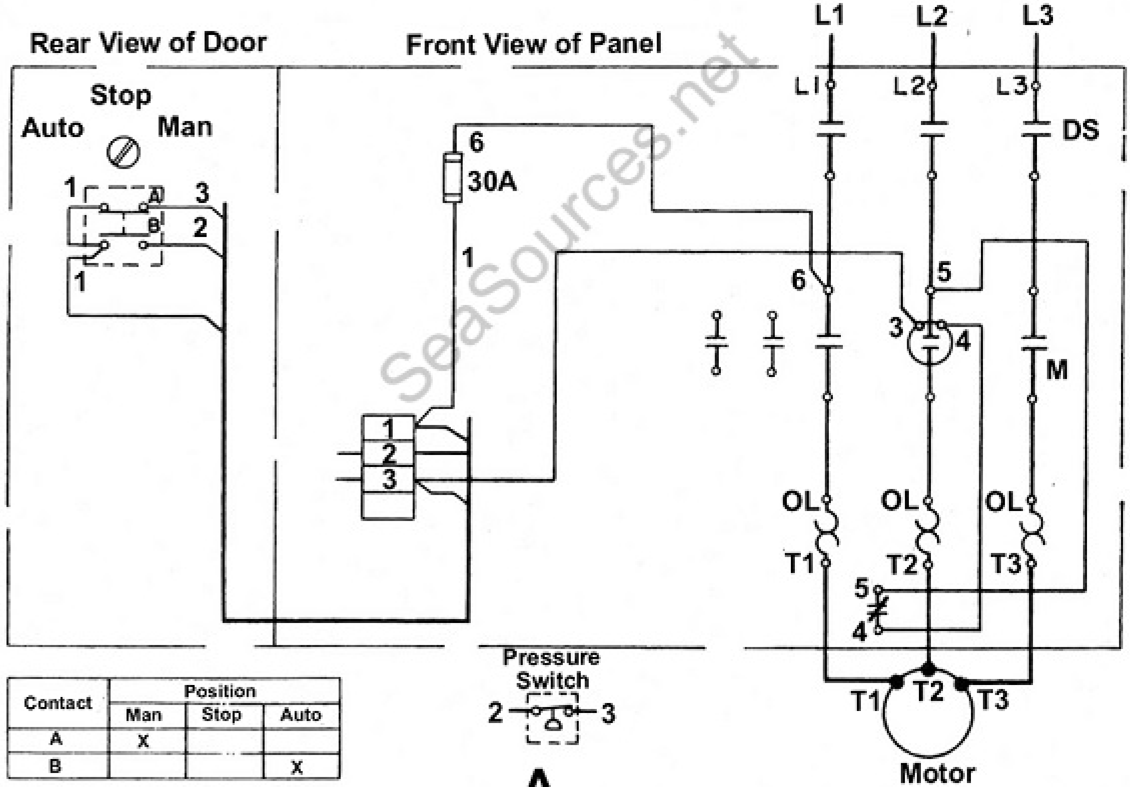
A

Air Compressor Motor Controller



B

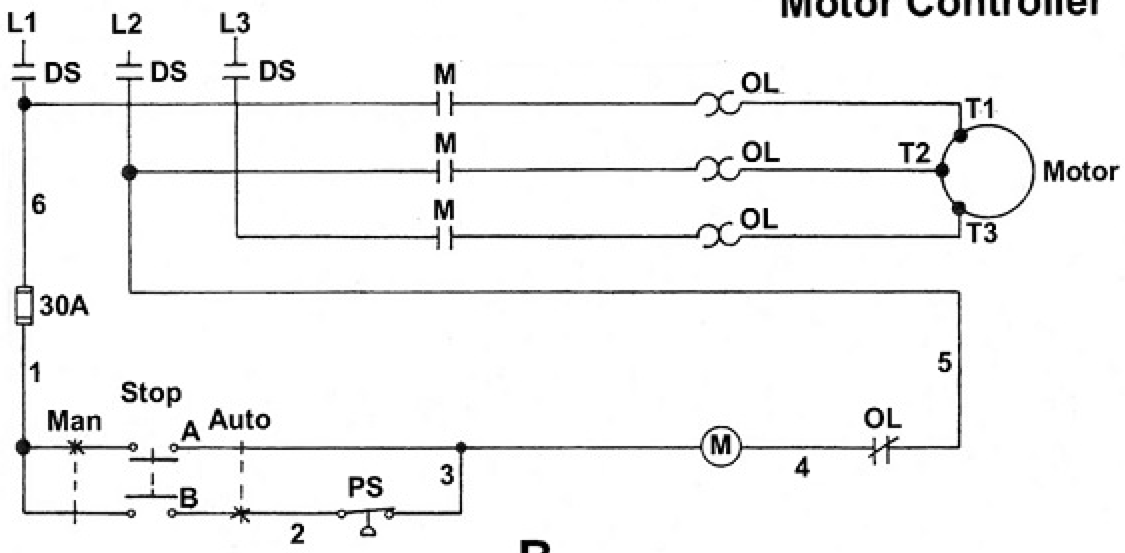
EL-0043



Contact	Position		
	Man	Stop	Auto
A	X		
B			X

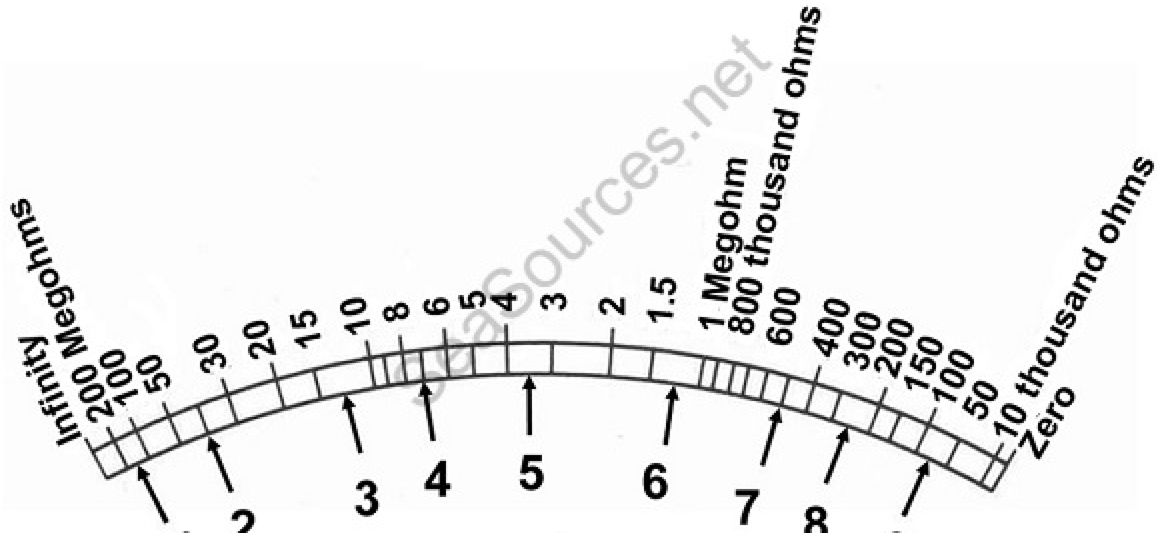
A

Potable Water Pump Motor Controller

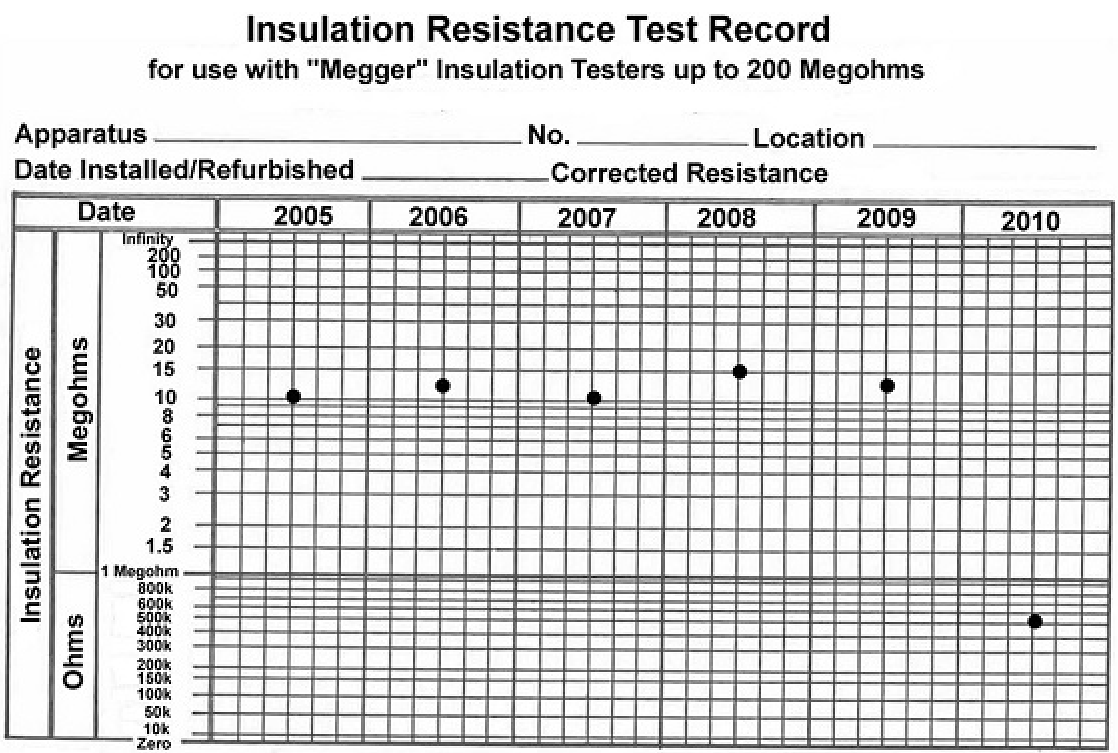


B

EL-0044

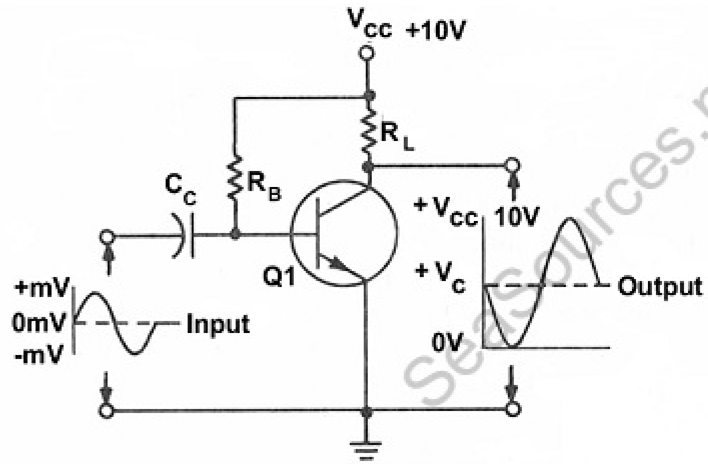

Infinity
200 Megohms
100
50
30
20
15
10
8
6
5
4
3
2
1.5
1 Megohm
800 thousand ohms
600
400
300
200
150
100
50
10 thousand ohms
Zero
1
2
3
4
5
6
7
8
9

A


Insulation Resistance Test Record
for use with "Megger" Insulation Testers up to 200 Megohms
Apparatus
No.
Location
Date Installed/Refurbished
Corrected Resistance
Date
2005
2006
2007
2008
2009
2010
Insulation Resistance
Megohms
Ohms
Infinity
200
100
50
30
20
15
10
8
6
5
4
3
2
1.5
1 Megohm
800k
600k
500k
400k
300k
200k
150k
100k
50k
10k
Zero

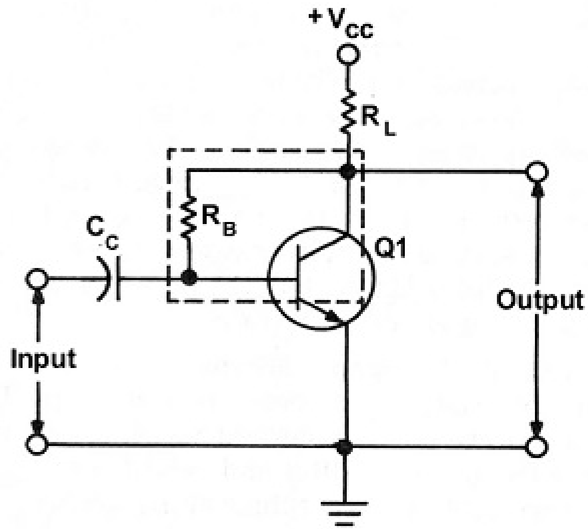
B

EL-0045



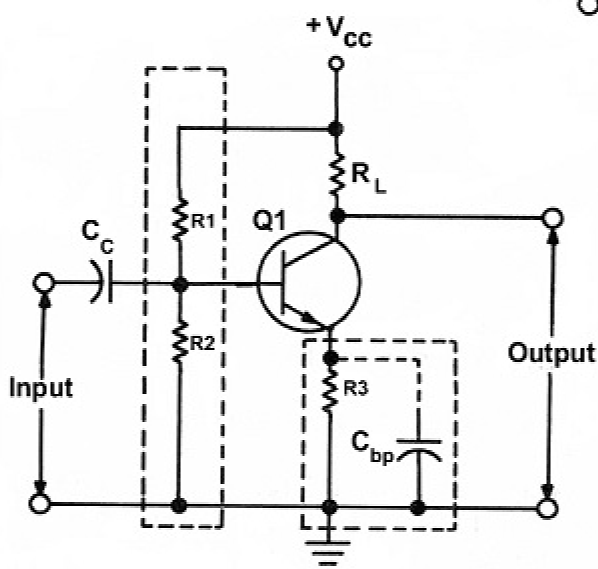
V_{CC} +10V
R_L
R_B
C_C
Q1
+V_{CC}
10V
+V_C
Output
0V
+mV
0mV
-mV
Input

A



+V_{CC}
R_L
R_B
C_C
Q1
Output
Input

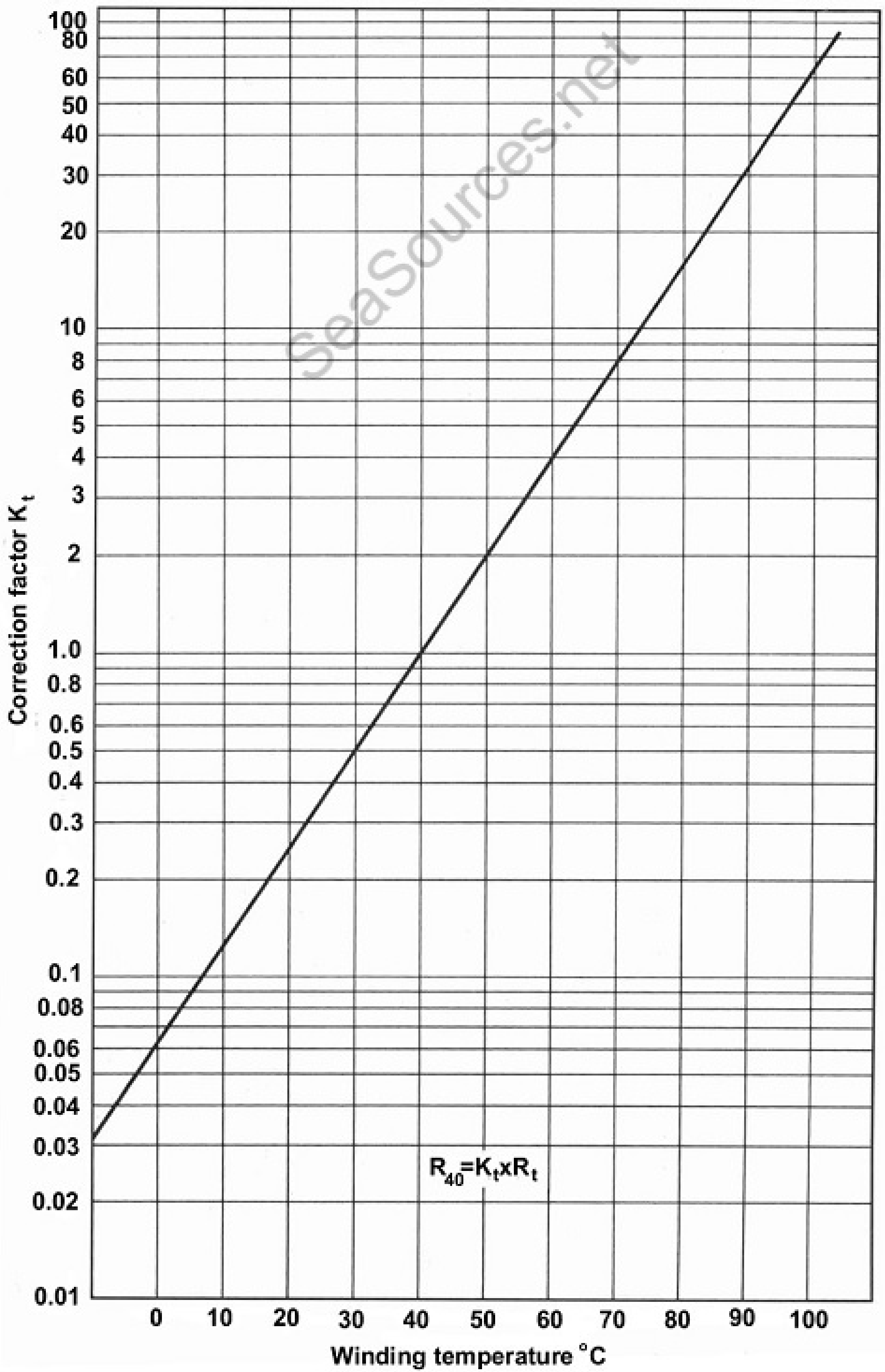
B



+V_{CC}
R_L
Q1
R1
C_C
R2
R3
C_{bp}
Input
Output

C

EL-0046



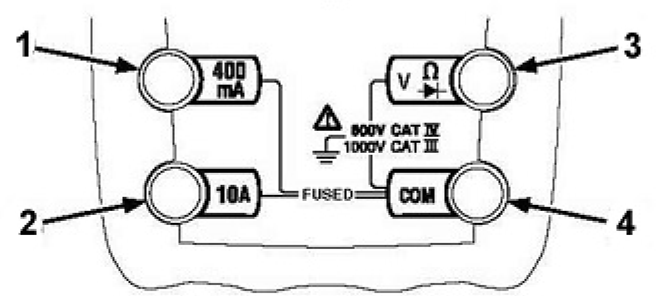
Correction factor K_t
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1.0
0.8
0.6
0.5
0.4
0.3
0.2
0.1
0.08
0.06
0.05
0.04
0.03
0.02
0.01
0
10
20
30
40
50
60
70
80
90
100
Winding temperature °C
$R_{40}=K_t x R_t$

EL-0047

A

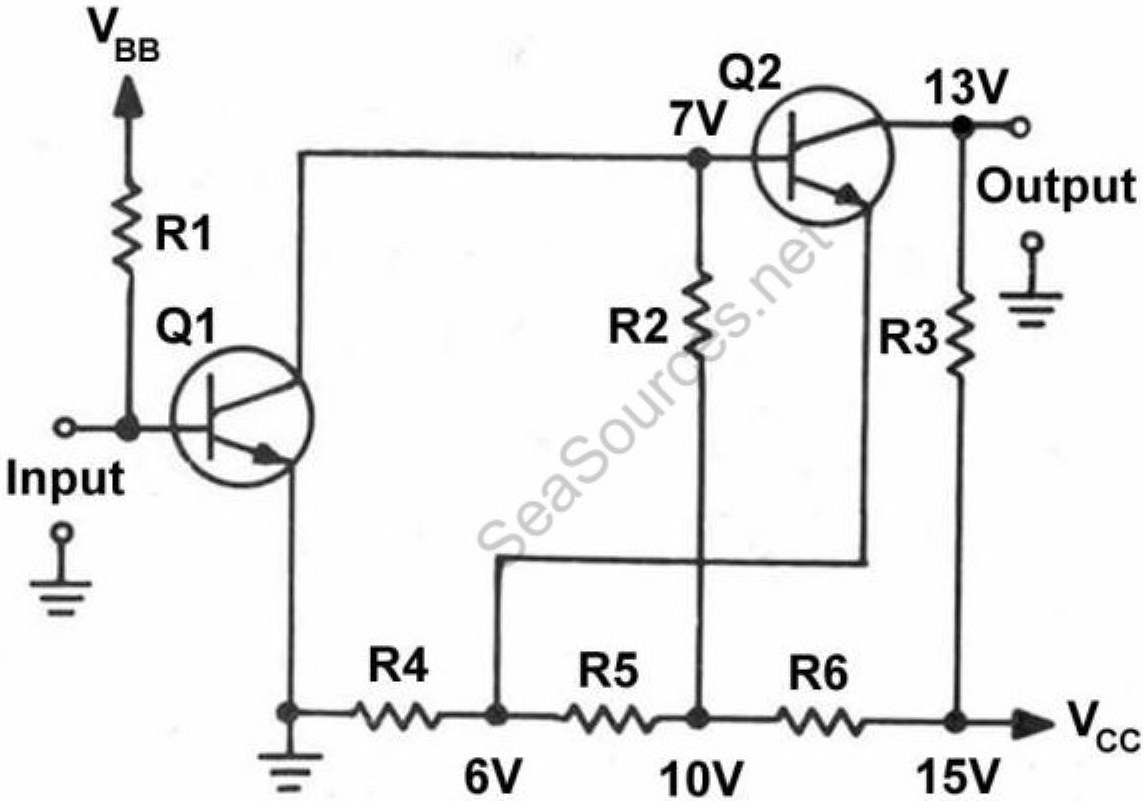
	Switch Position	Measurement Function
1	Ṽ Hz	
2	V⎓	
3	mV⎓	
4	Ω ⊣⊢	
5	·))) ⊳⊢	
6	⎓~ mA	
7	⎓ ~A	

B



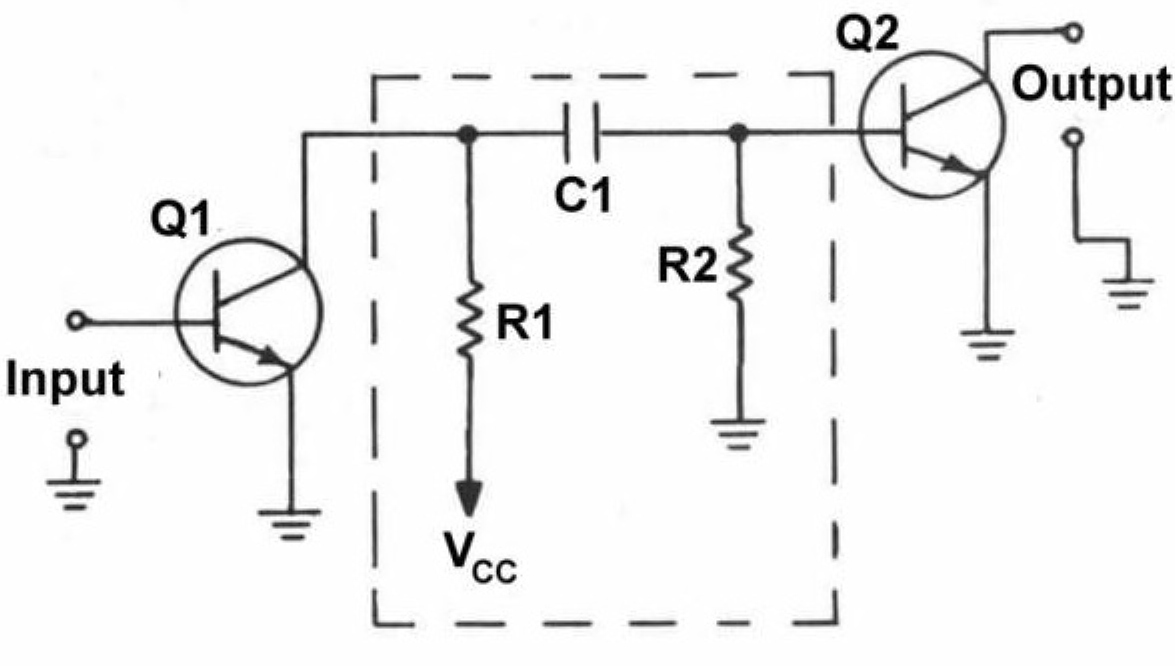
C

EL-0048



V_{BB}
R1
Q1
Input
Q2
7V
13V
Output
R2
R3
R4
R5
R6
6V
10V
15V
V_{CC}
SeaSources.net

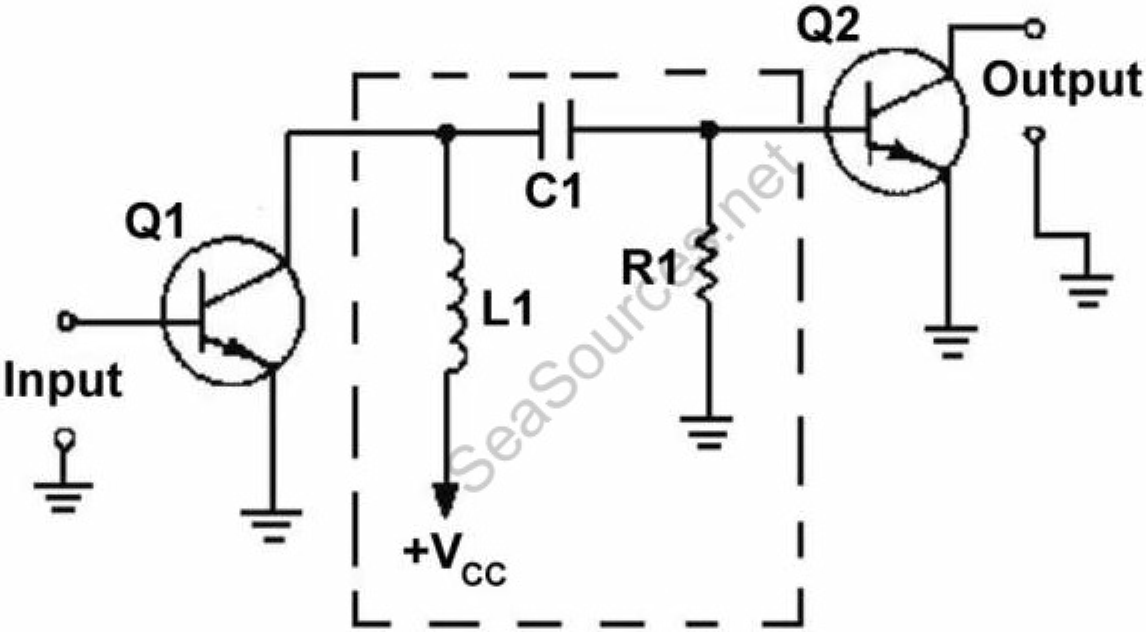
A



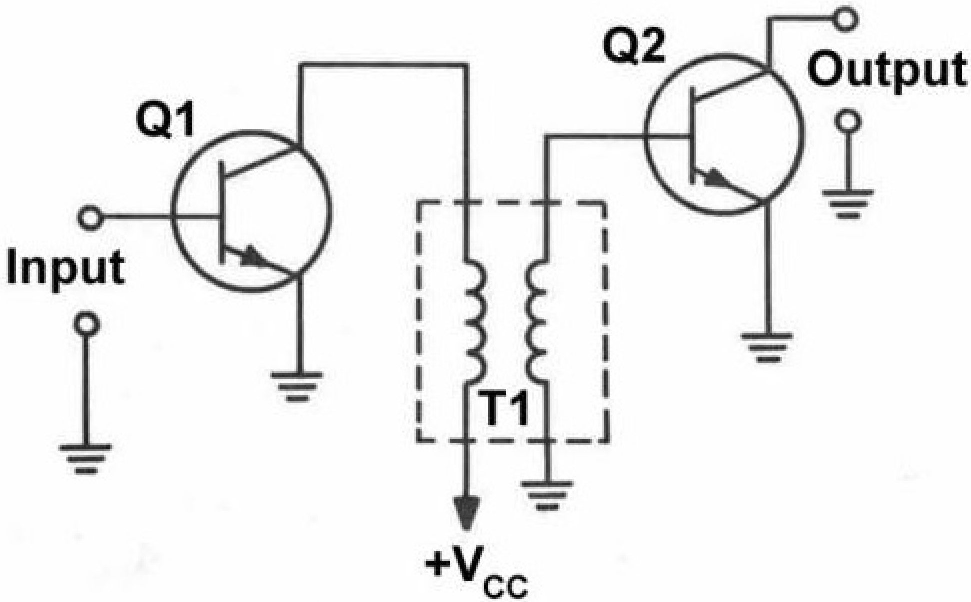
Q2
Output
C1
Q1
R2
R1
Input
V_{CC}

B

EL-0049

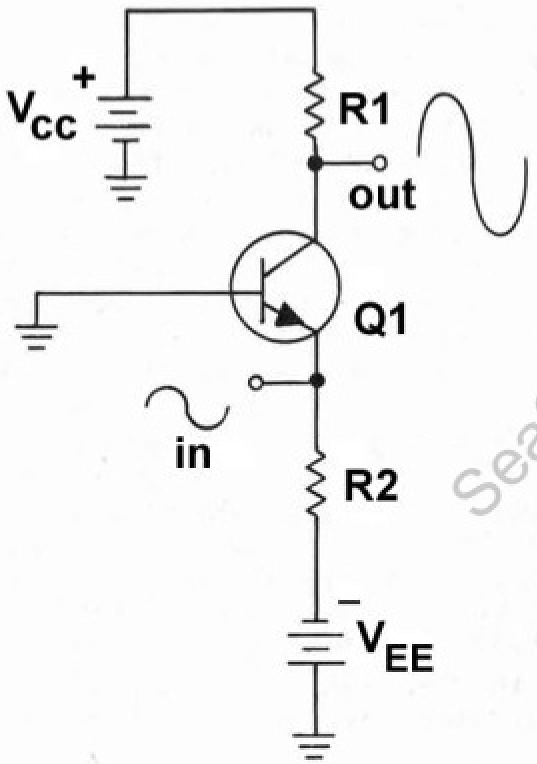


A



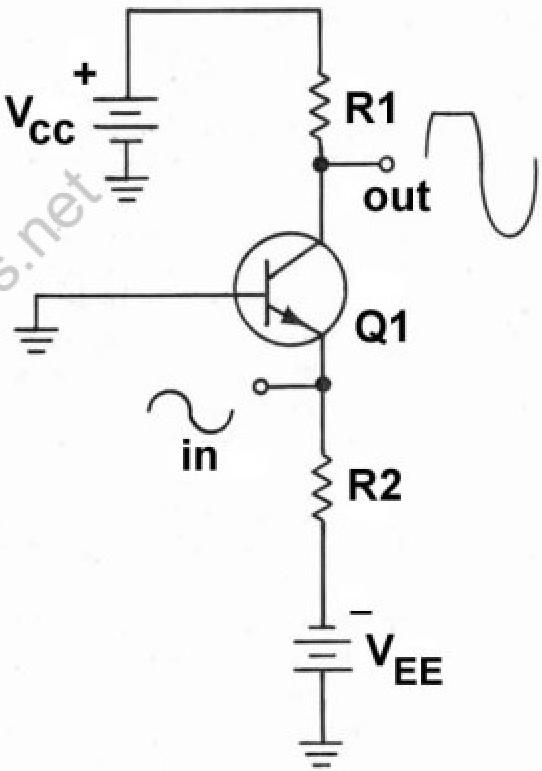
B

EL-0050



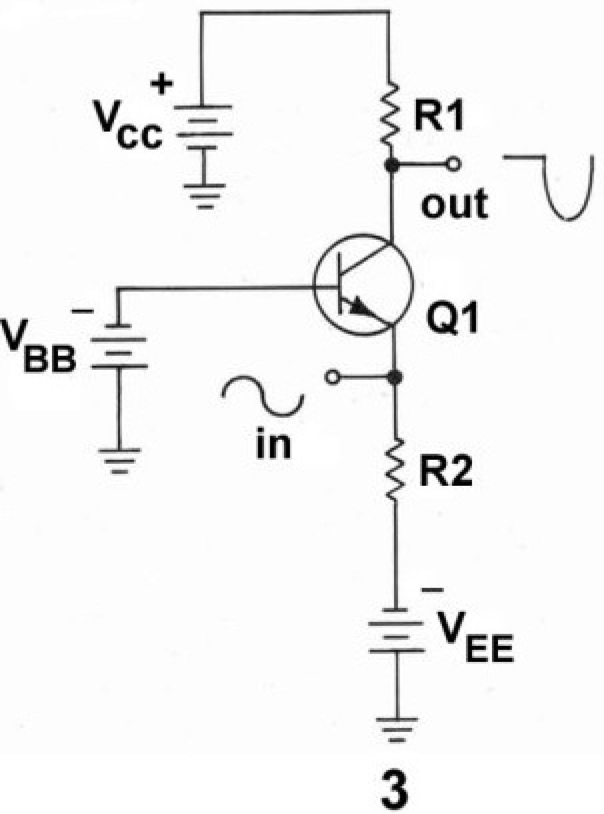
+
V_{CC}
R1
out
Q1
in
R2
–
V_{EE}

1



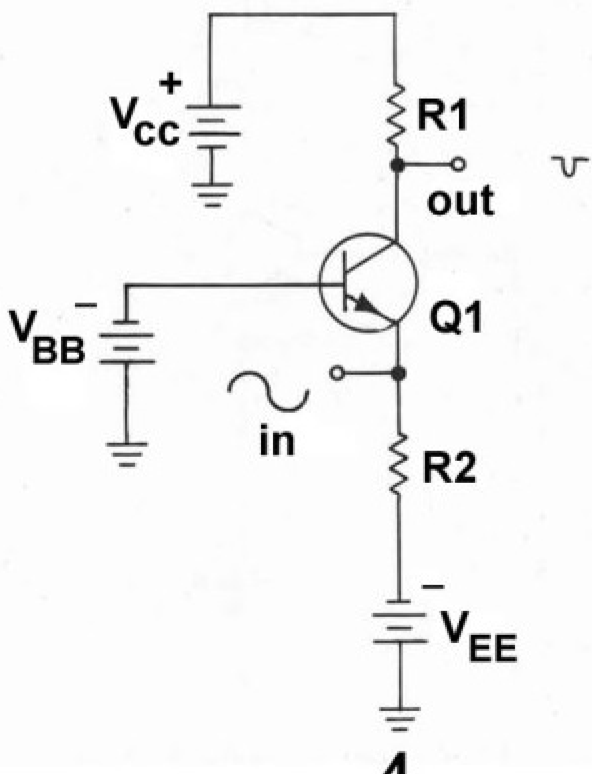
+
V_{CC}
R1
out
Q1
in
R2
–
V_{EE}

2



+
V_{CC}
R1
out
–
V_{BB}
Q1
in
R2
–
V_{EE}

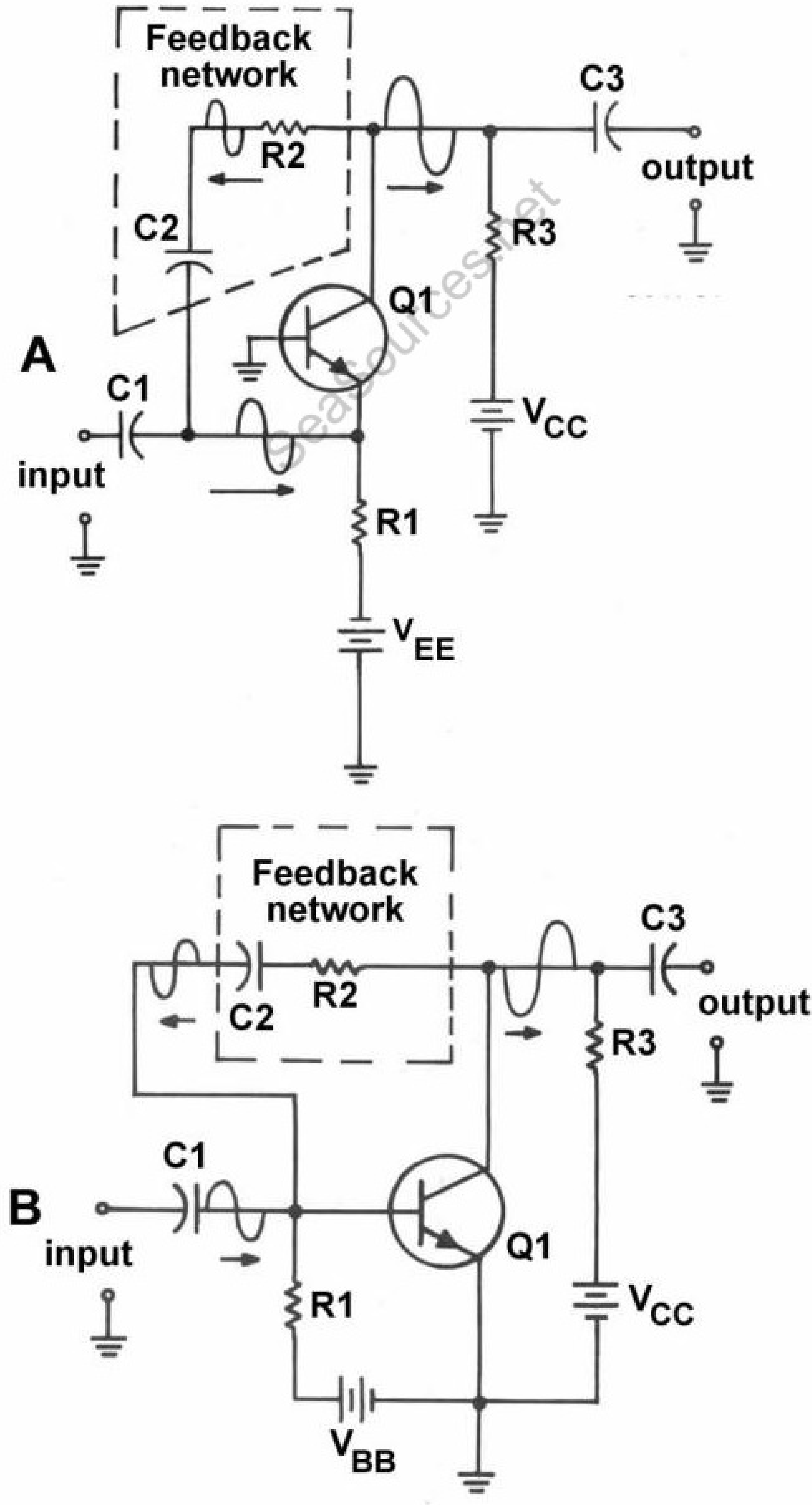
3



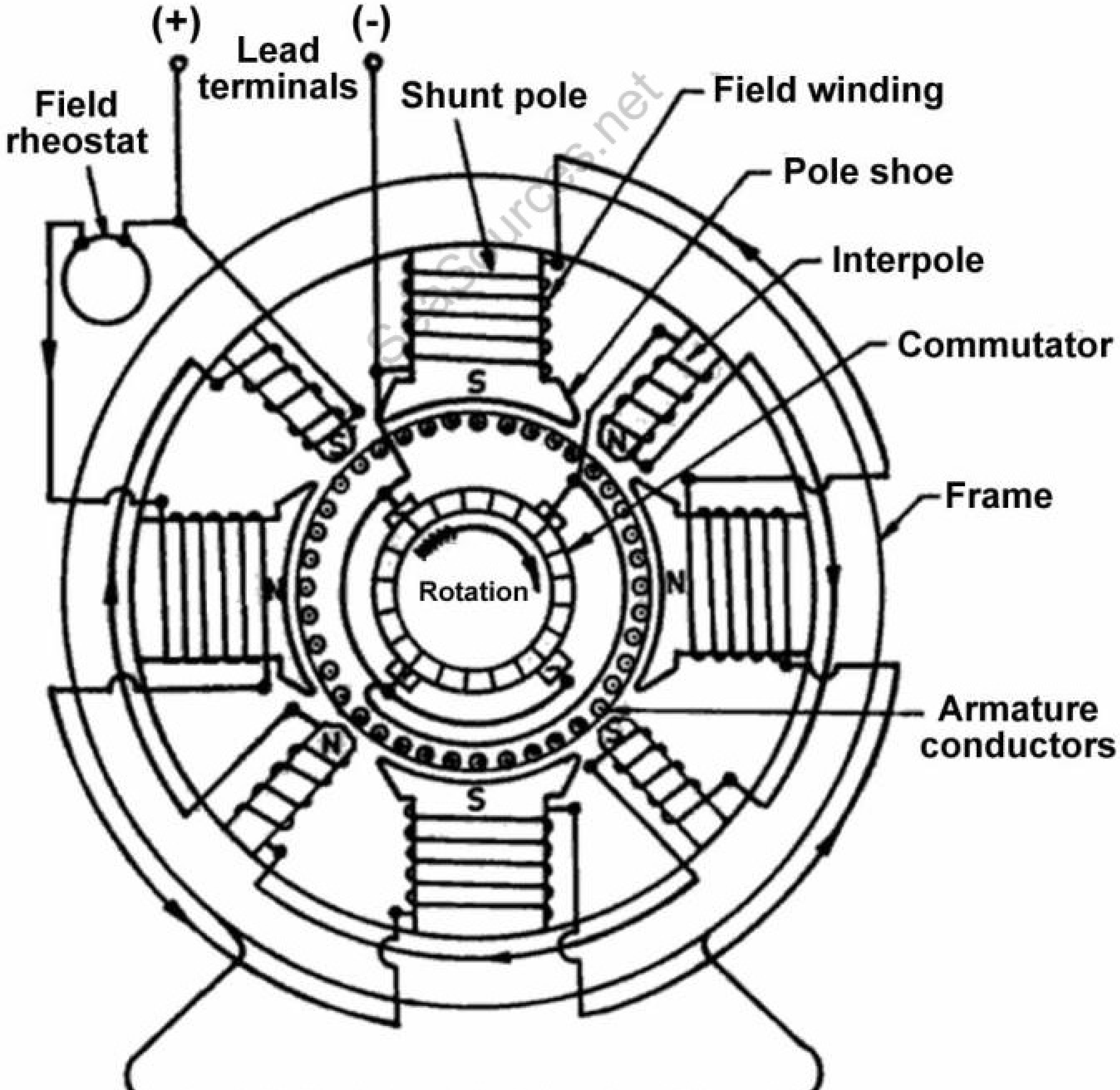
+
V_{CC}
R1
out
–
V_{BB}
Q1
in
R2
–
V_{EE}

4

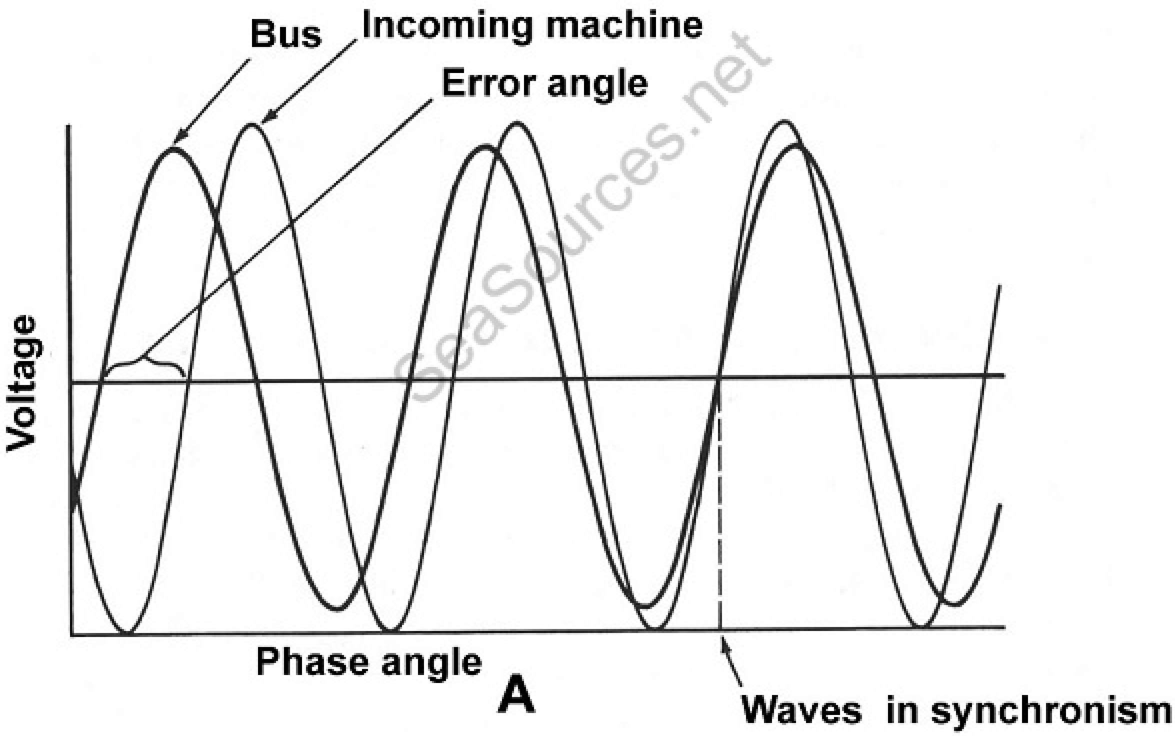
EL-0051


A
Feedback network
R2
C2
C3
output
R3
Q1
C1
input
R1
V_{CC}
V_{EE}
B
Feedback network
C2
R2
C3
output
R3
C1
input
Q1
R1
V_{CC}
V_{BB}

EL-0052


(+)
(-)
Lead terminals
Field rheostat
Shunt pole
Field winding
Pole shoe
Interpole
Commutator
Frame
Armature conductors
Rotation
S
N
N
S
S
N
N
S

EL-0053

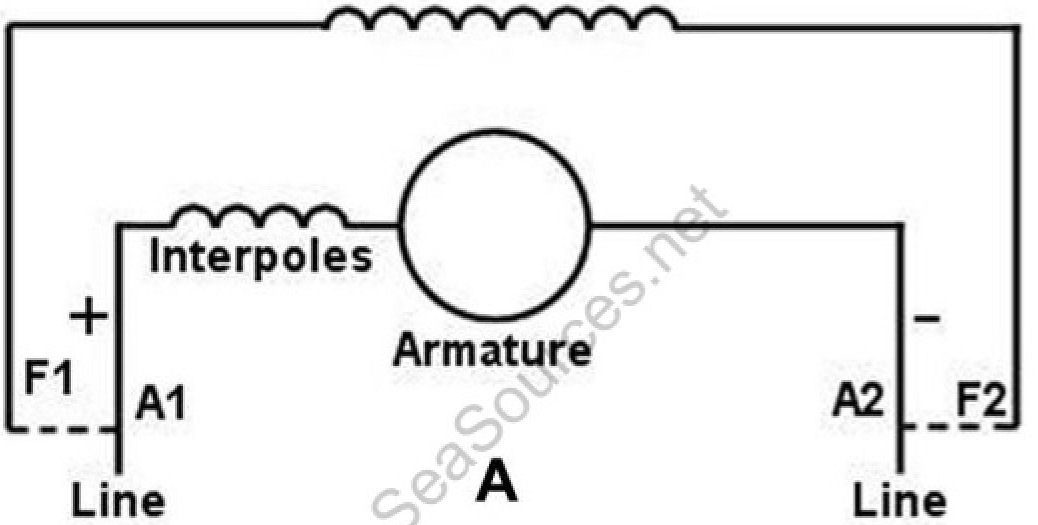

Bus
Incoming machine
Error angle
Voltage
Phase angle
Waves in synchronism

A

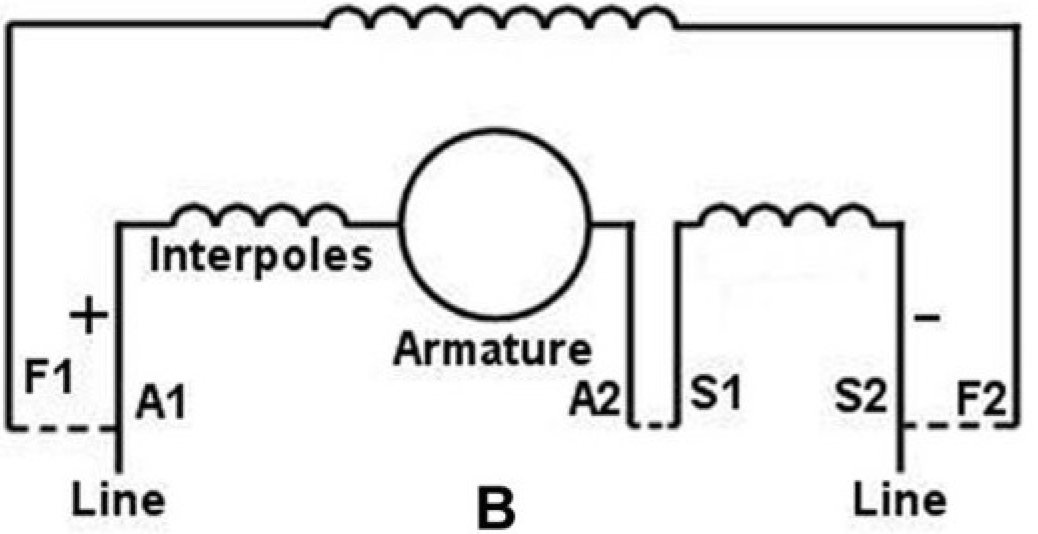

SLOW
FAST
SYNCHROSCOPE

B

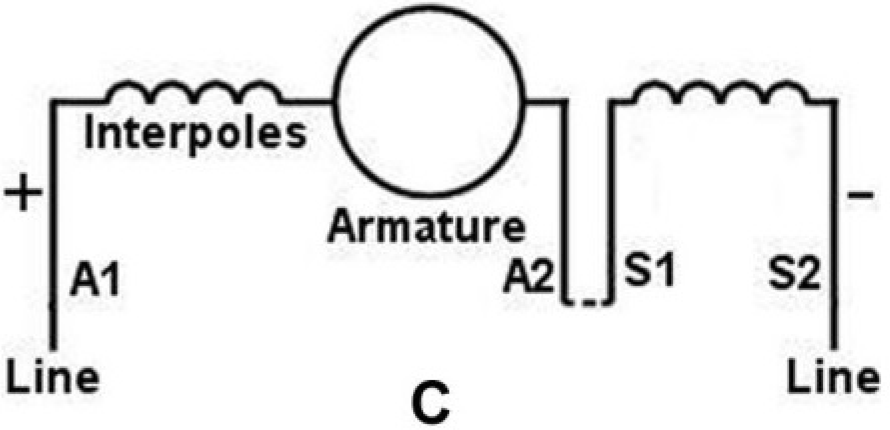
EL-0054


Interpoles
+
Armature
–
F1
A1
A2
F2
Line
Line

A

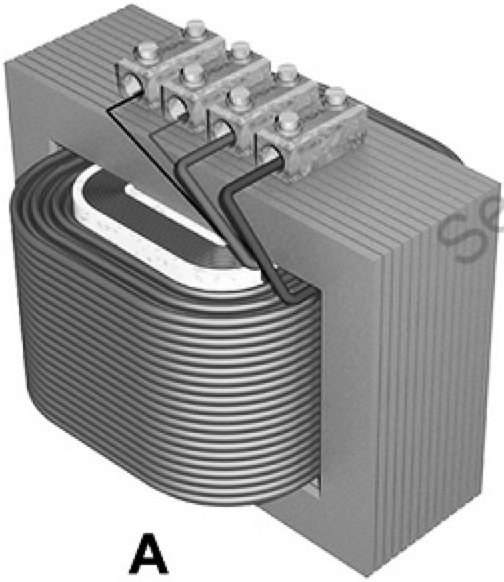

Interpoles
+
Armature
–
F1
A1
A2
S1
S2
F2
Line
Line

B

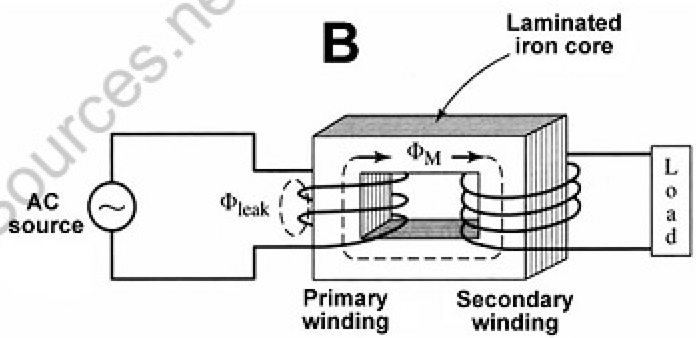

Interpoles
+
Armature
–
A1
A2
S1
S2
Line
Line

C

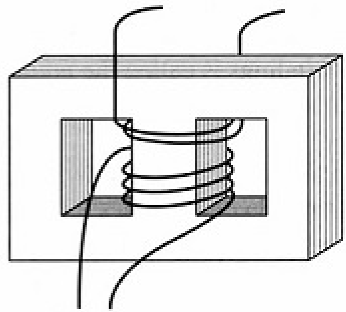
EL-0055



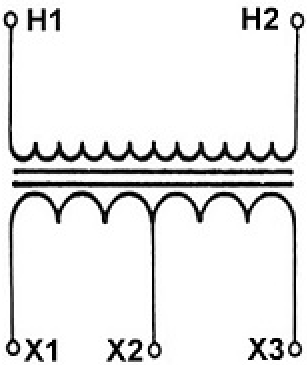
A



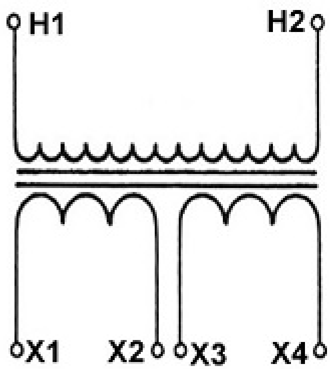
B



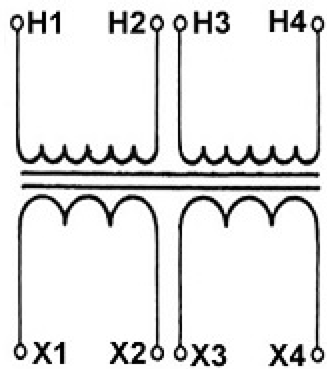
C



D



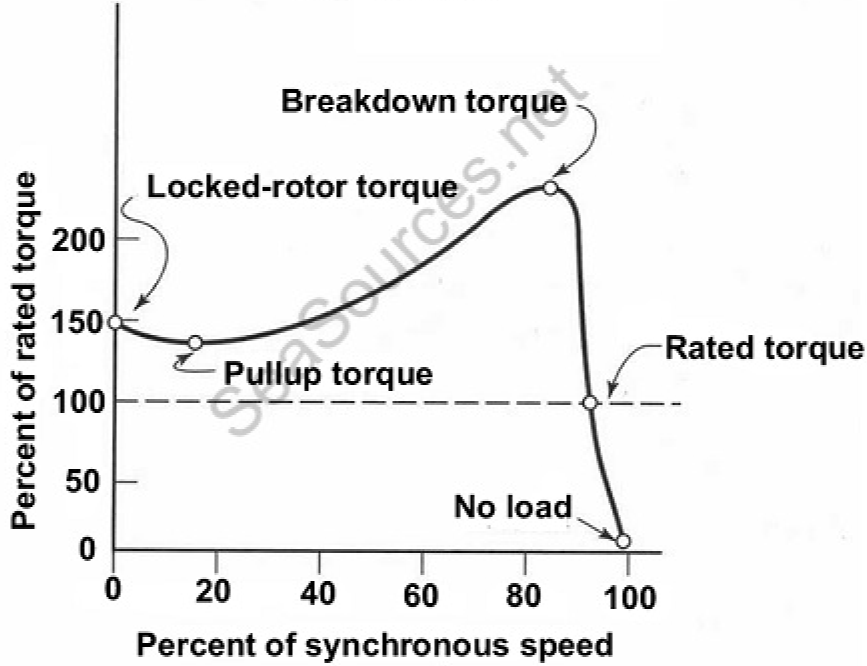
E



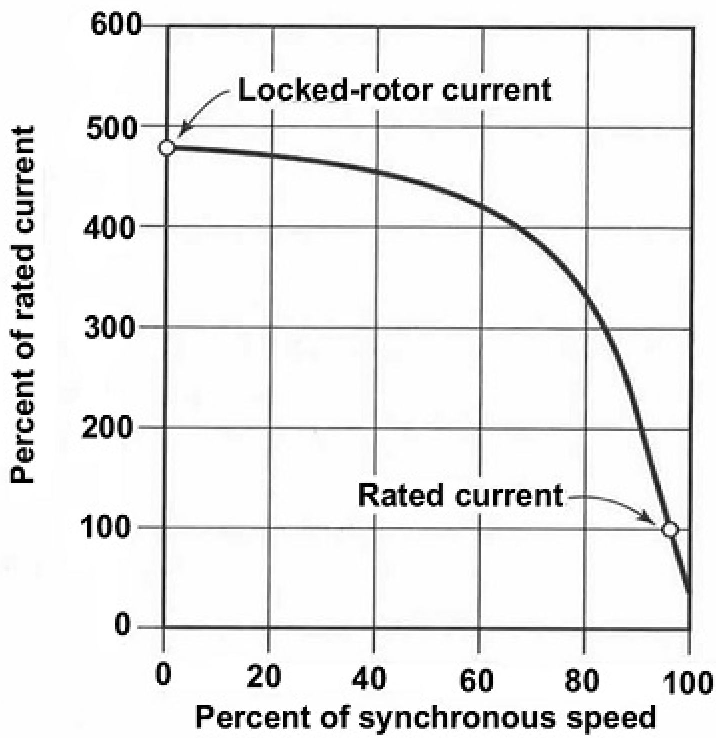
F

EL-0056

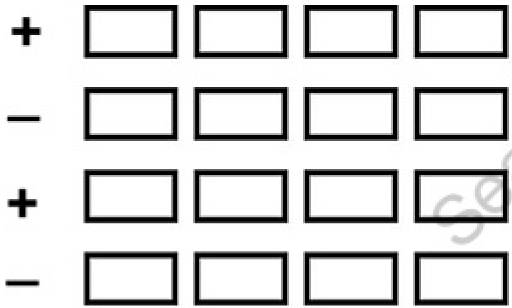
A


Breakdown torque
Locked-rotor torque
Percent of rated torque
200
150
100
50
0
Pullup torque
Rated torque
No load
0
20
40
60
80
100
Percent of synchronous speed
SeaSources.net

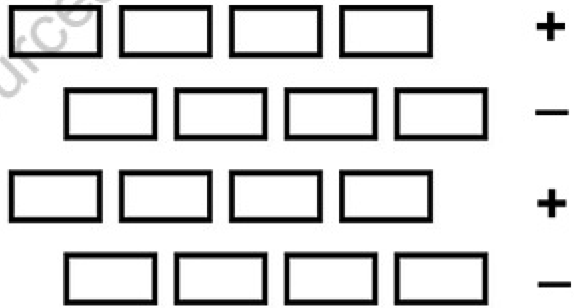
B


600
500
400
300
200
100
0
Locked-rotor current
Percent of rated current
Rated current
0
20
40
60
80
100
Percent of synchronous speed

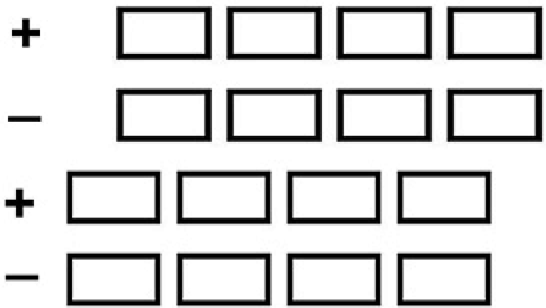
EL-0057



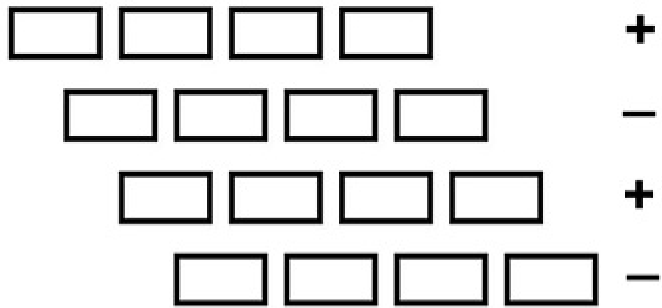
A



B

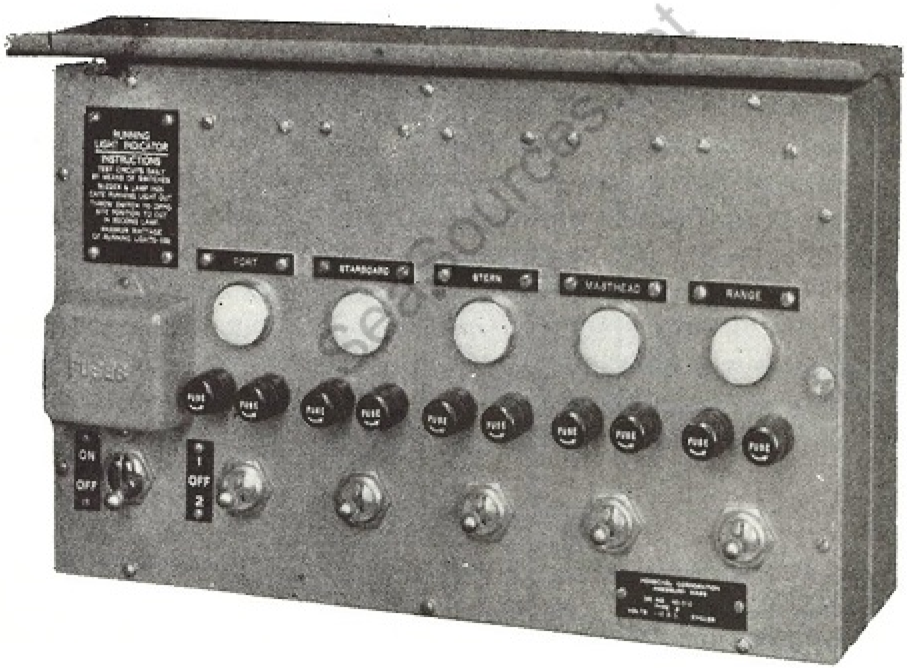


C

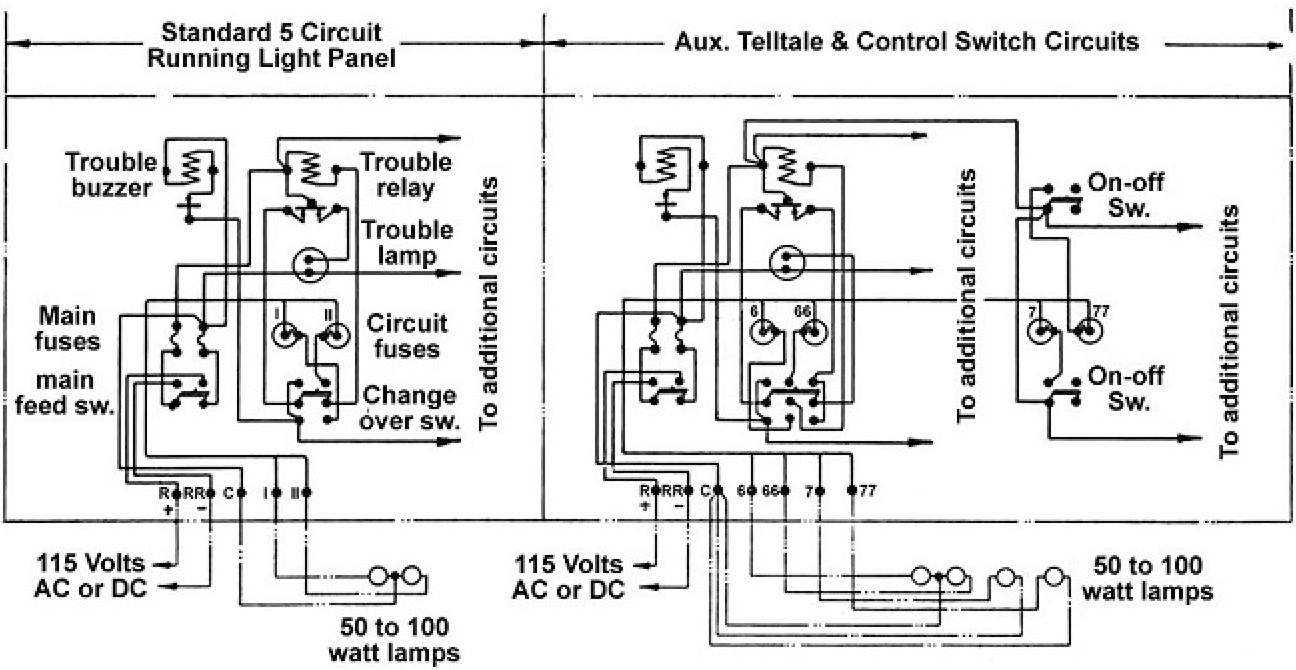


D

EL-0058



PORT
STARBOARD
STERN
MASTHEAD
RANGE
FUSES
ON
OFF
1
OFF
2



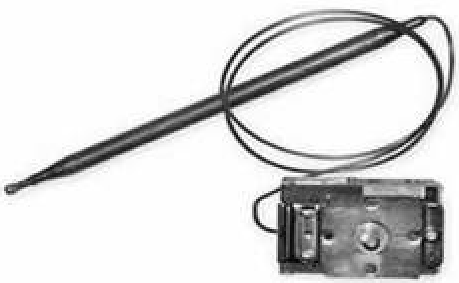
Standard 5 Circuit
Running Light Panel
Aux. Telltale & Control Switch Circuits
Trouble buzzer
Trouble relay
Trouble lamp
Main fuses
main feed sw.
Circuit fuses
Change over sw.
To additional circuits
I
II
R
RR
C
I
II
+
−
115 Volts
AC or DC
50 to 100
watt lamps
On-off
Sw.
6
66
7
77
To additional circuits
On-off
Sw.
To additional circuits
R
RR
C
6
66
7
77
+
−
115 Volts
AC or DC
50 to 100
watt lamps

EL-0059

A

B

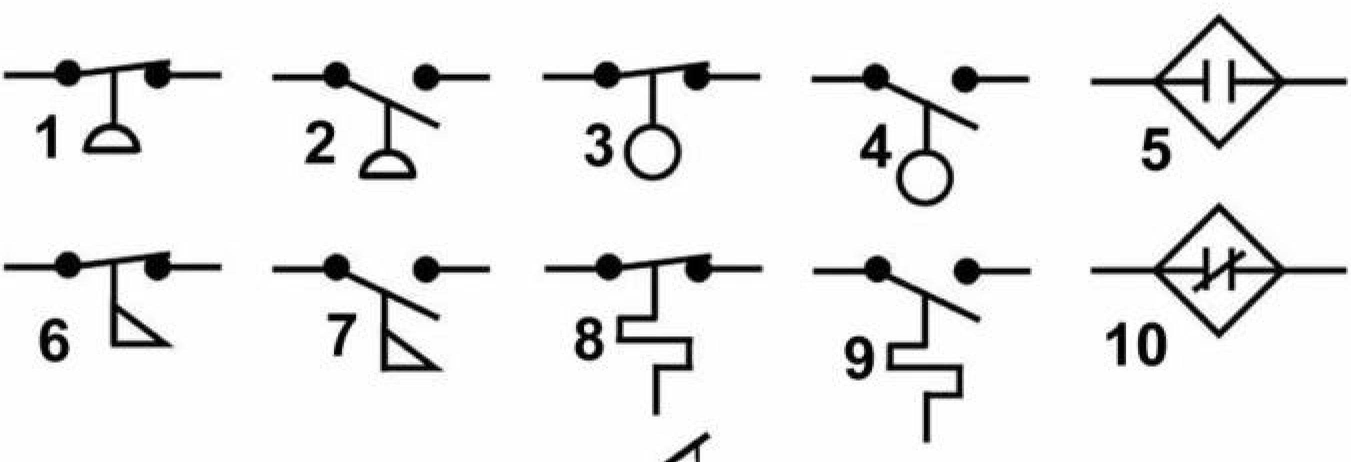
C



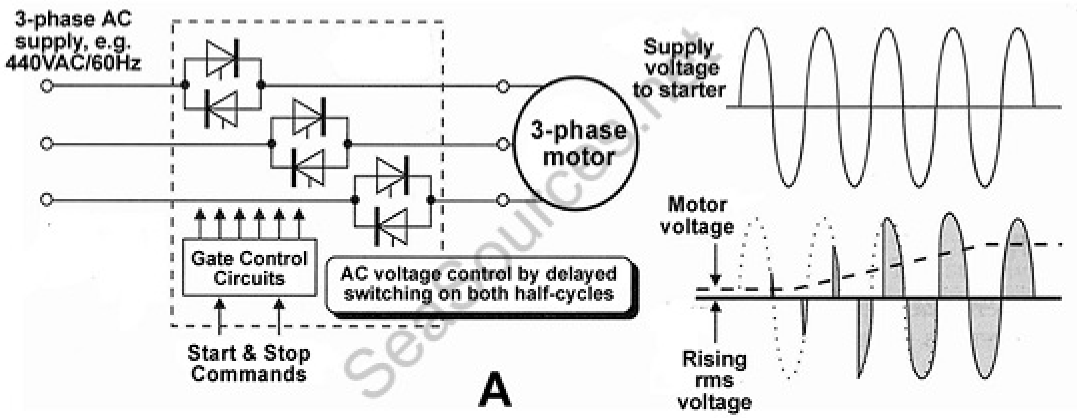
D

E

F

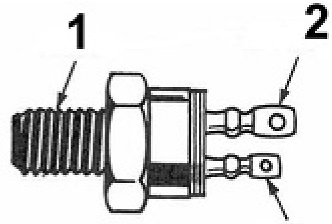


EL-0060



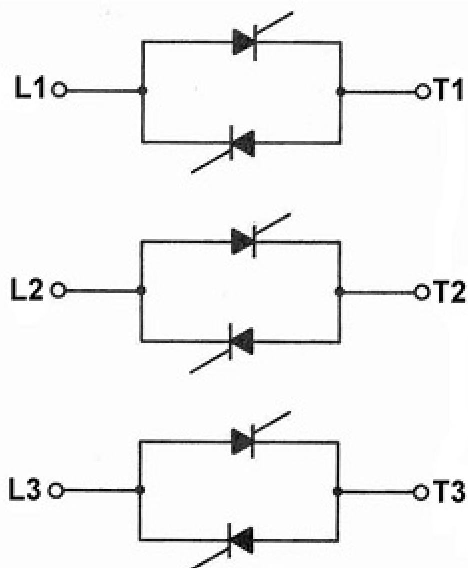
3-phase AC
supply, e.g.
440VAC/60Hz
3-phase
motor
Gate Control
Circuits
AC voltage control by delayed
switching on both half-cycles
Start & Stop
Commands
Supply
voltage
to starter
Motor
voltage
Rising
rms
voltage

A



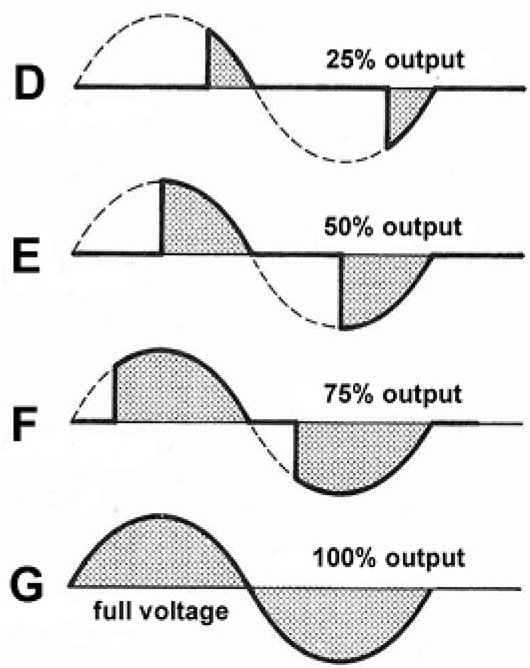
1
2
3

B



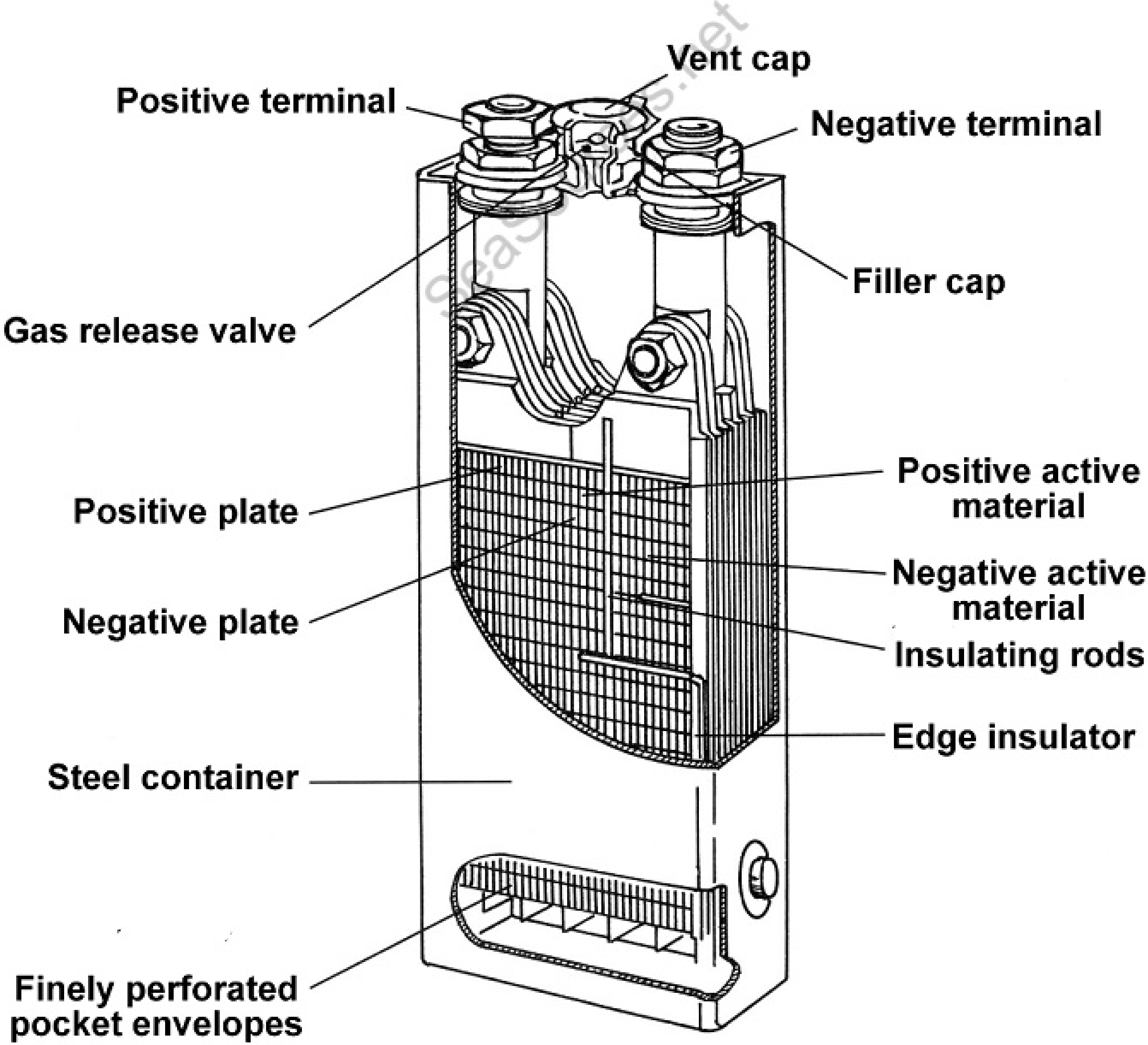
L1
T1
L2
T2
L3
T3

C



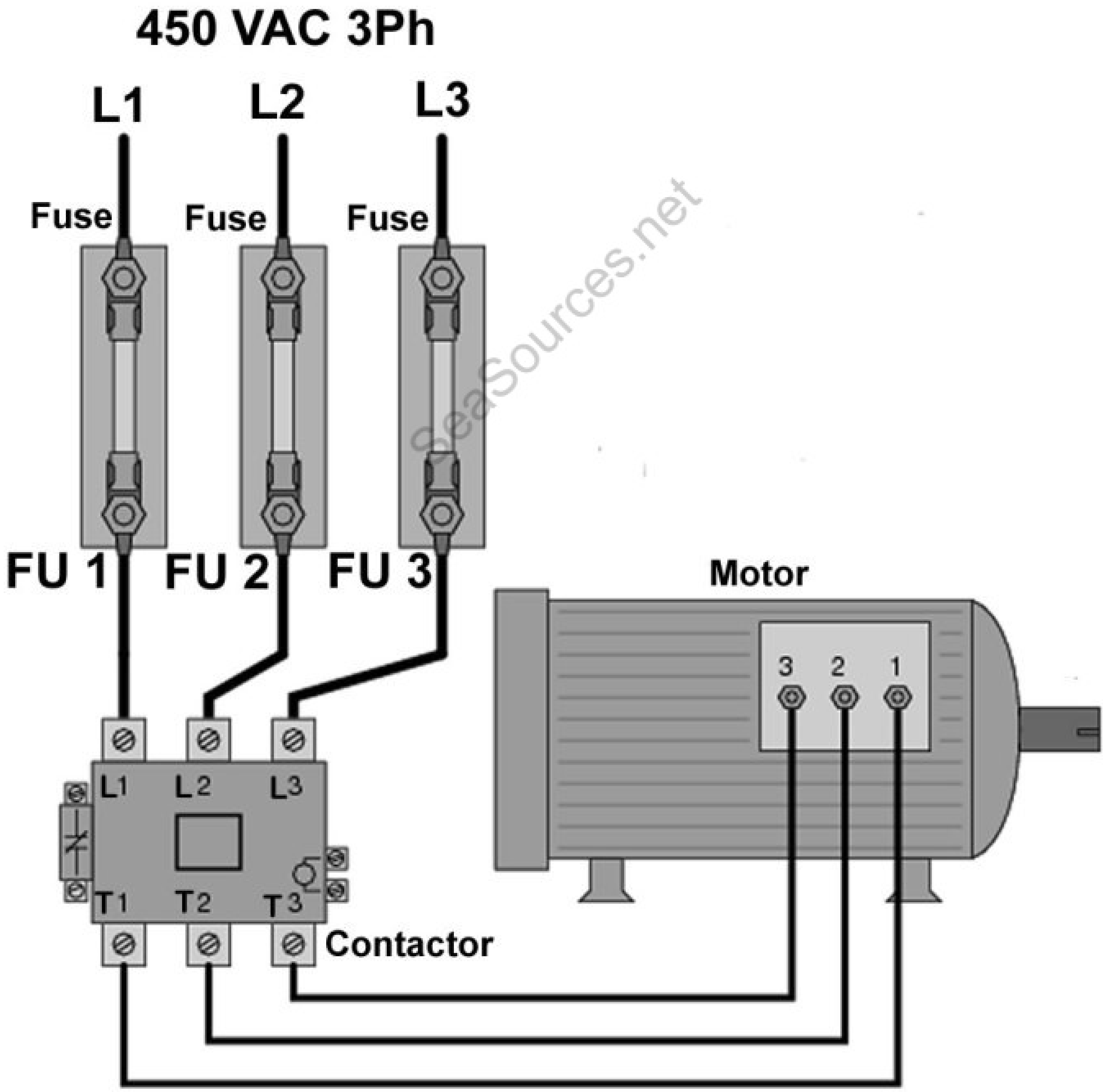
D
25% output
E
50% output
F
75% output
G
100% output
full voltage

EL-0061

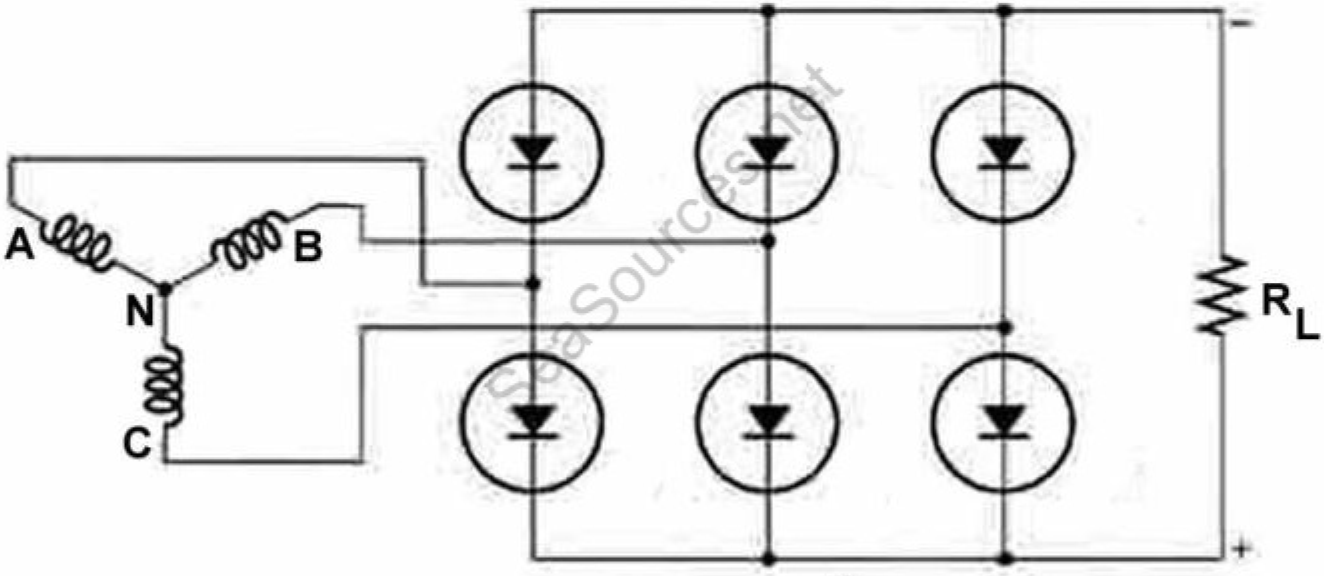


Vent cap
Positive terminal
Negative terminal
Filler cap
Gas release valve
Positive active material
Positive plate
Negative active material
Negative plate
Insulating rods
Edge insulator
Steel container
Finely perforated pocket envelopes

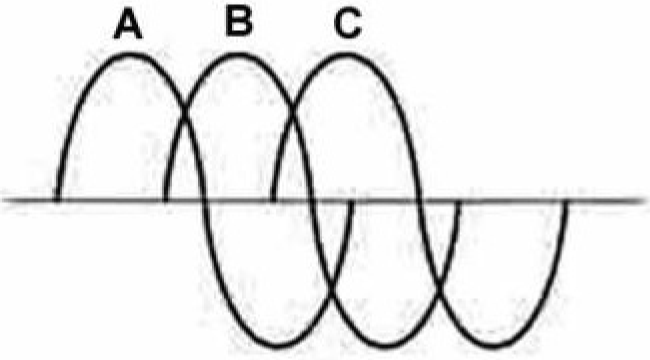
EL-0062


450 VAC 3Ph
L1
L2
L3
Fuse
Fuse
Fuse
FU 1
FU 2
FU 3
Motor
3
2
1
L1
L2
L3
T1
T2
T3
Contactor

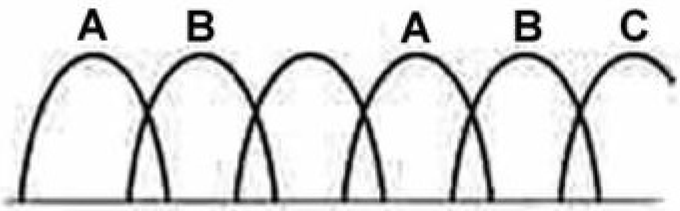
EL-0063



A

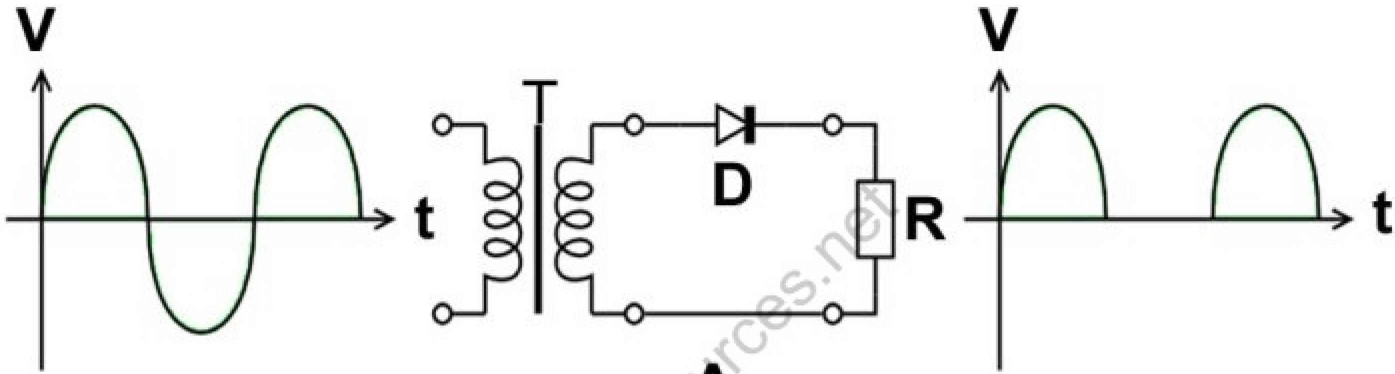


B

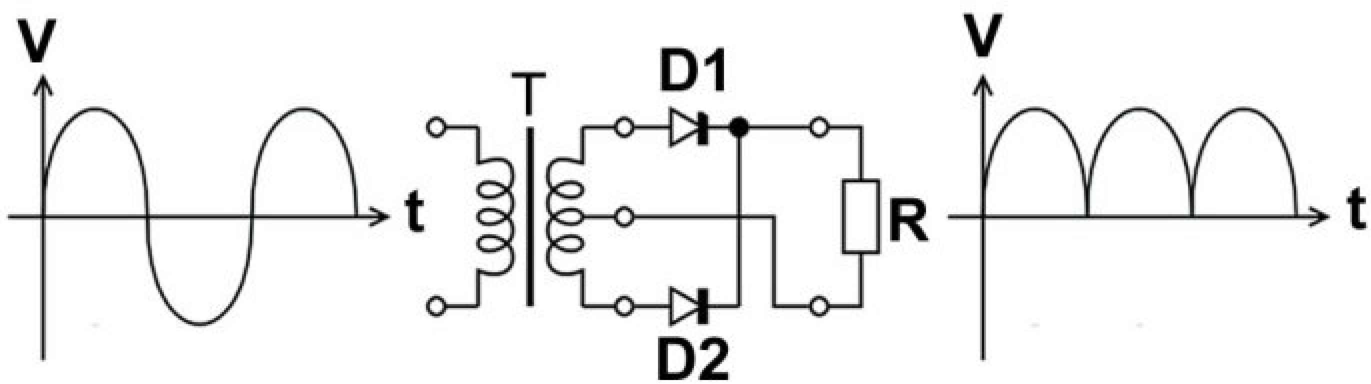


C

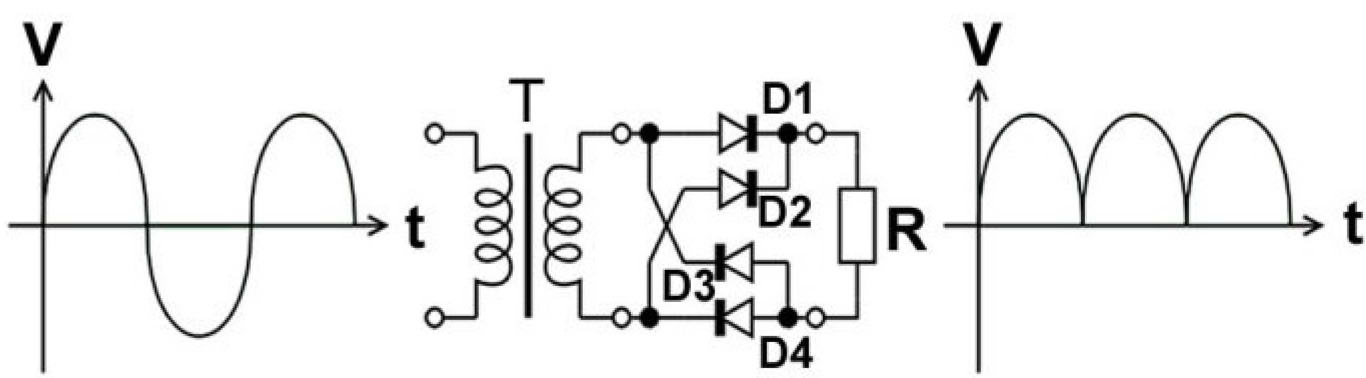
EL-0064



A

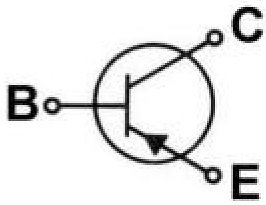


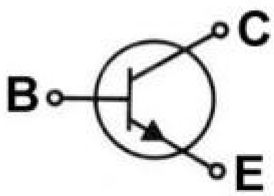
B

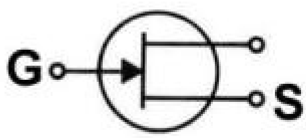


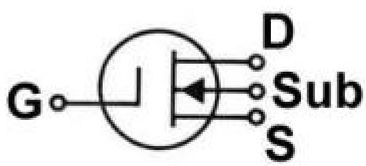
C

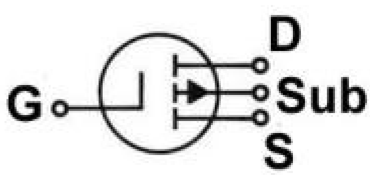
EL-0065

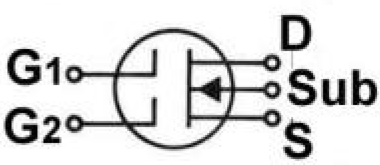
1


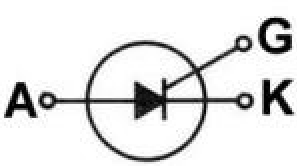
2


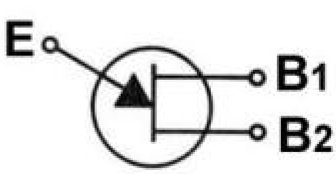
3


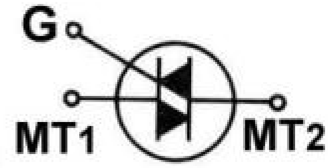
4


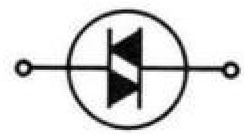
5


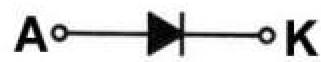
6


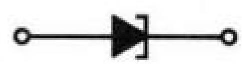
7


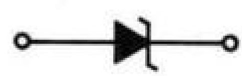
8


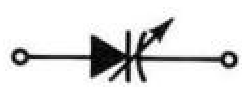
9


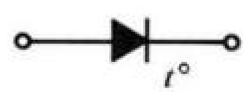
10


11


12


13


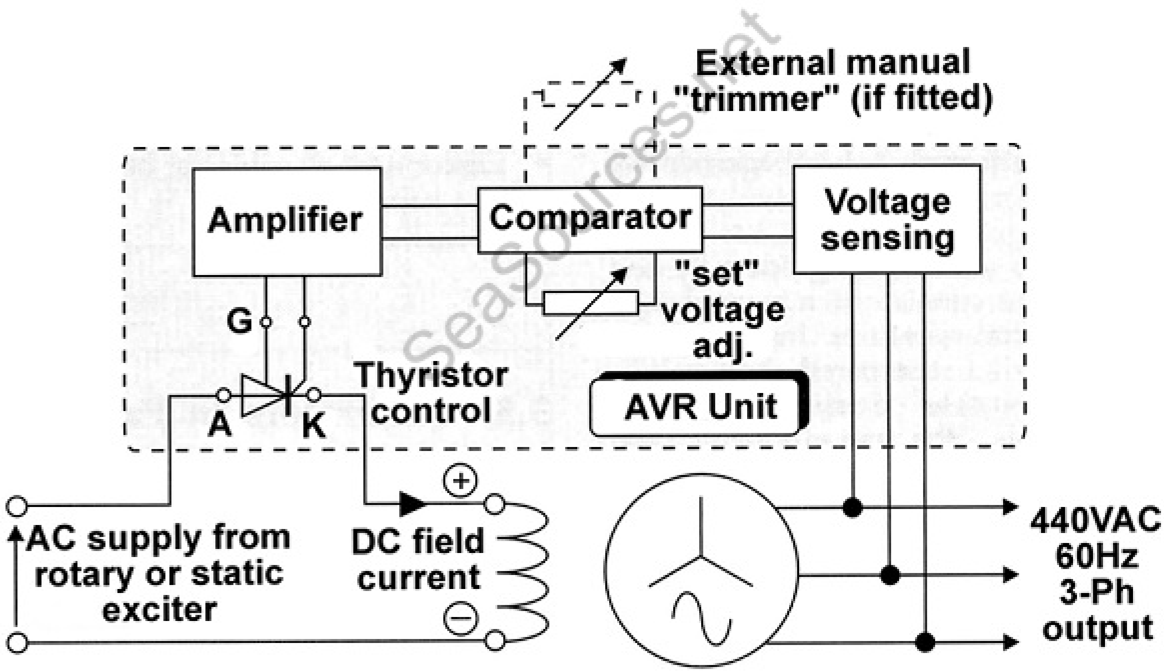
14


15


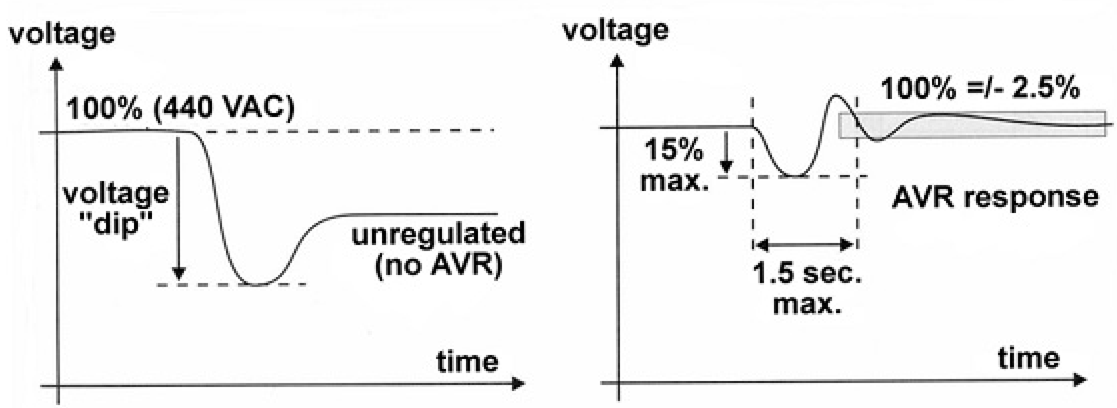
16


17


EL-0066

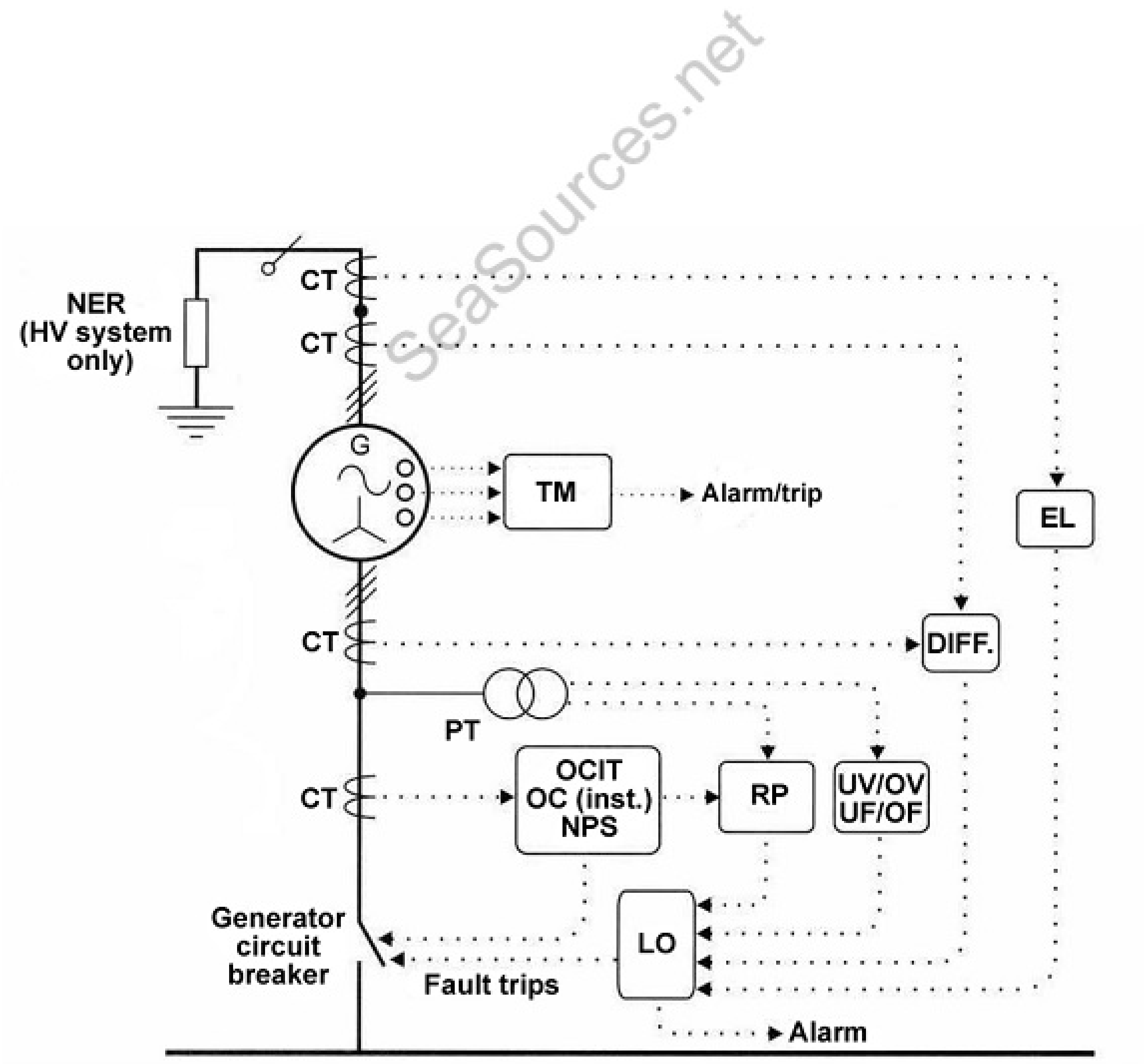

External manual
"trimmer" (if fitted)
Amplifier
Comparator
Voltage
sensing
"set"
voltage
adj.
G
A
K
Thyristor
control
AVR Unit
AC supply from
rotary or static
exciter
DC field
current
440VAC
60Hz
3-Ph
output

A


voltage
100% (440 VAC)
voltage
"dip"
unregulated
(no AVR)
time
voltage
100% =/- 2.5%
15%
max.
AVR response
1.5 sec.
max.
time

B

EL-0067



NER
(HV system
only)
CT
CT
G
TM
Alarm/trip
EL
CT
DIFF.
PT
CT
OCIT
OC (inst.)
NPS
RP
UV/OV
UF/OF
Generator
circuit
breaker
LO
Fault trips
Alarm
SeaSources.net

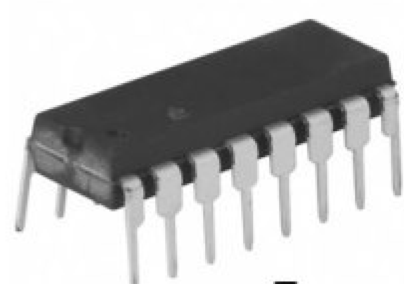
EL-0068

1

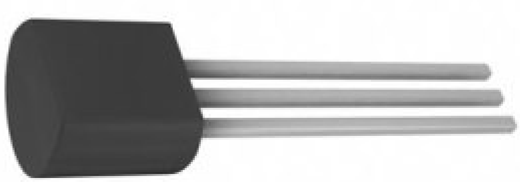
2

3

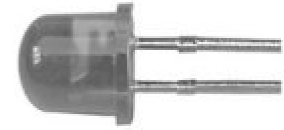
4



5

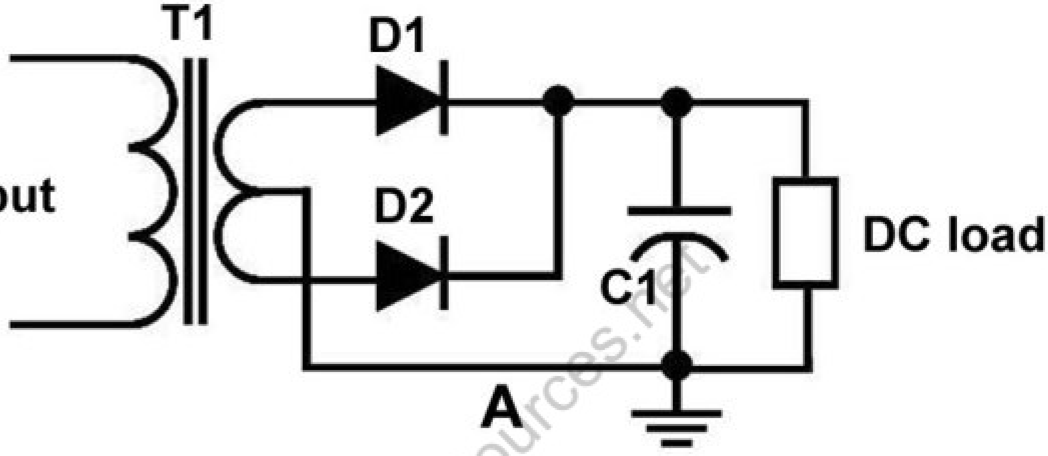


6



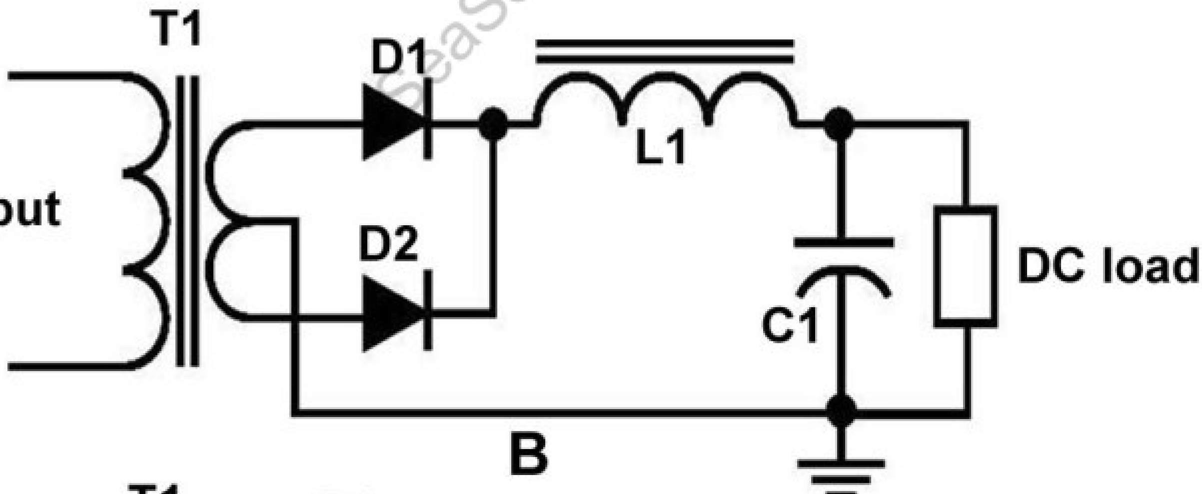
7

EL-0069



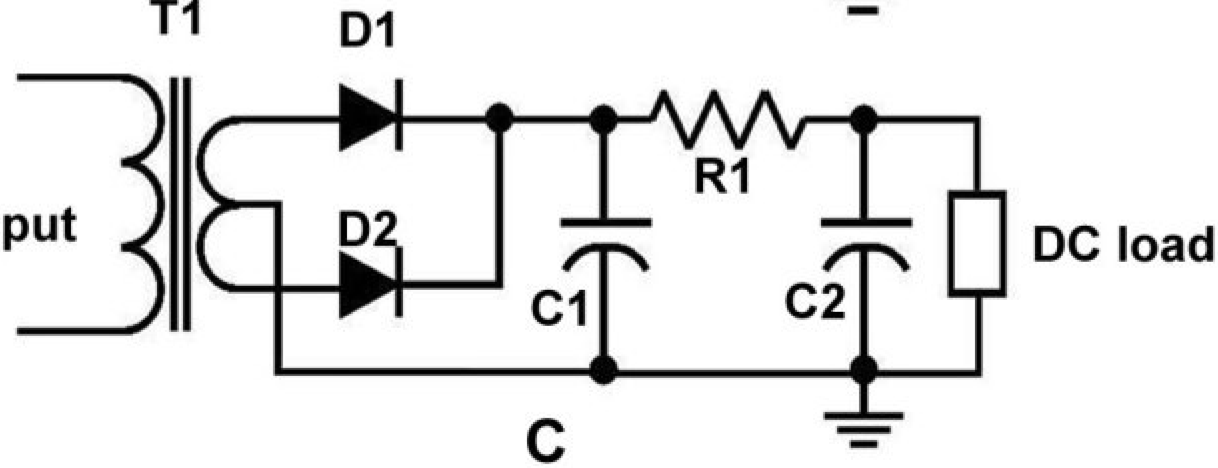
T1
D1
D2
AC input
C1
DC load

A



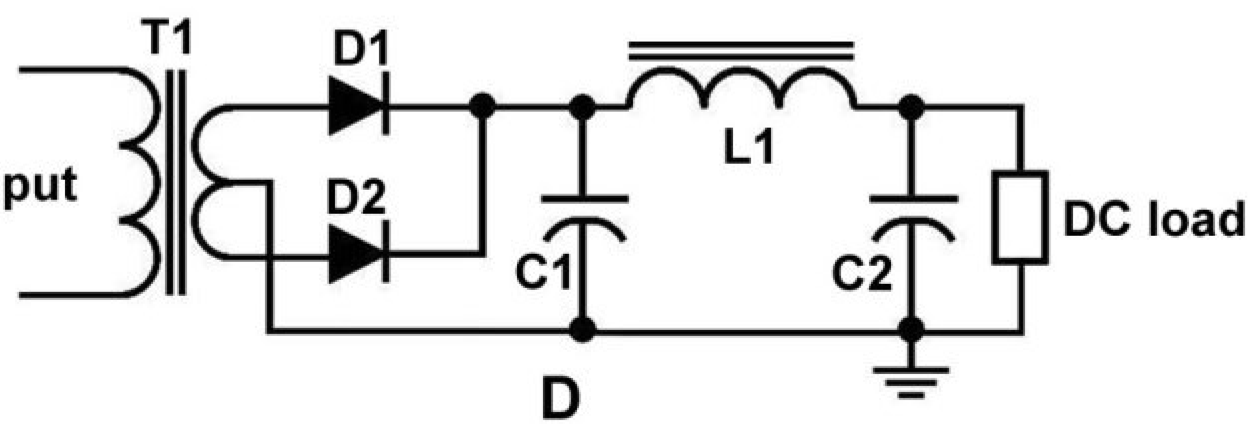
T1
D1
D2
L1
AC input
C1
DC load

B



T1
D1
D2
R1
AC input
C1
C2
DC load

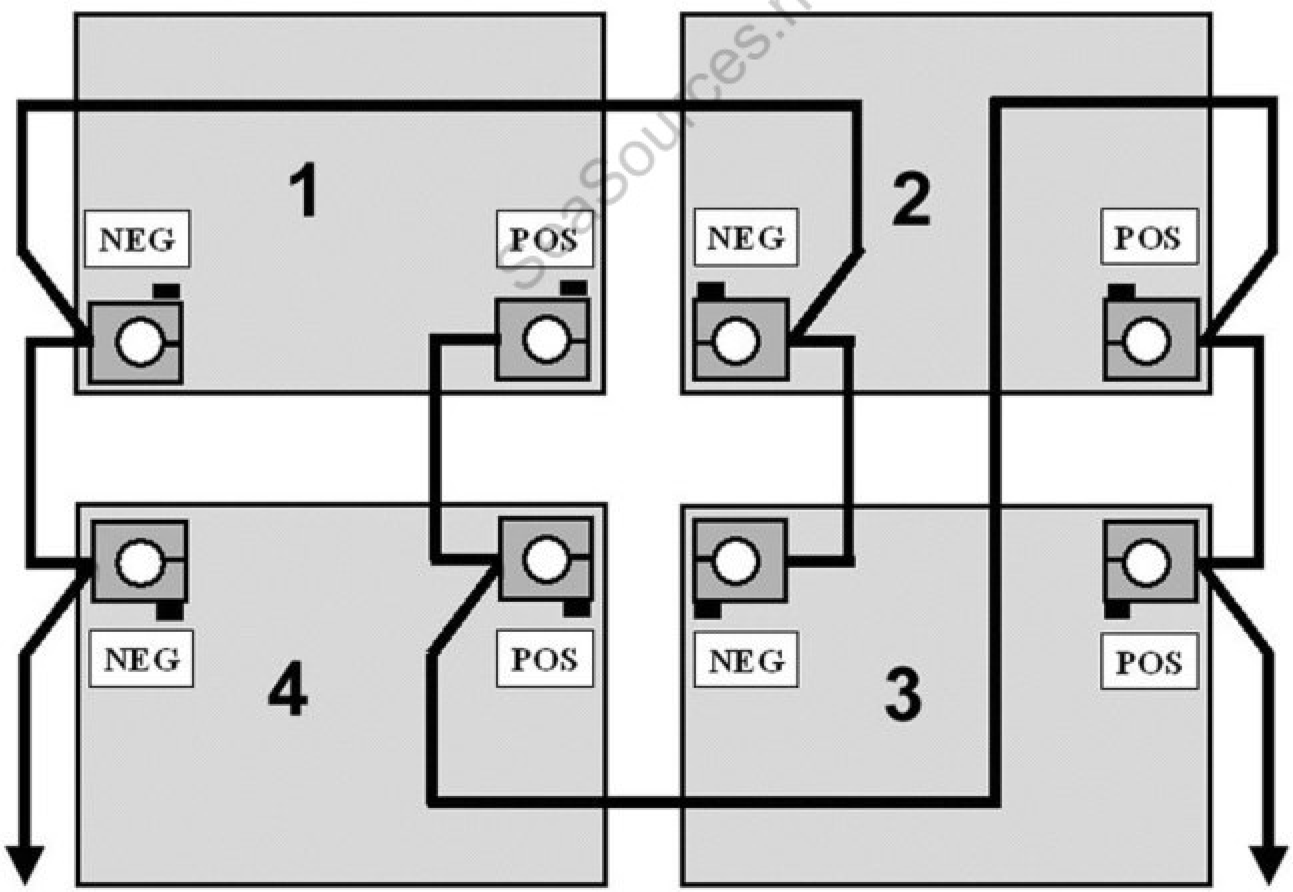
C



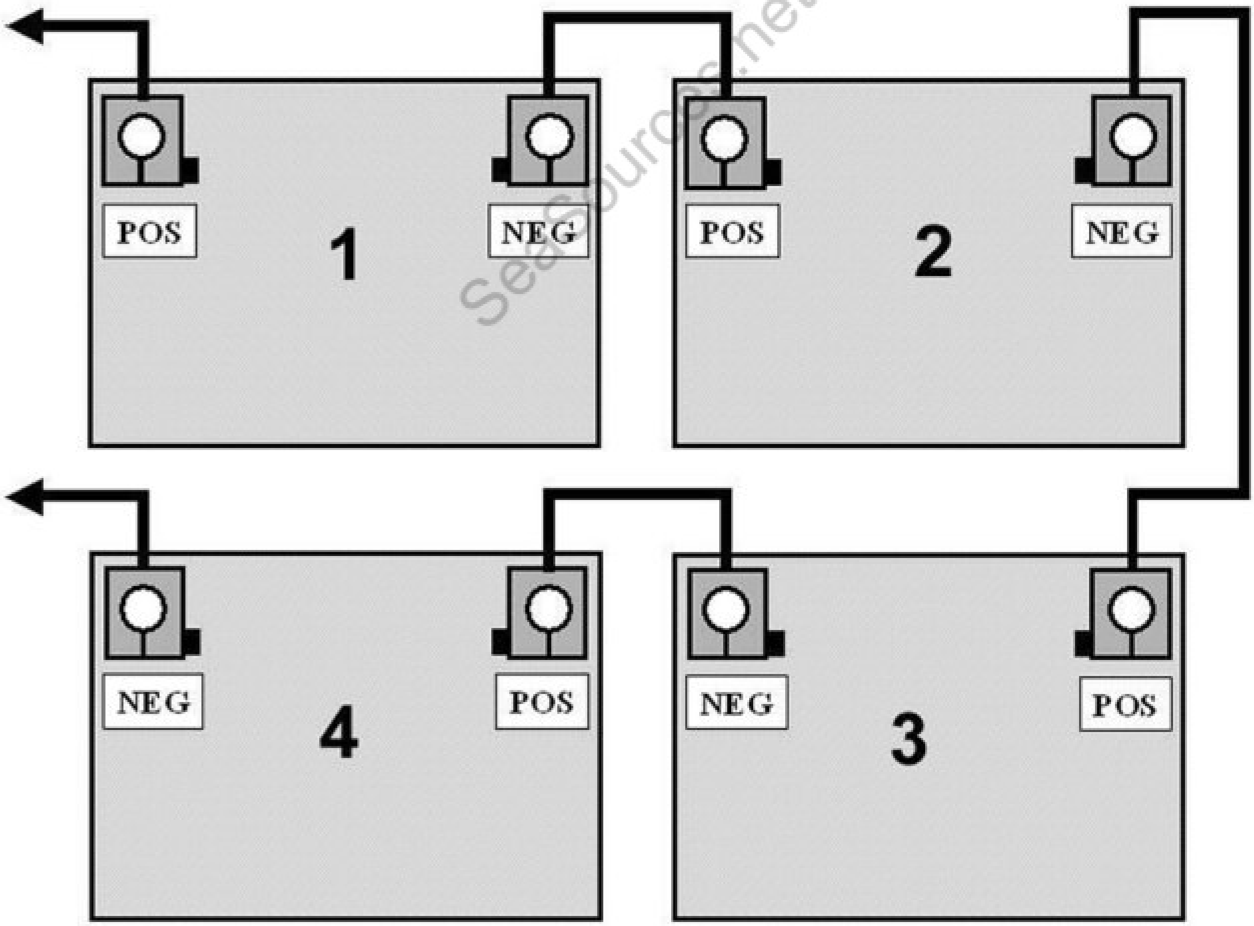
T1
D1
D2
L1
AC input
C1
C2
DC load

D

EL-0070



EL-0071



EL-0072

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

A

A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

B

A	B	Output
0	0	1
0	1	1
1	0	1
1	1	0

C

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

D

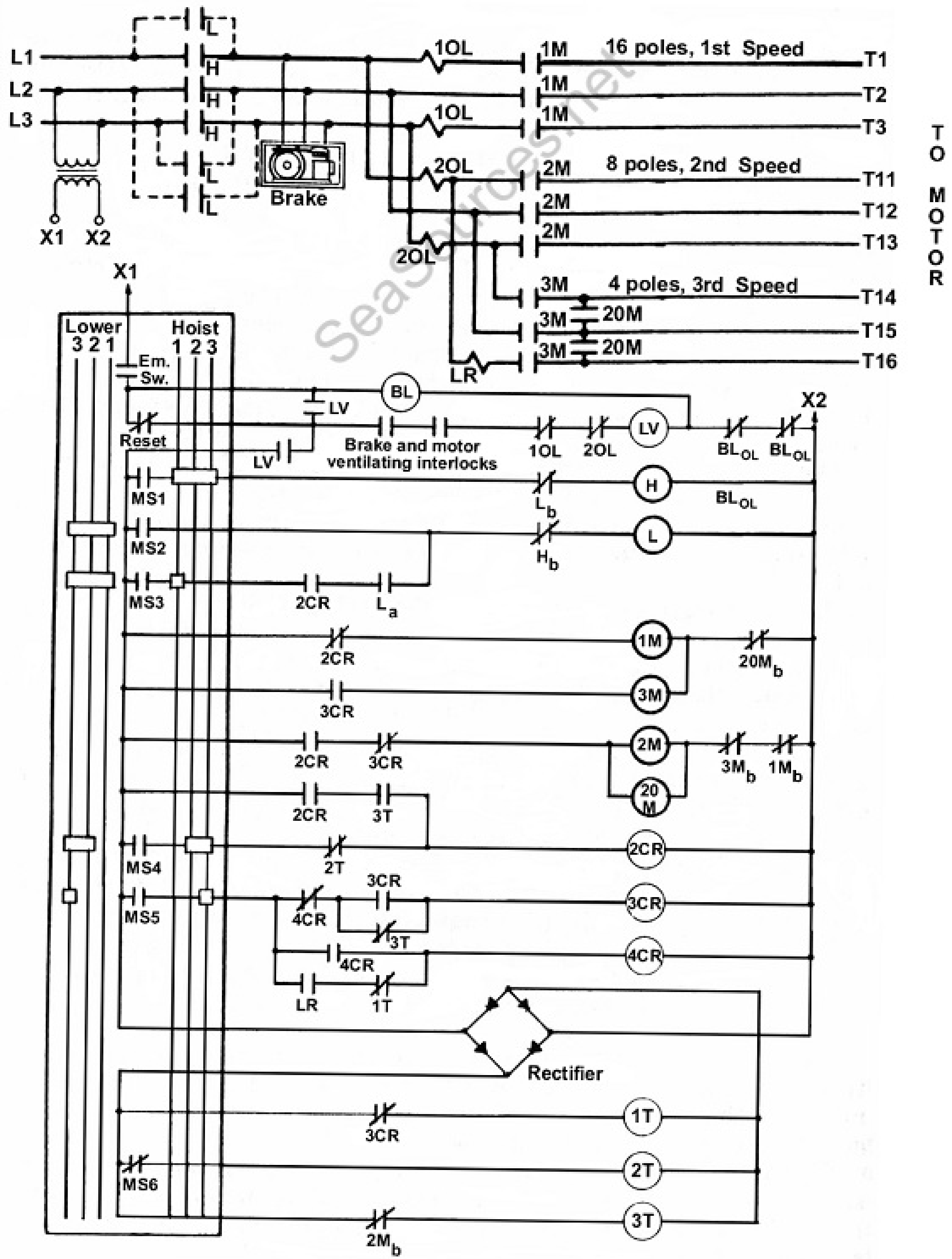
A	B	Output
0	0	0
0	1	1
1	0	1
1	1	0

E

A	B	Output
0	0	1
0	1	0
1	0	0
1	1	1

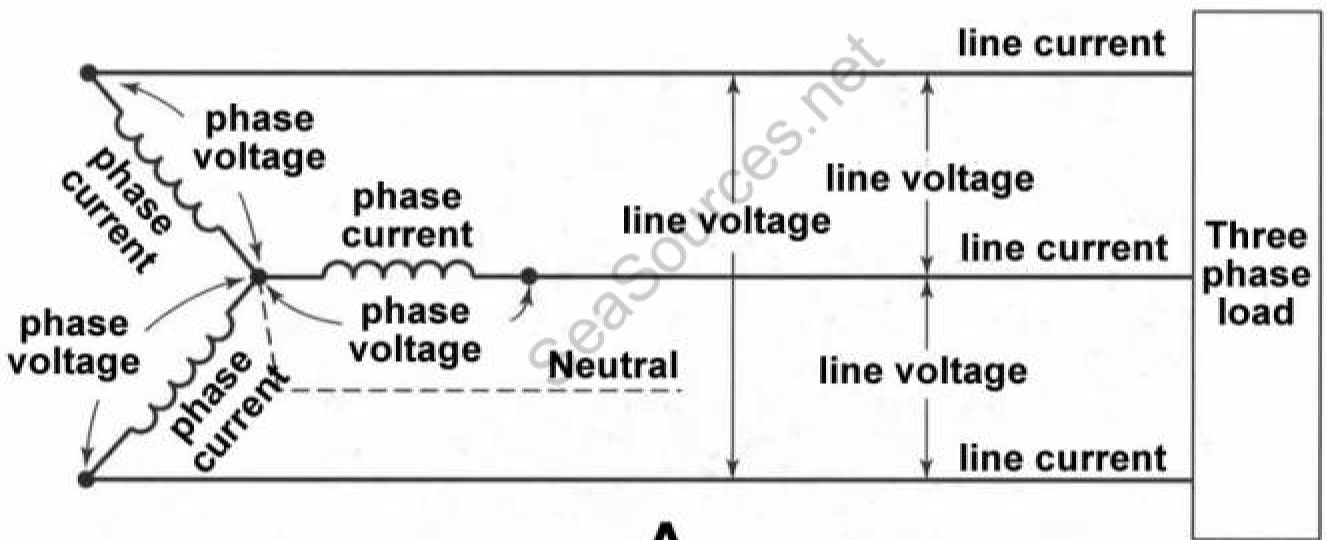
F

EL-0073



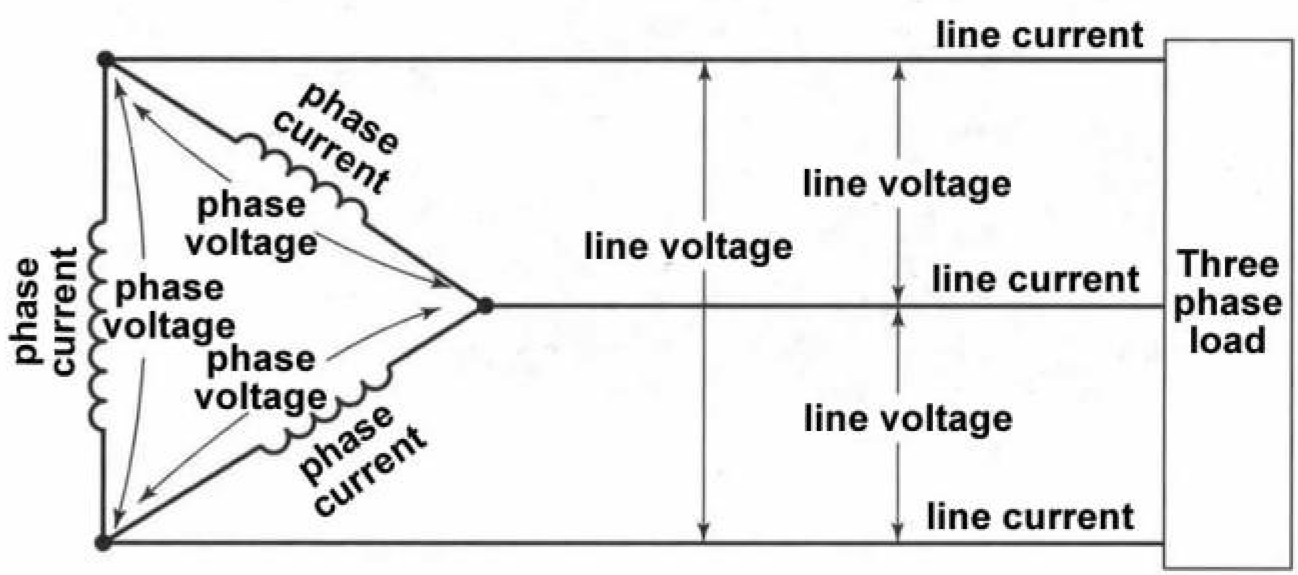
L1
L2
L3
X1
X2
L
H
H
H
L
L
Brake
1OL
1OL
2OL
2OL
LR
1M
1M
1M
16 poles, 1st Speed
2M
2M
2M
8 poles, 2nd Speed
3M
3M
3M
4 poles, 3rd Speed
20M
20M
T1
T2
T3
T11
T12
T13
T14
T15
T16
TO MOTOR
X1
Lower
3 2 1
Hoist
1 2 3
Em. Sw.
BL
LV
Reset
LV
Brake and motor ventilating interlocks
1OL
2OL
LV
X2
BL_{OL}
BL_{OL}
MS1
L_b
H
BL_{OL}
MS2
H_b
L
MS3
2CR
L_a
2CR
1M
$20M_b$
3CR
3M
2CR
3CR
2M
$3M_b$
$1M_b$
20 M
2CR
3T
MS4
2T
2CR
MS5
4CR
3CR
3T
3CR
4CR
4CR
LR
1T
Rectifier
3CR
1T
MS6
2T
$2M_b$
3T

EL-0074



line current
phase voltage
phase current
phase current
line voltage
line voltage
line current
Three phase load
phase voltage
phase voltage
phase current
Neutral
line voltage
line current

A

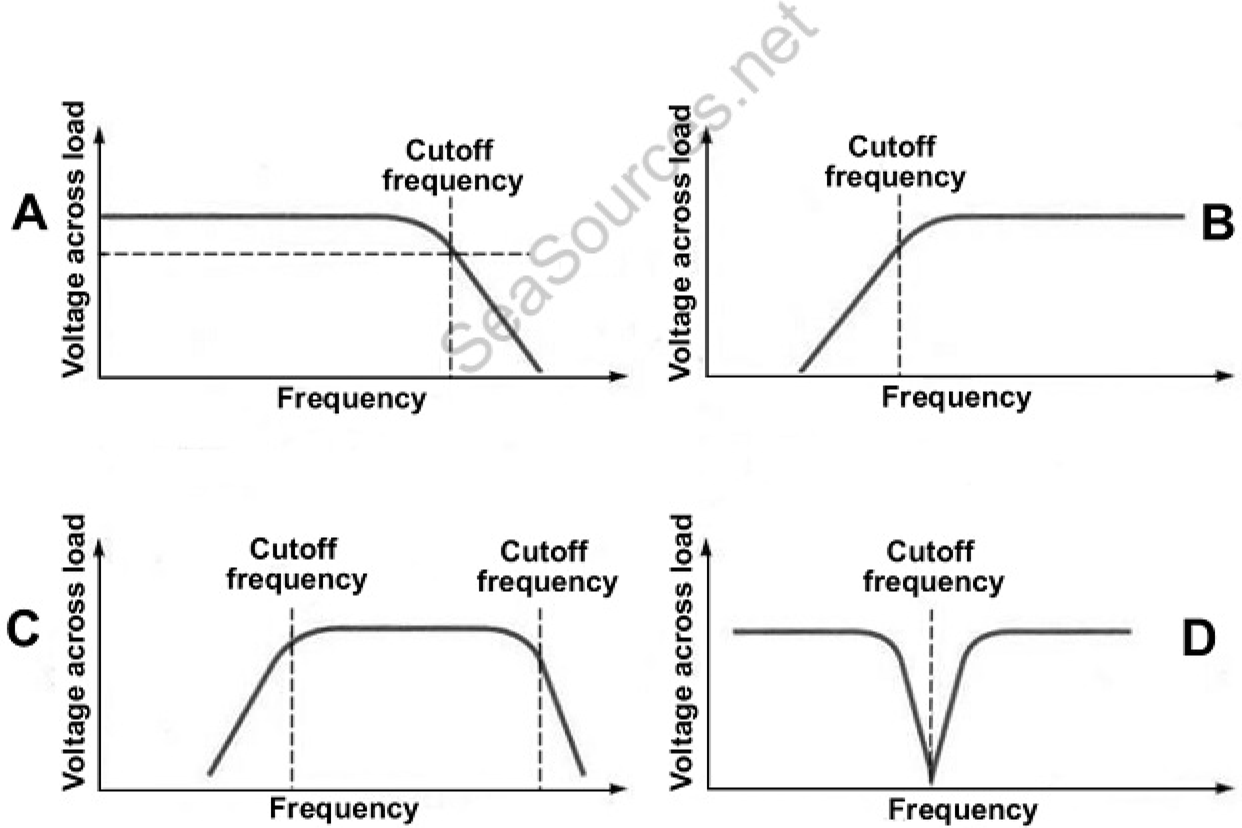


line current
phase current
line voltage
phase voltage
line voltage
line current
Three phase load
phase current
phase voltage
phase voltage
line voltage
phase current
line current

B

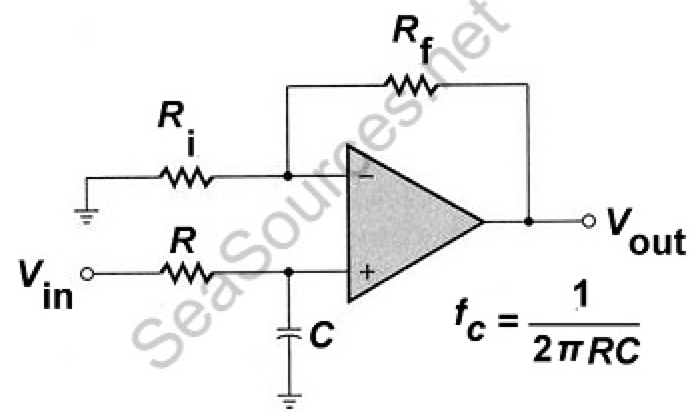
El-0075: The new Illustration associated with this question has not yet been made available to the public from the National Maritime Center even though they are already using them in the exam room. We hope to have them posted soon.

EL-0076

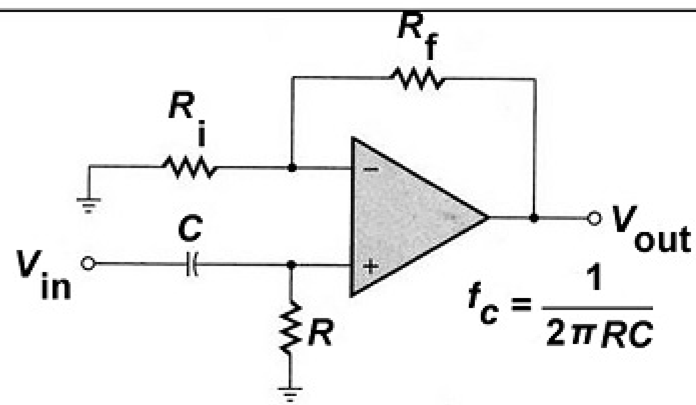

A
Cutoff frequency
Voltage across load
Frequency
B
Cutoff frequency
Voltage across load
Frequency
C
Cutoff frequency
Cutoff frequency
Voltage across load
Frequency
D
Cutoff frequency
Voltage across load
Frequency
SeaSources.net

EL-0077

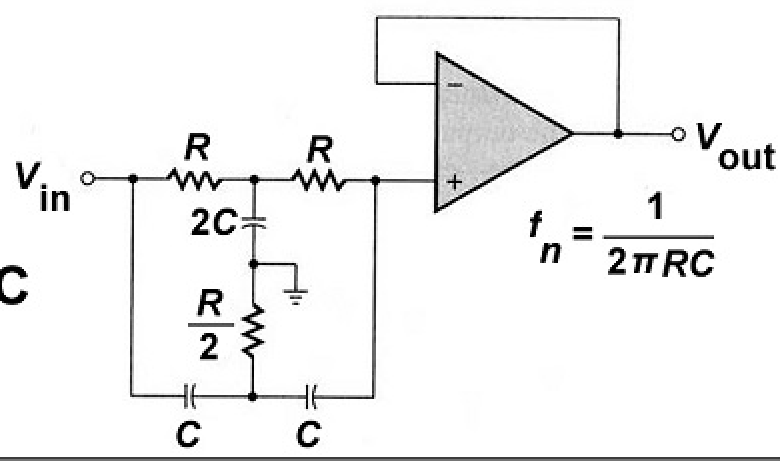
A


R_f
R_i
R
V_{in}
V_{out}
C
$f_c = \frac{1}{2\pi RC}$

B

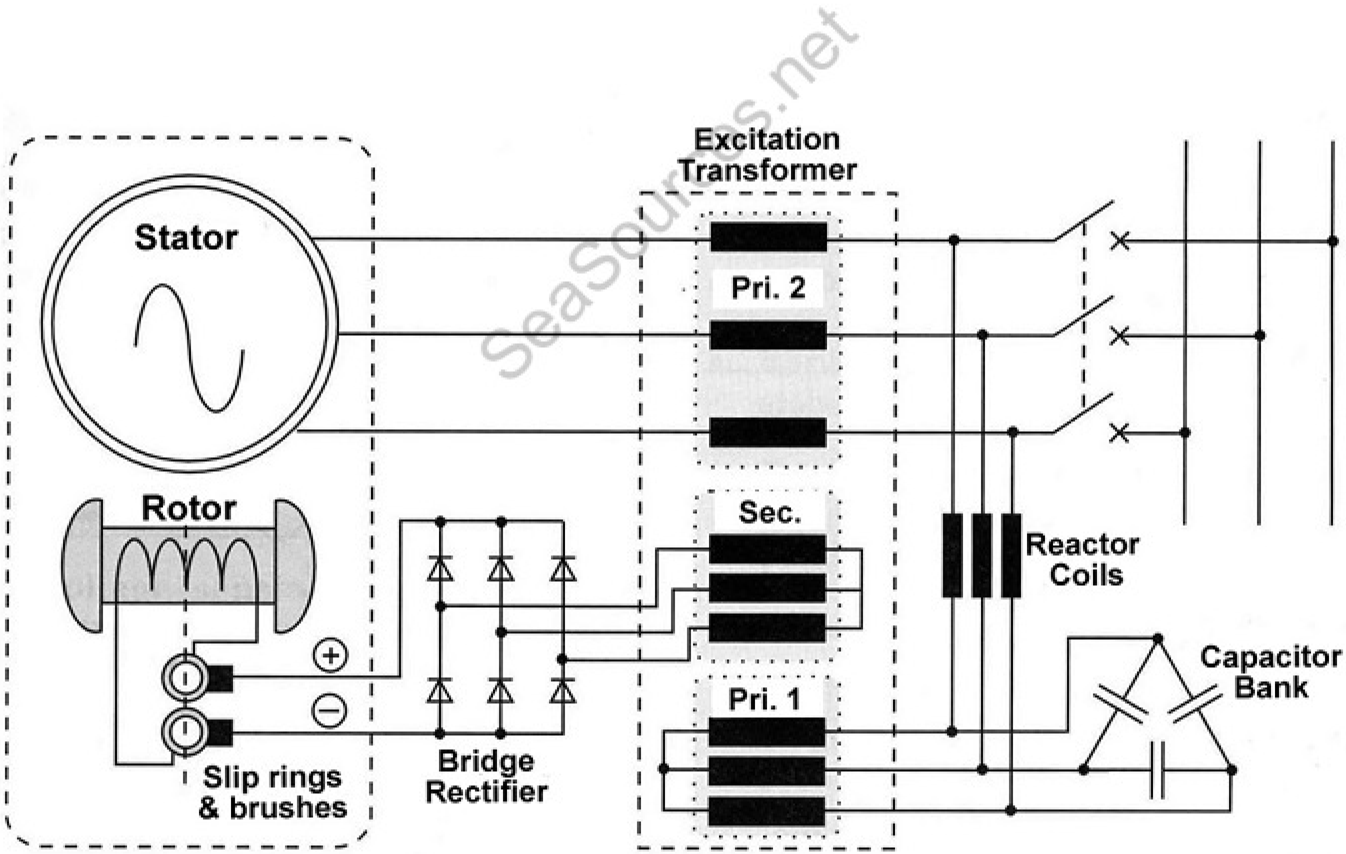

R_f
R_i
C
V_{in}
V_{out}
R
$f_c = \frac{1}{2\pi RC}$

C


V_{in}
R
R
$2C$
$\frac{R}{2}$
C
C
V_{out}
$f_n = \frac{1}{2\pi RC}$

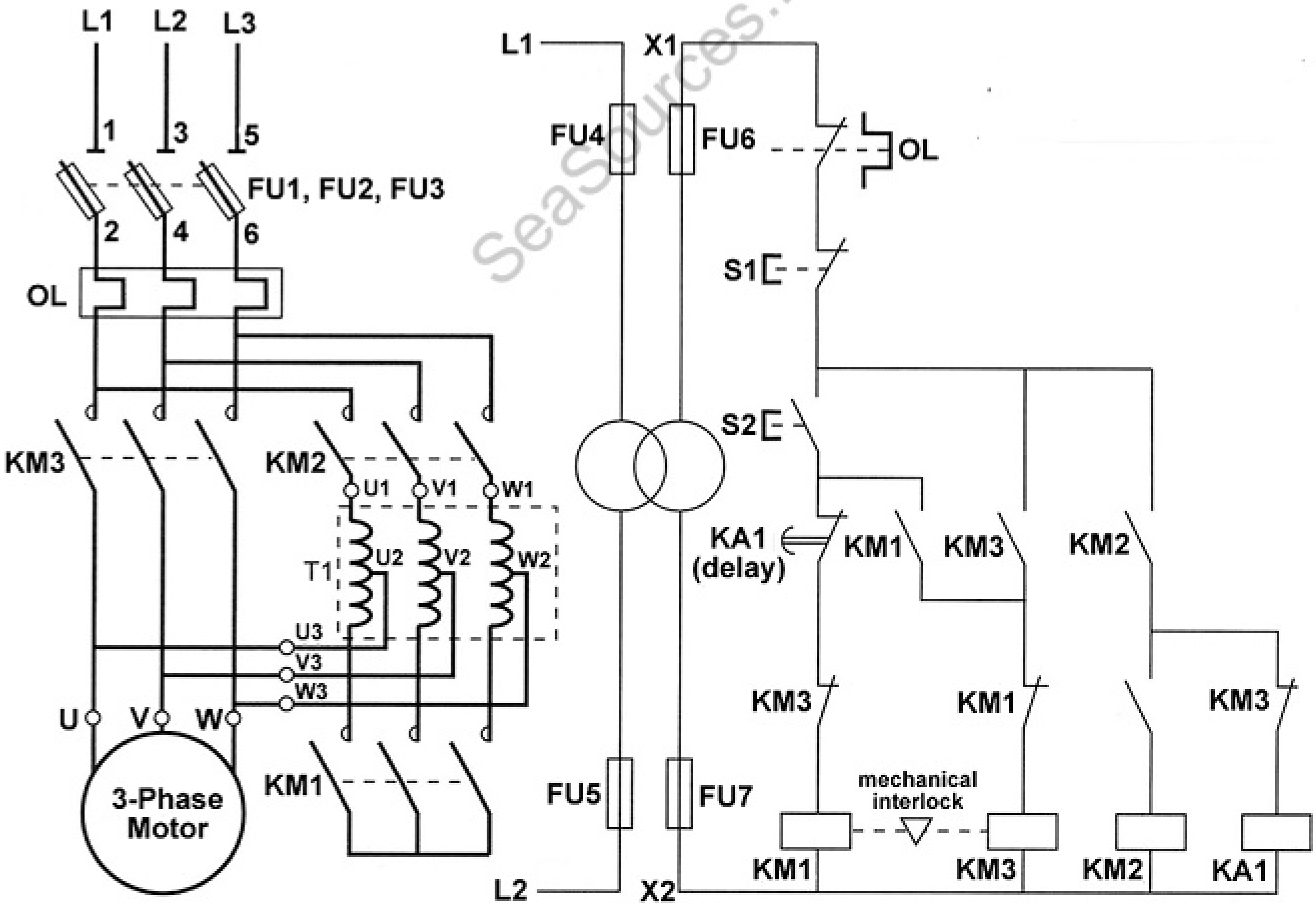
El-0078: The new Illustration associated with this question has not yet been made available to the public from the National Maritime Center even though they are already using them in the exam room. We hope to have them posted soon.

EL-0079



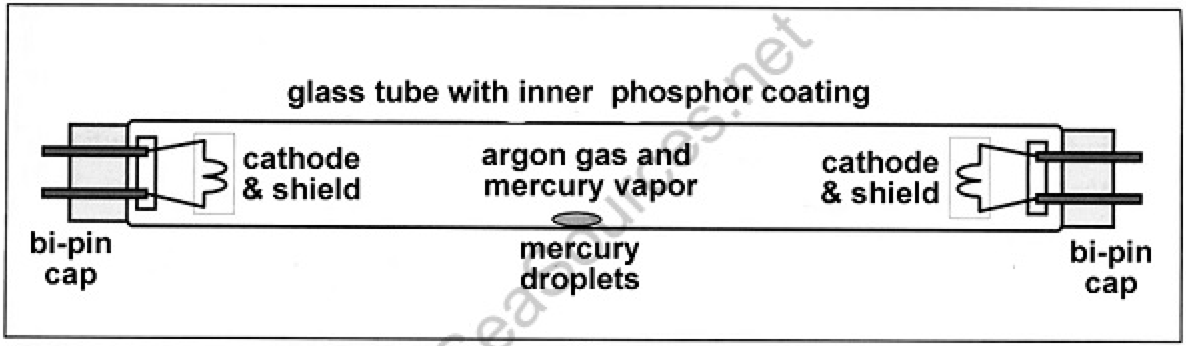
Excitation
Transformer
Stator
Pri. 2
Rotor
Sec.
Reactor
Coils
Capacitor
Bank
Pri. 1
Bridge
Rectifier
Slip rings
& brushes

EL-0080

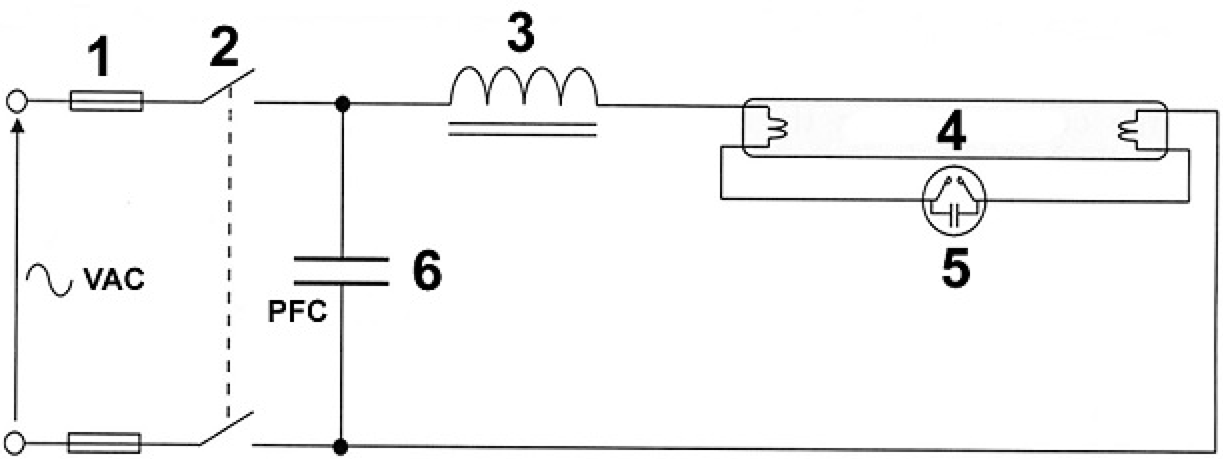


L1
L2
L3
1
3
5
FU1, FU2, FU3
2
4
6
OL
KM3
KM2
U1
V1
W1
T1
U2
V2
W2
U3
V3
W3
U
V
W
3-Phase Motor
KM1
L1
X1
FU4
FU6
OL
S1
S2
KA1 (delay)
KM1
KM3
KM2
KM3
KM1
KM3
mechanical interlock
FU5
FU7
KM1
KM3
KM2
KA1
L2
X2

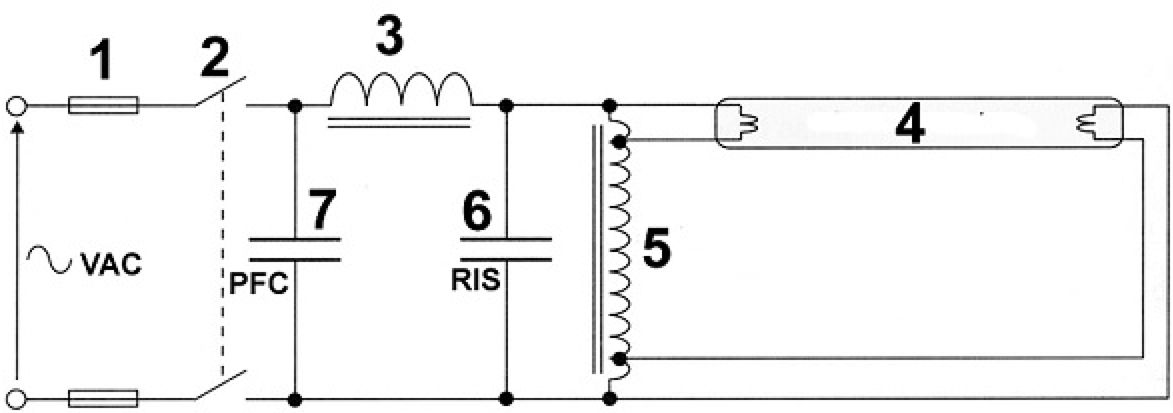
EL-0081


glass tube with inner phosphor coating
cathode & shield
argon gas and mercury vapor
cathode & shield
bi-pin cap
mercury droplets
bi-pin cap

A

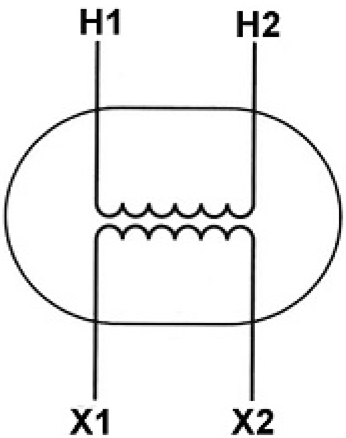

1
2
3
4
5
6
VAC
PFC

B

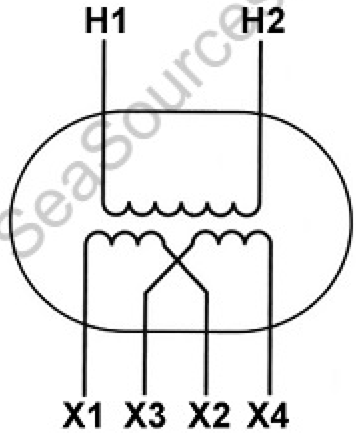

1
2
3
4
5
6
7
VAC
PFC
RIS

C

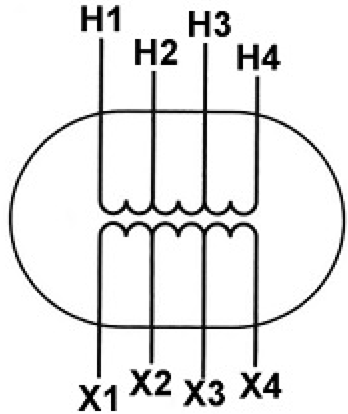
EL-0082



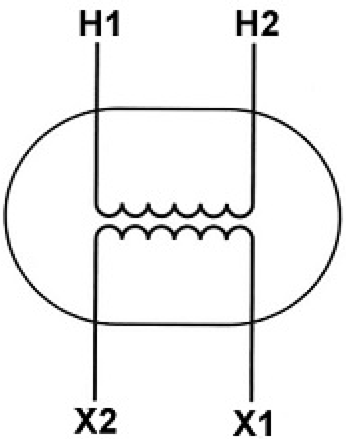
A



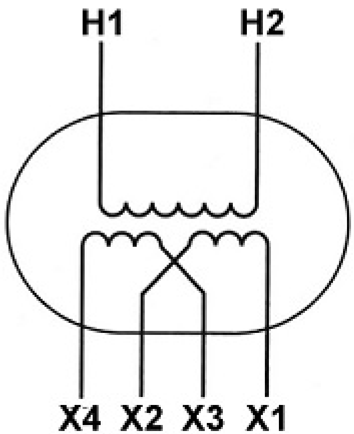
B



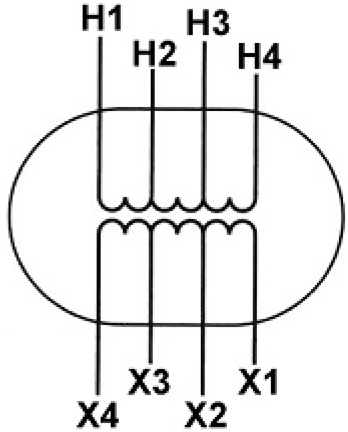
C



D

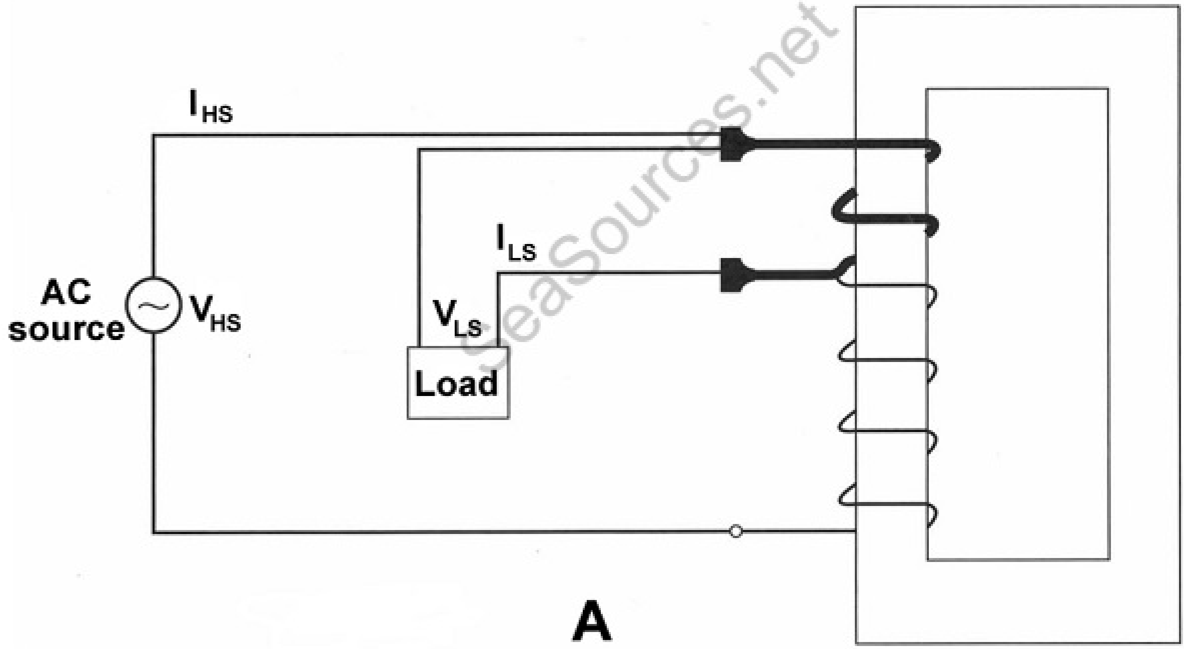


E

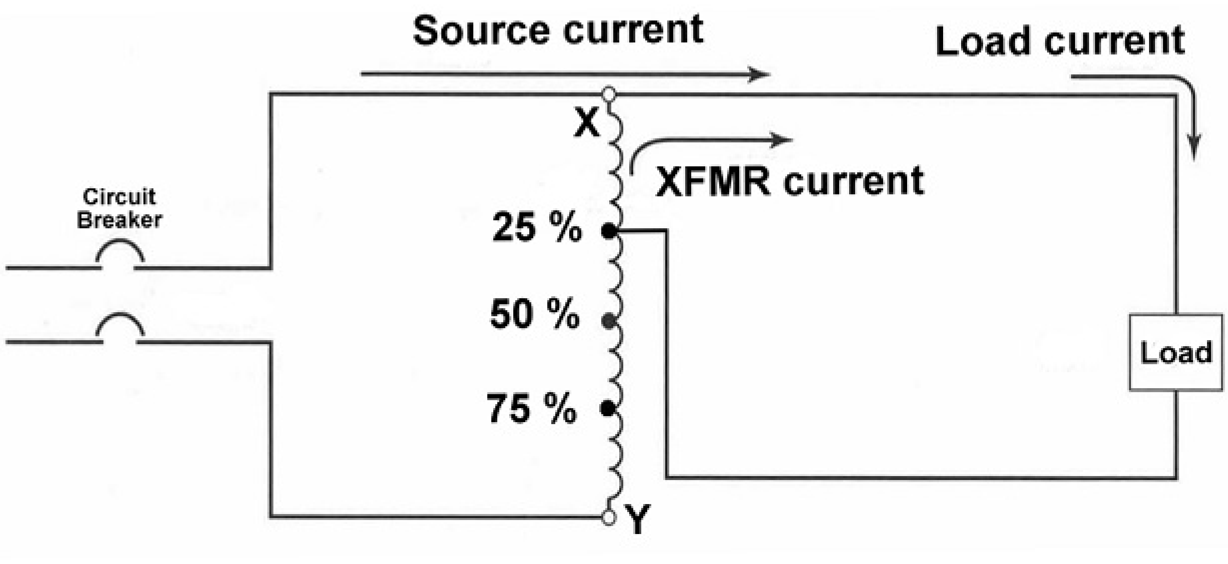


F

EL-0083

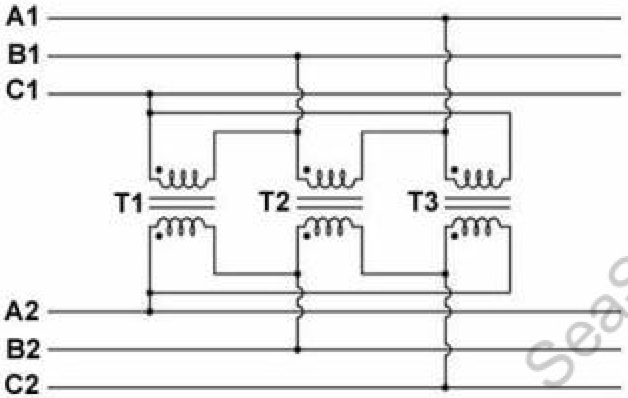

I_{HS}
AC source
V_{HS}
I_{LS}
V_{LS}
Load

A

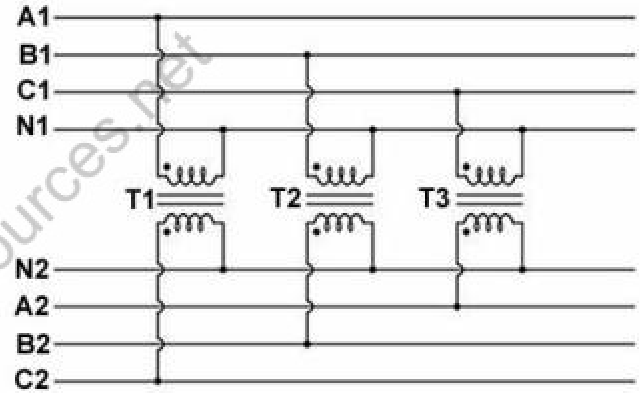

Source current
Load current
X
XFMR current
Circuit Breaker
25 %
50 %
75 %
Y
Load

B

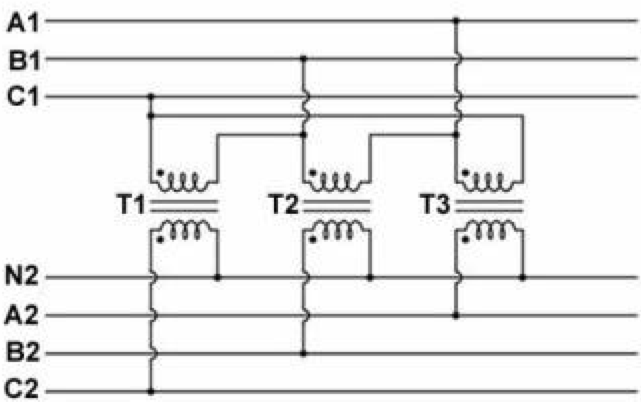
EL-0084



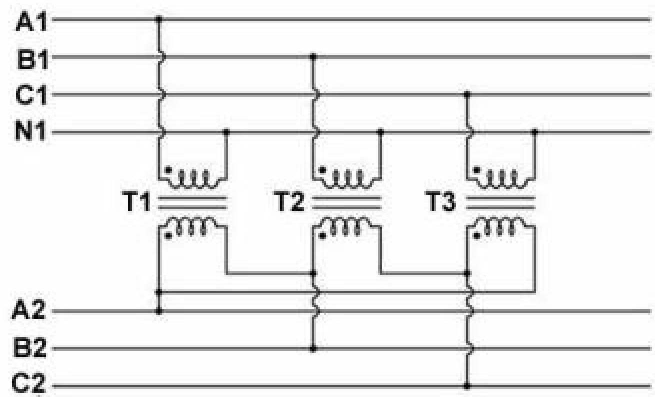
1



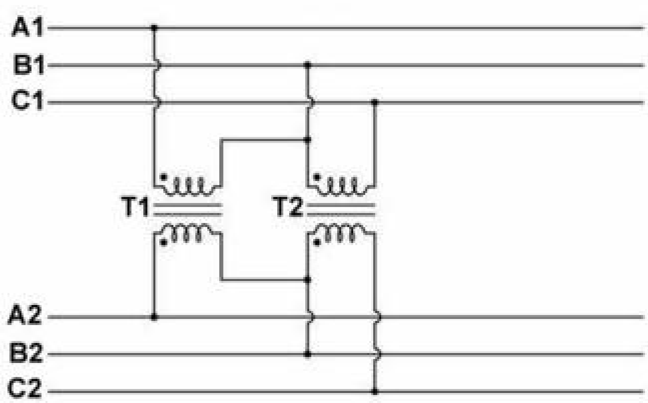
2



3

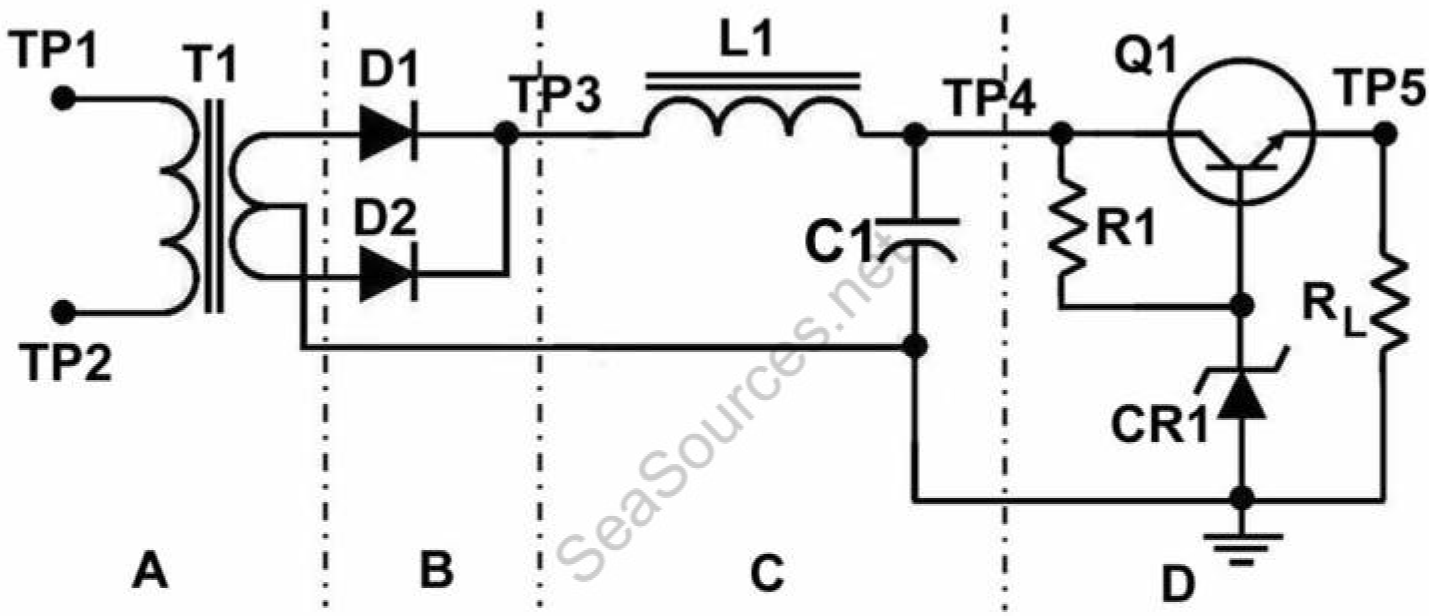


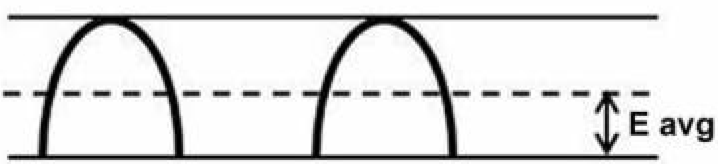
4



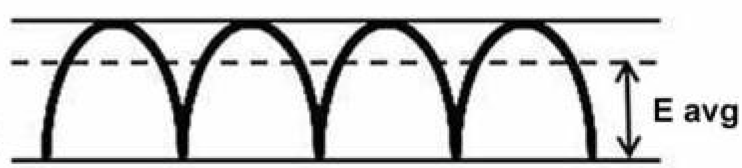
5

EL-0085





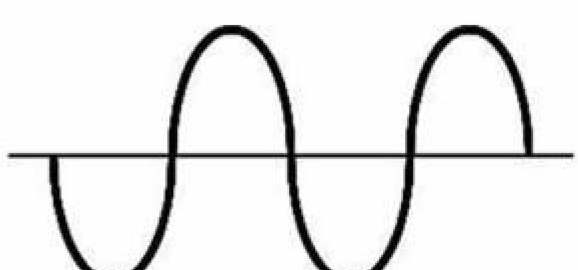
E



F

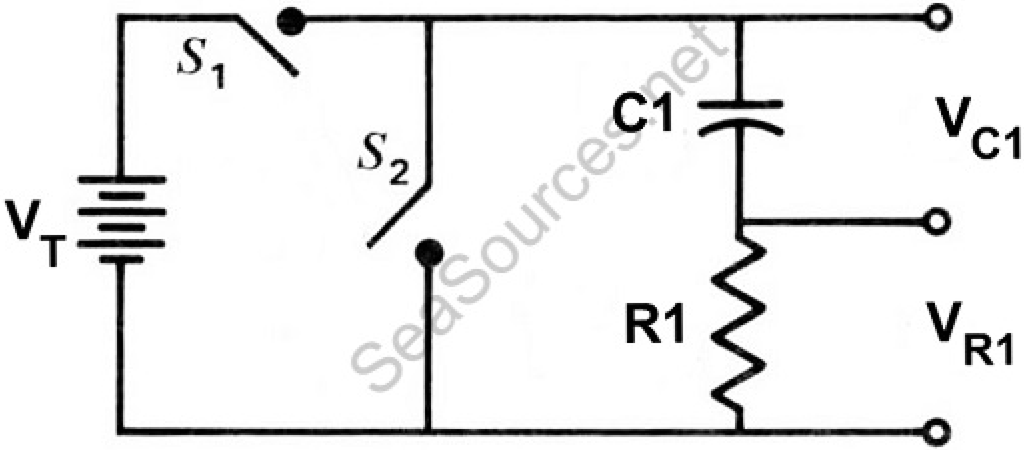
G

H



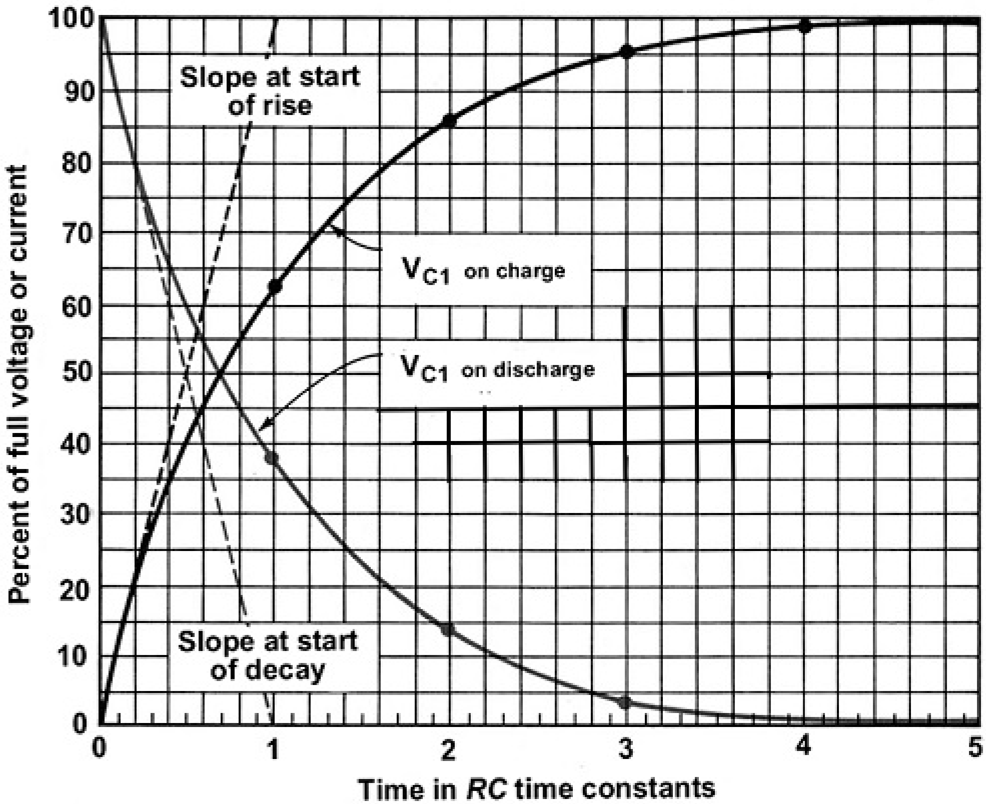
I

EL-0086



S1
S2
C1
VT
R1
VC1
VR1

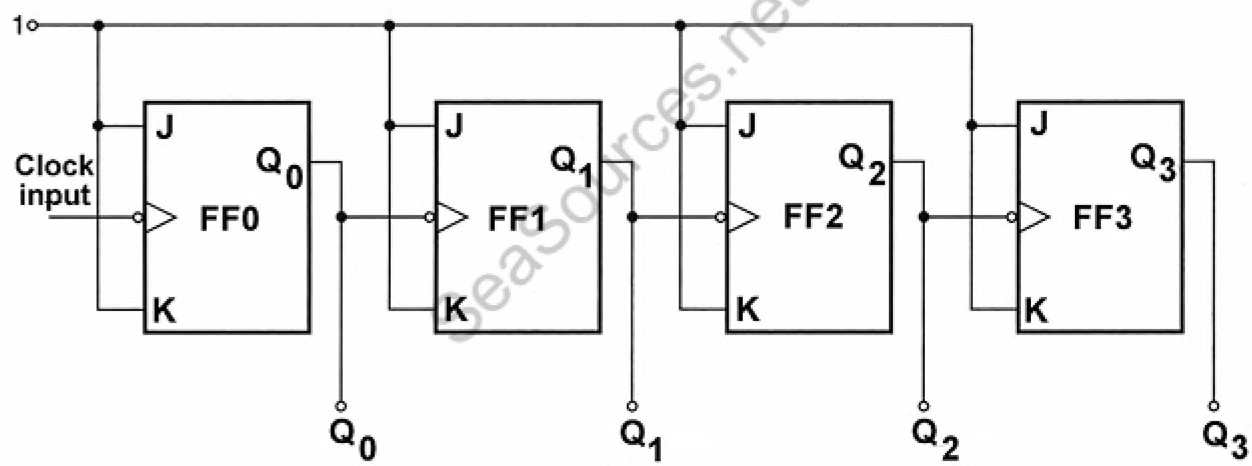
A



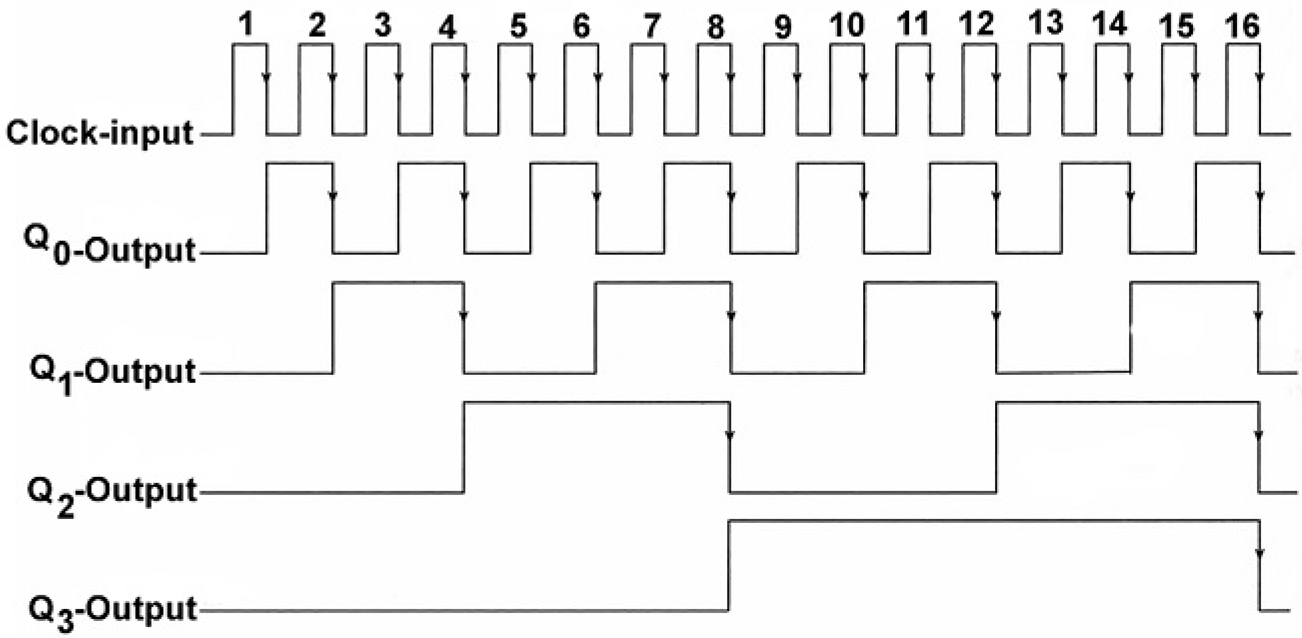
Slope at start of rise
VC1 on charge
VC1 on discharge
Slope at start of decay
Percent of full voltage or current
Time in RC time constants
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5

B

EL-0087

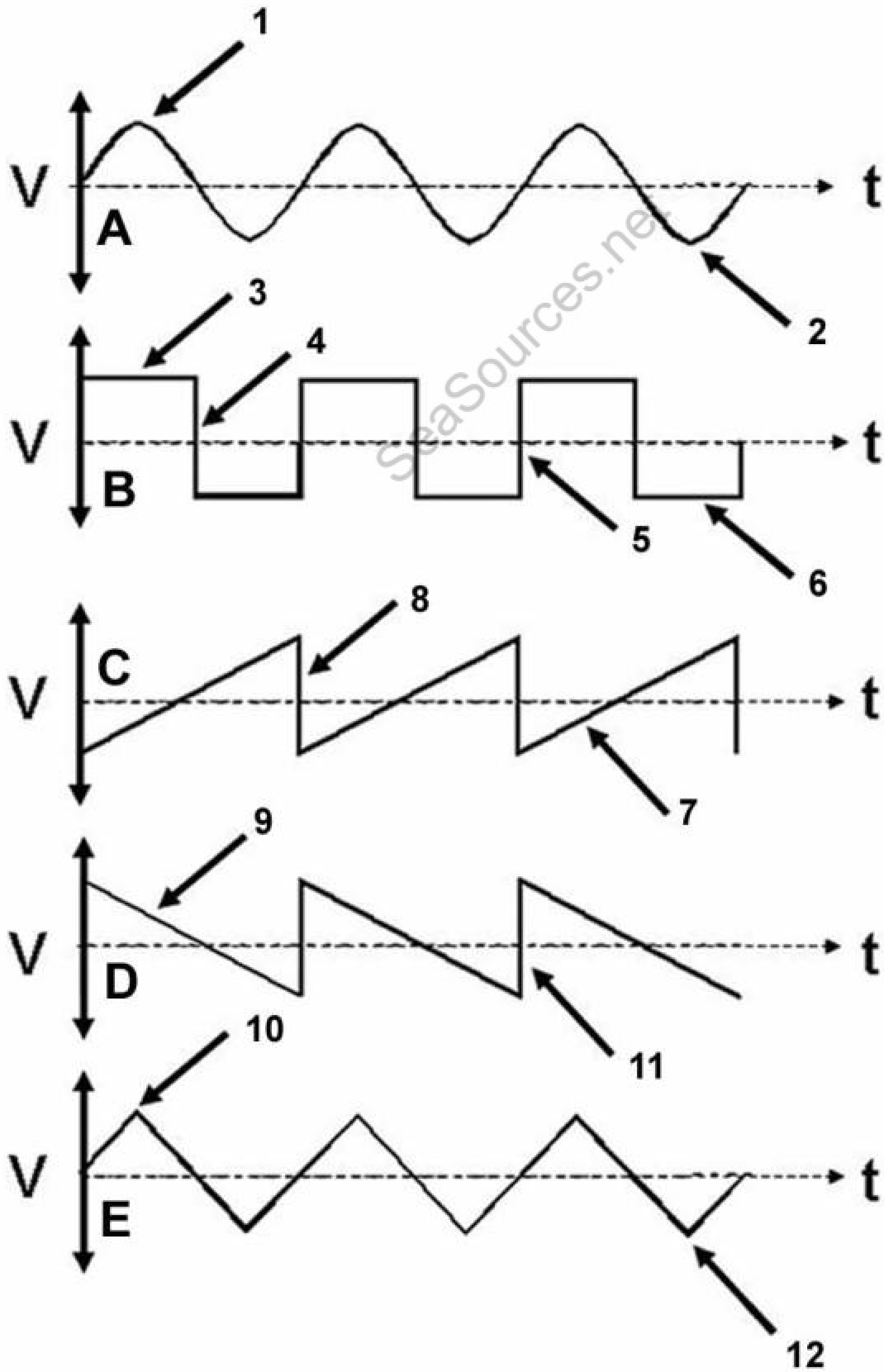

1
Clock
input
J
K
FF0
Q0
FF1
Q1
FF2
Q2
FF3
Q3
Q0
Q1
Q2
Q3

A

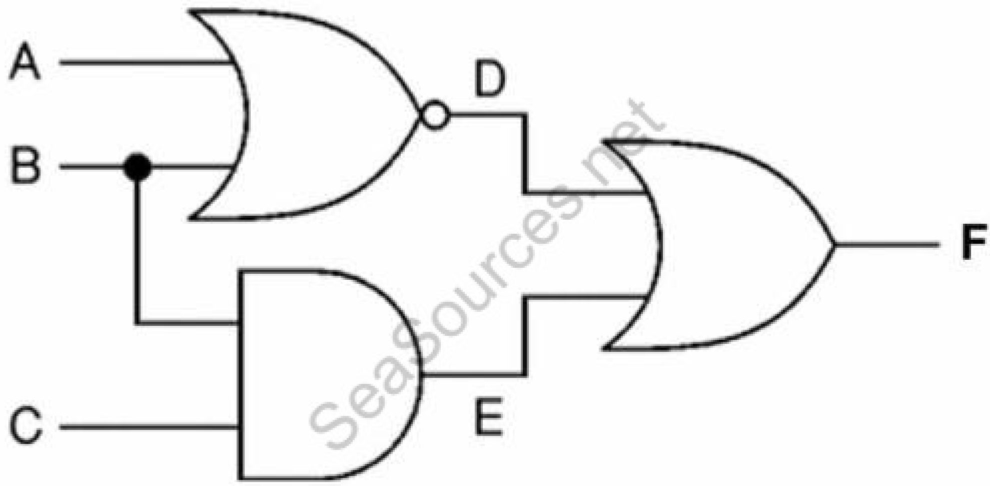

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Clock-input
Q0-Output
Q1-Output
Q2-Output
Q3-Output

B

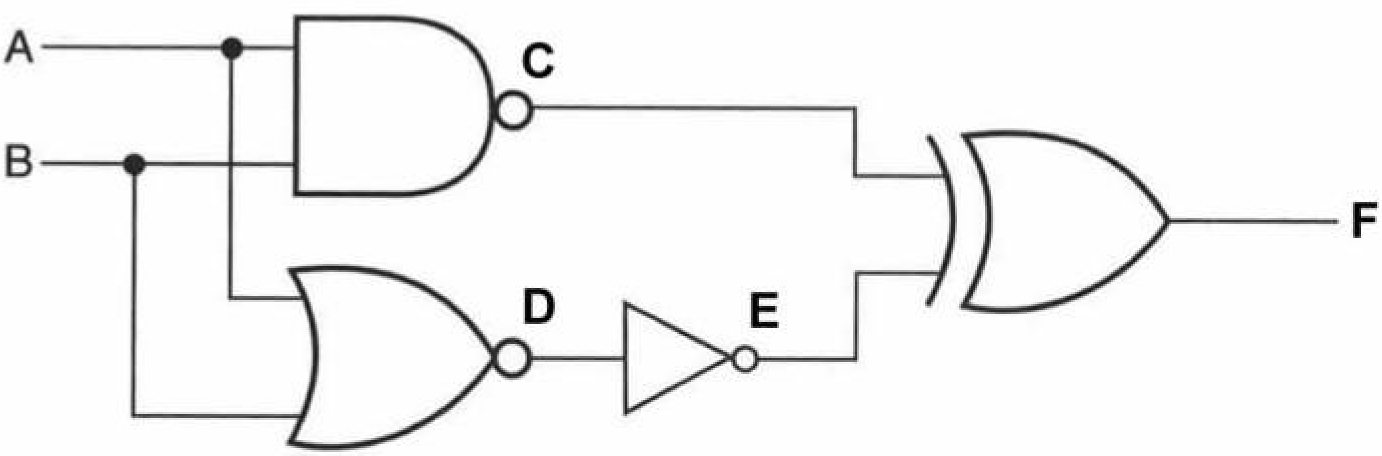
EL-0088



EL-0089

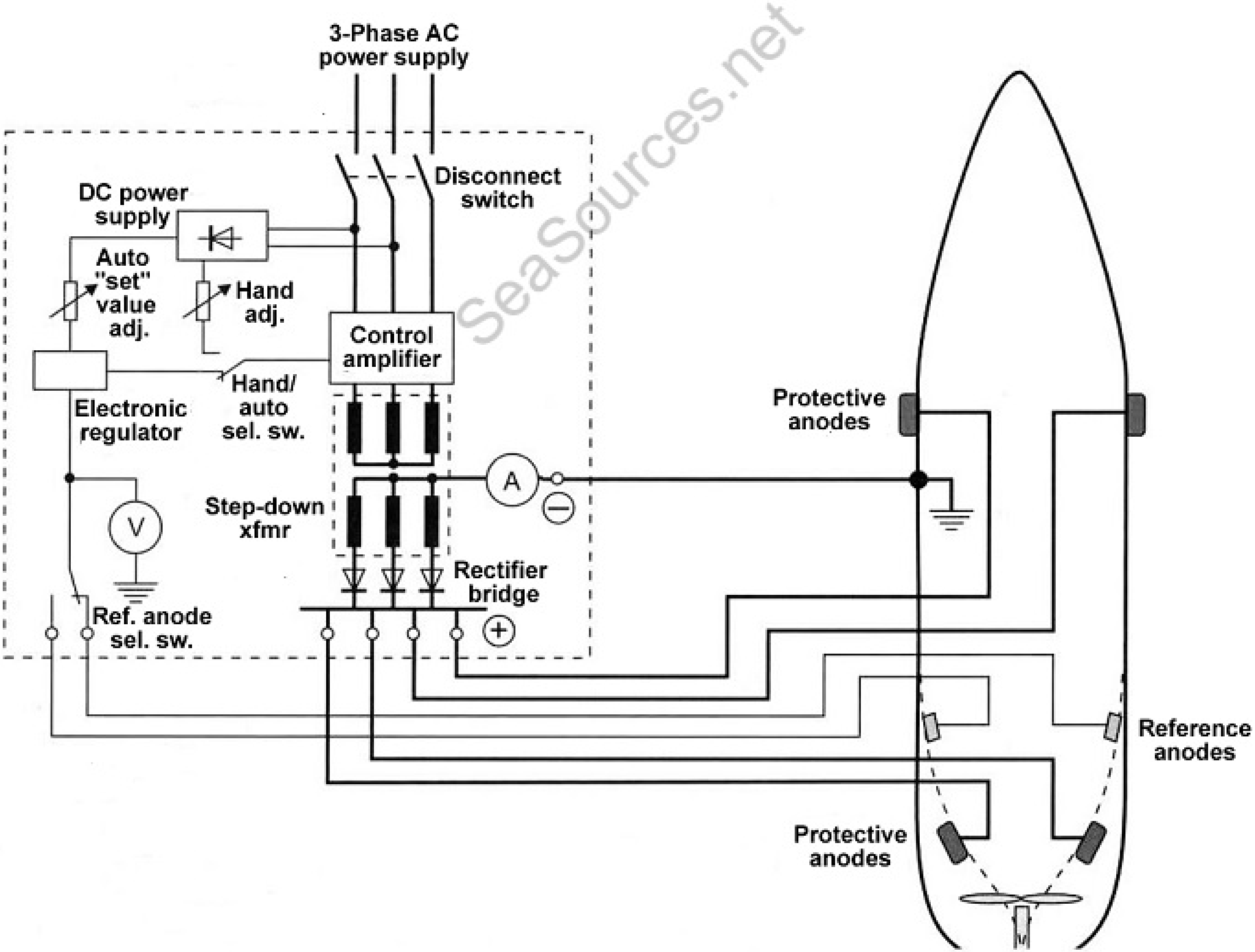


1

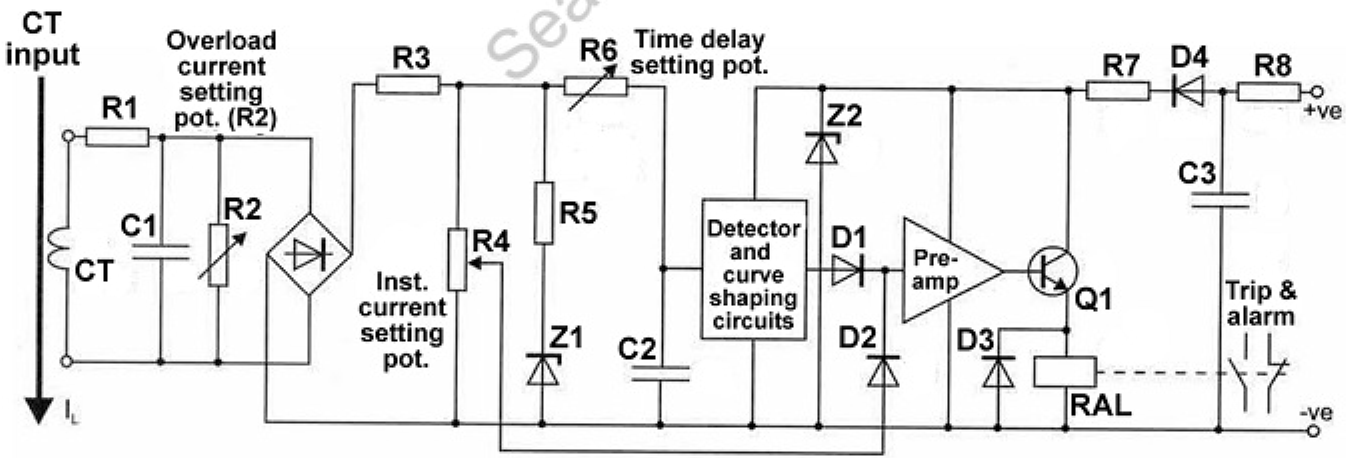


2

EL-0090

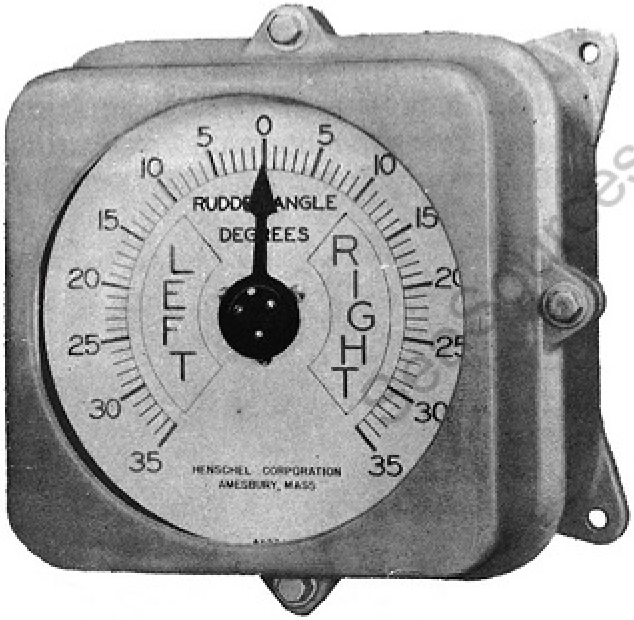

3-Phase AC
power supply
Disconnect
switch
DC power
supply
Auto
"set"
value
adj.
Hand
adj.
Control
amplifier
Electronic
regulator
Hand/
auto
sel. sw.
Step-down
xfmr
A
V
Rectifier
bridge
Ref. anode
sel. sw.
Protective
anodes
Reference
anodes
Protective
anodes

EL-0091



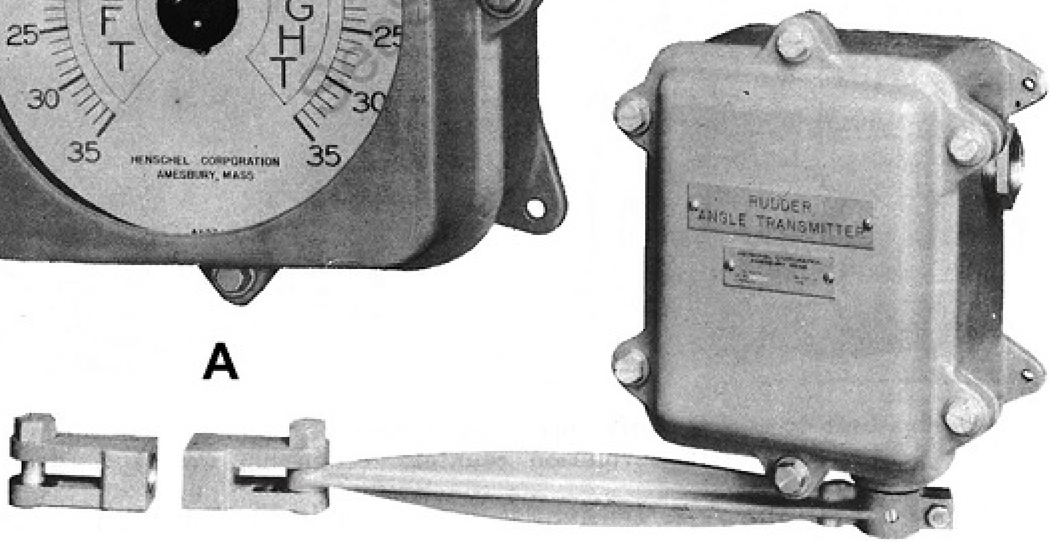
CT
input
Overload
current
setting
pot. (R2)
R1
R2
C1
CT
I_L
R3
R4
Inst.
current
setting
pot.
R5
R6
Time delay
setting pot.
Z1
C2
Detector
and
curve
shaping
circuits
Z2
D1
D2
Pre-
amp
D3
Q1
RAL
R7
D4
R8
+ve
C3
Trip &
alarm
-ve

EL-0092



RUDDER ANGLE
DEGREES
LEFT
RIGHT
HENSCHEL CORPORATION
AMESBURY, MASS.

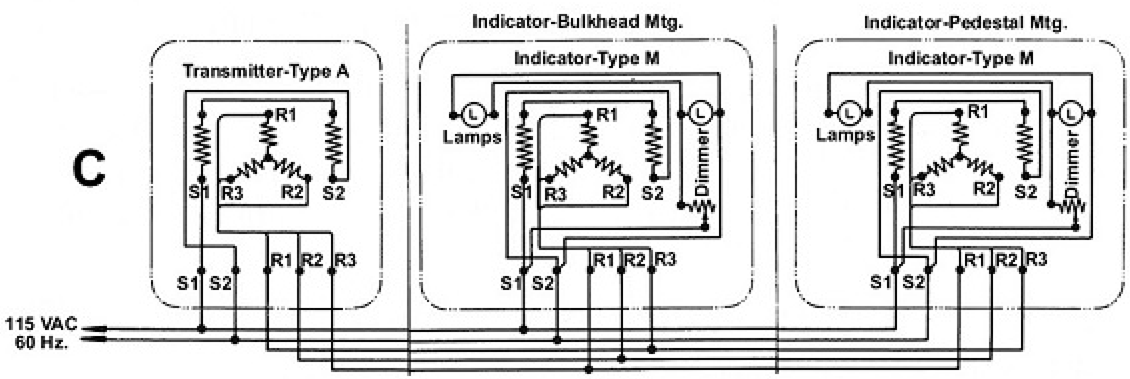
A



RUDDER
ANGLE TRANSMITTER

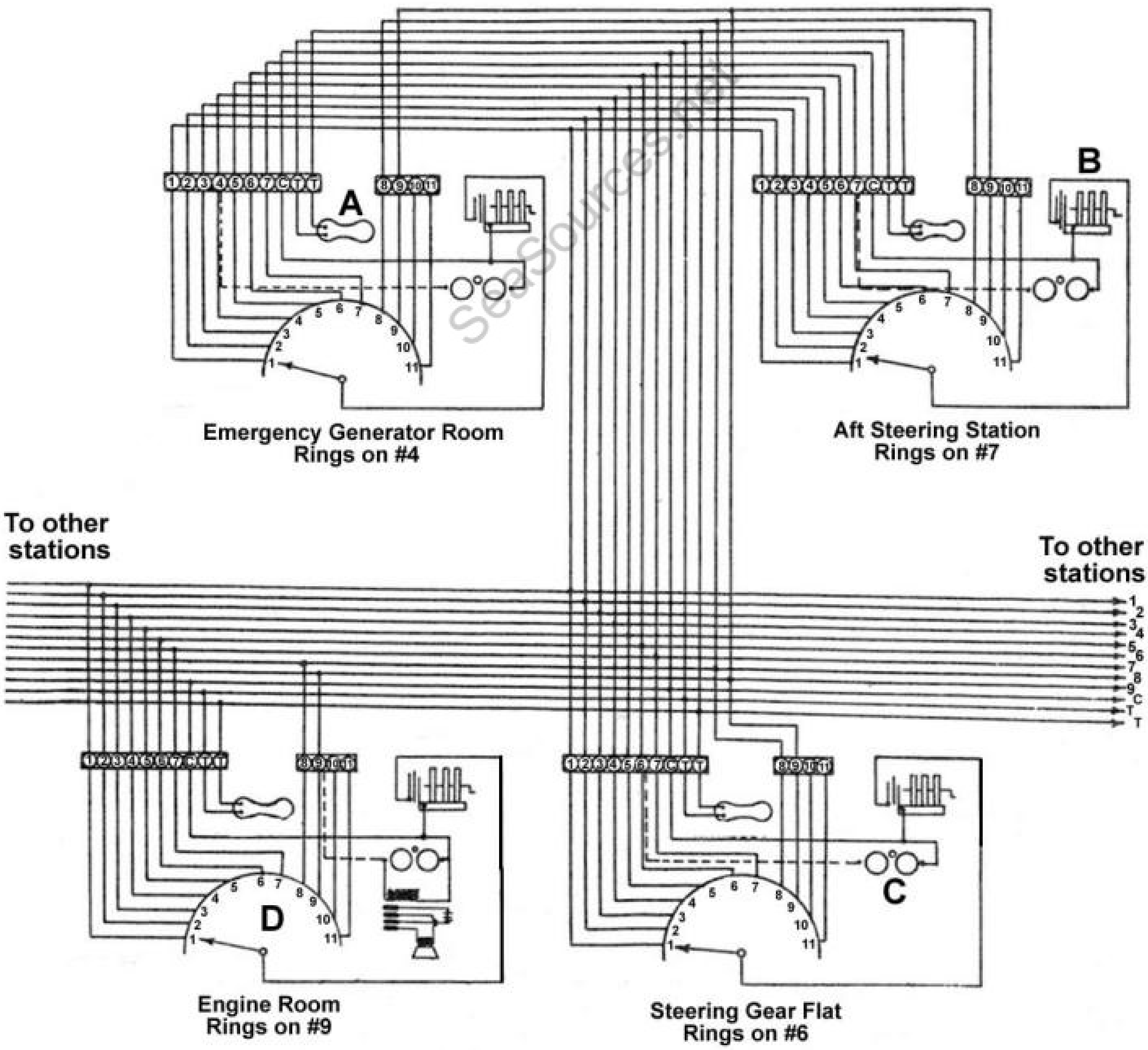
B

C



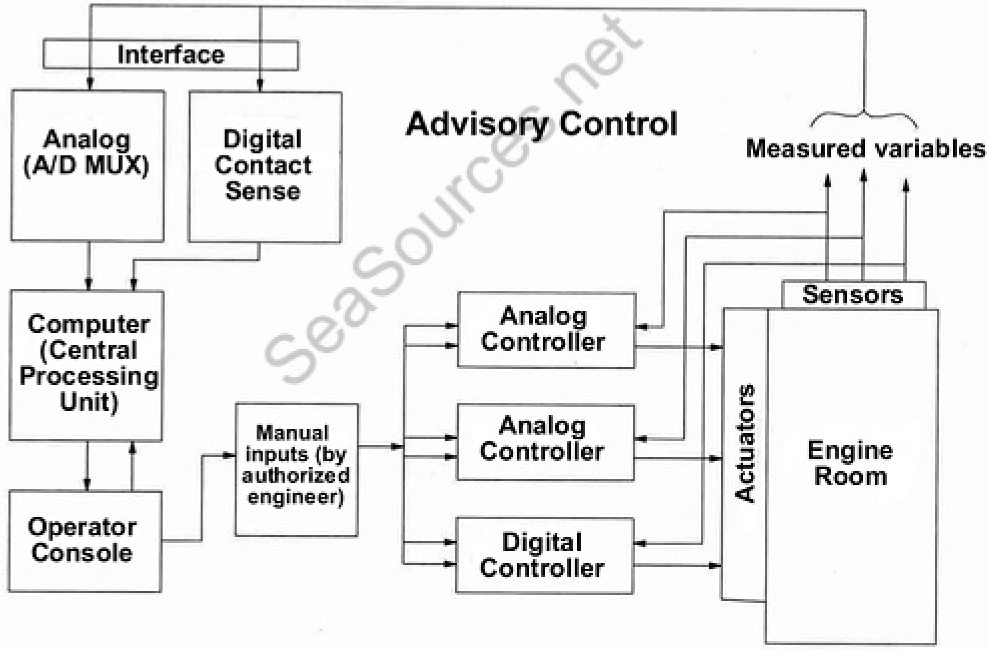
Indicator-Bulkhead Mtg.
Indicator-Pedestal Mtg.
Transmitter-Type A
Indicator-Type M
Indicator-Type M
Lamps
Dimmer
R1
R2
R3
S1
S2
115 VAC
60 Hz.

EL-0093

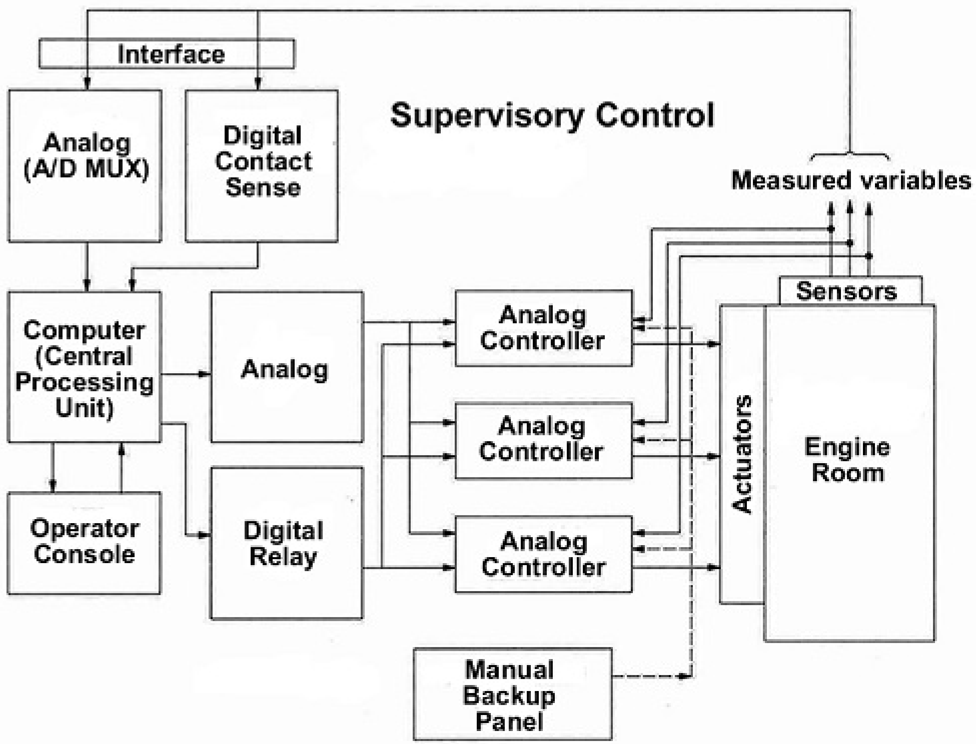

A
B
C
D
Emergency Generator Room
Rings on #4
Aft Steering Station
Rings on #7
To other stations
To other stations
Engine Room
Rings on #9
Steering Gear Flat
Rings on #6

EL-0094

A

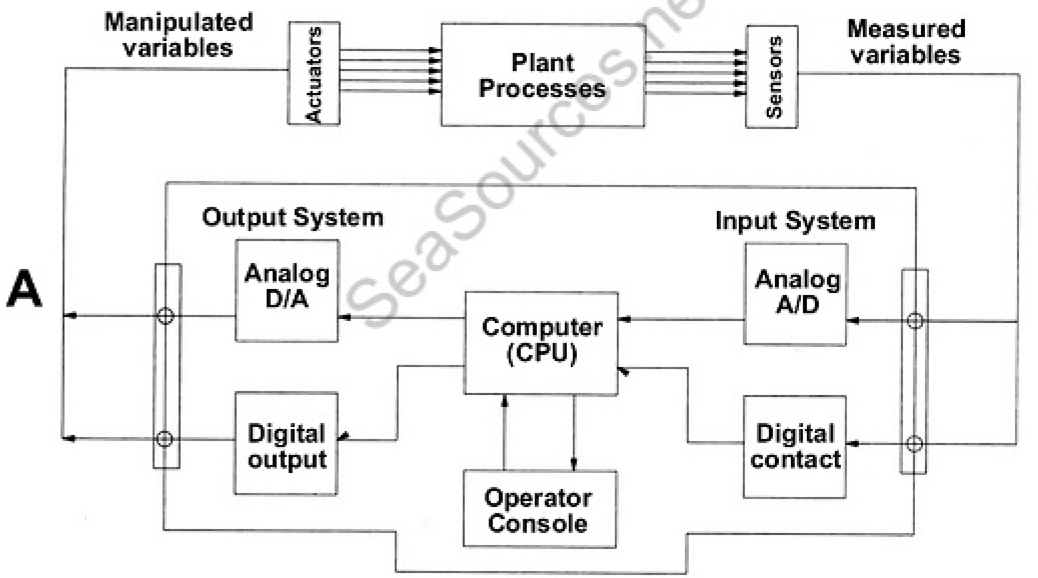

Interface
Analog (A/D MUX)
Digital Contact Sense
Advisory Control
Measured variables
Computer (Central Processing Unit)
Operator Console
Manual inputs (by authorized engineer)
Analog Controller
Analog Controller
Digital Controller
Sensors
Actuators
Engine Room

B

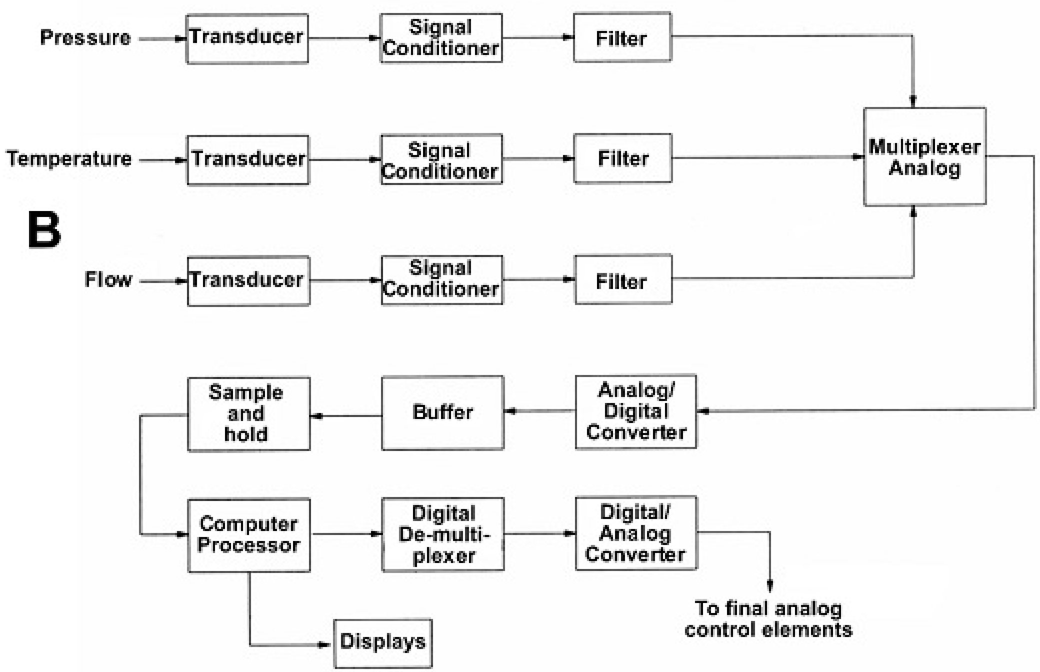

Interface
Analog (A/D MUX)
Digital Contact Sense
Supervisory Control
Measured variables
Computer (Central Processing Unit)
Analog
Operator Console
Digital Relay
Analog Controller
Analog Controller
Analog Controller
Sensors
Actuators
Engine Room
Manual Backup Panel

EL-0095

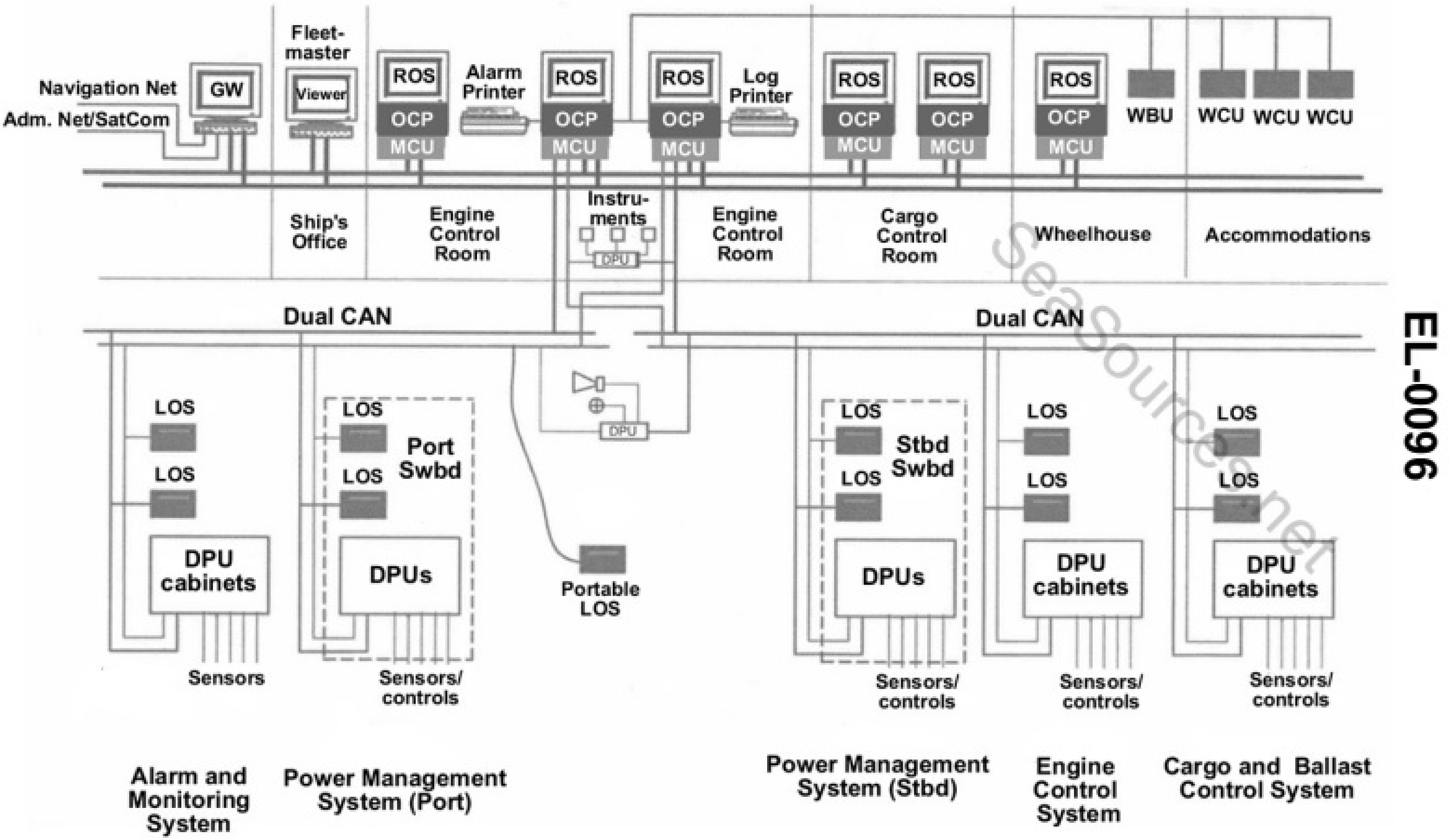
Direct Digital Control



Signal Processing Flowpath

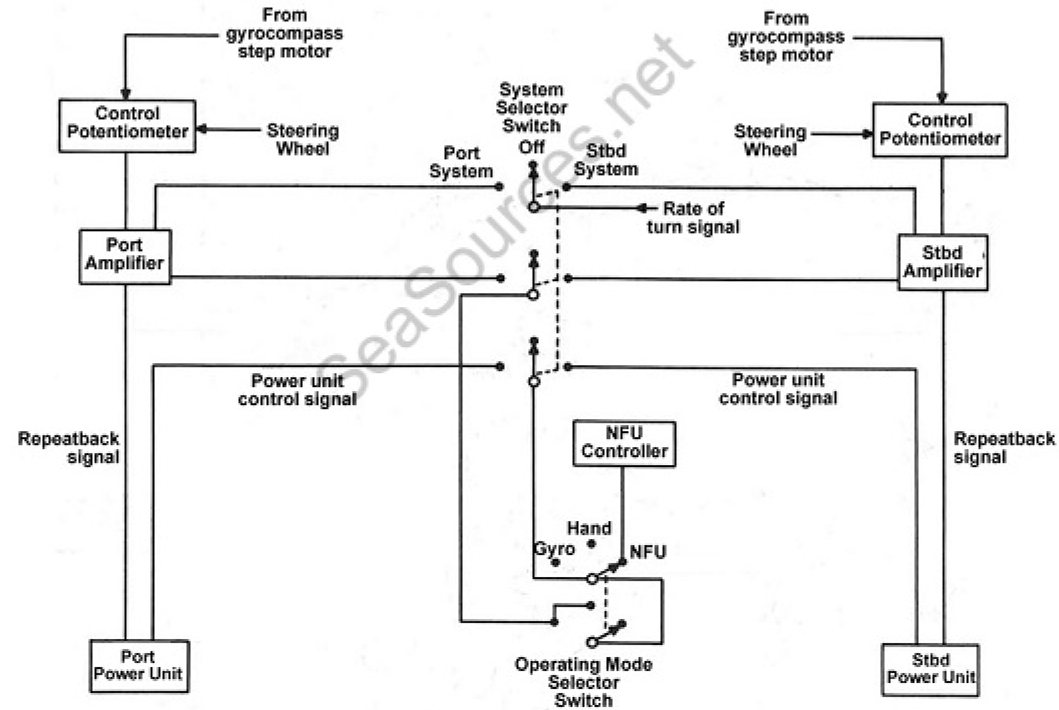


Distributed Automation System

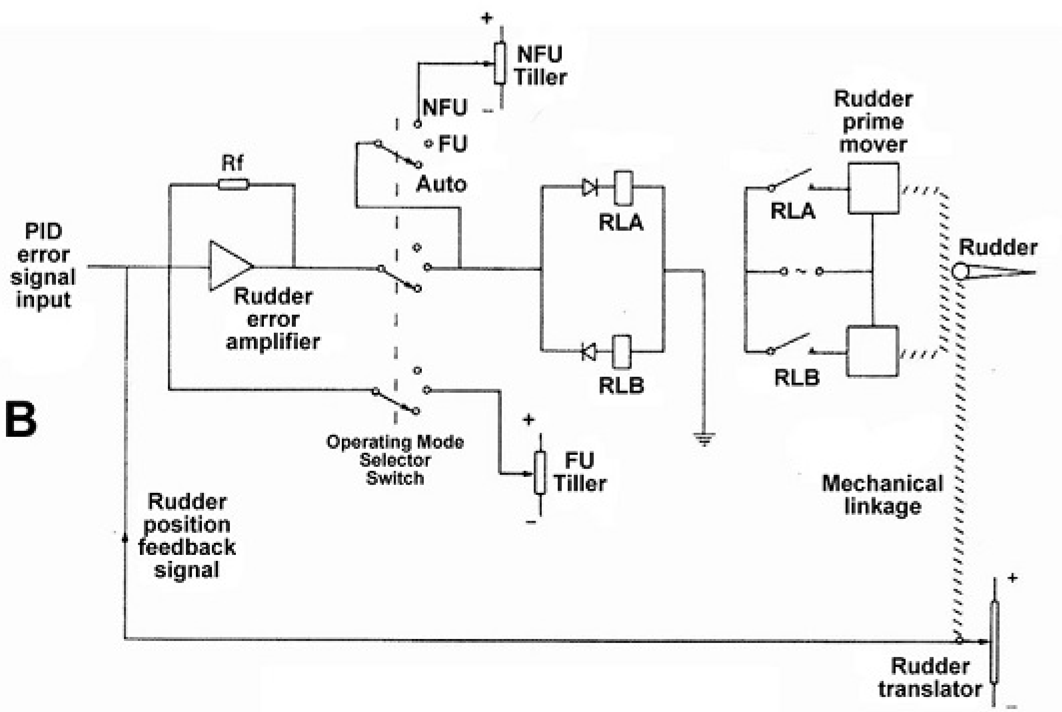


EL-0097

A

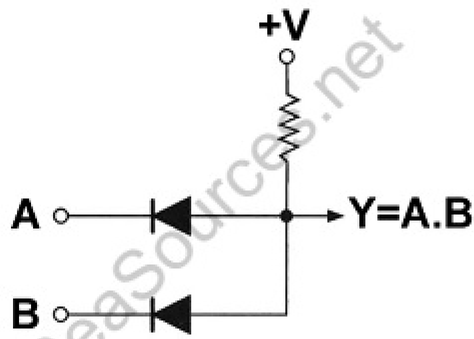

From gyrocompass step motor
Control Potentiometer
Steering Wheel
Port Amplifier
Port System
System Selector Switch
Off
Stbd System
Rate of turn signal
Stbd Amplifier
Power unit control signal
Power unit control signal
Repeatback signal
Repeatback signal
NFU Controller
Hand
Gyro
NFU
Port Power Unit
Stbd Power Unit
Operating Mode Selector Switch

B

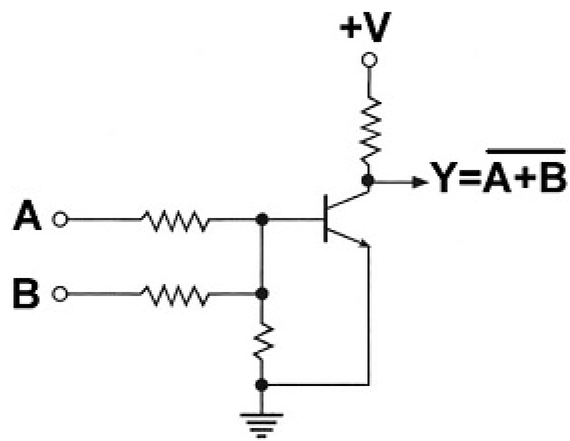

+
NFU Tiller
NFU
FU
Auto
Rf
PID error signal input
Rudder error amplifier
RLA
RLB
Rudder prime mover
RLA
RLB
Rudder
Operating Mode Selector Switch
+
FU Tiller
Mechanical linkage
Rudder position feedback signal
+
Rudder translator

El-0098: The new Illustration associated with this question has not yet been made available to the public from the National Maritime Center even though they are already using them in the exam room. We hope to have them posted soon.

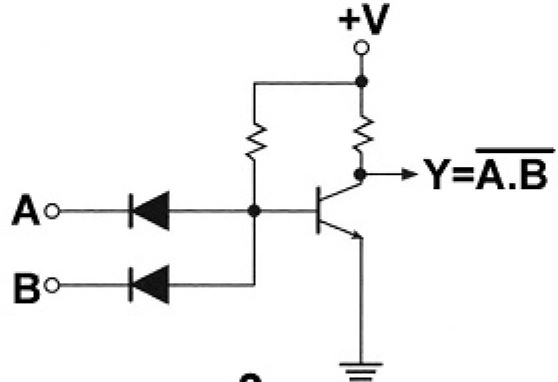
EL-0099



1

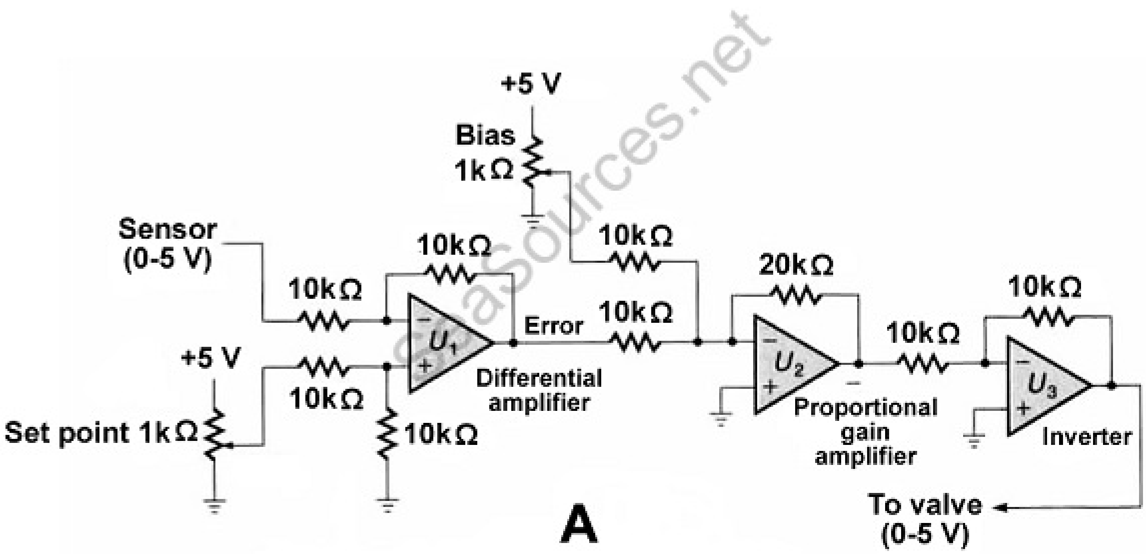


2



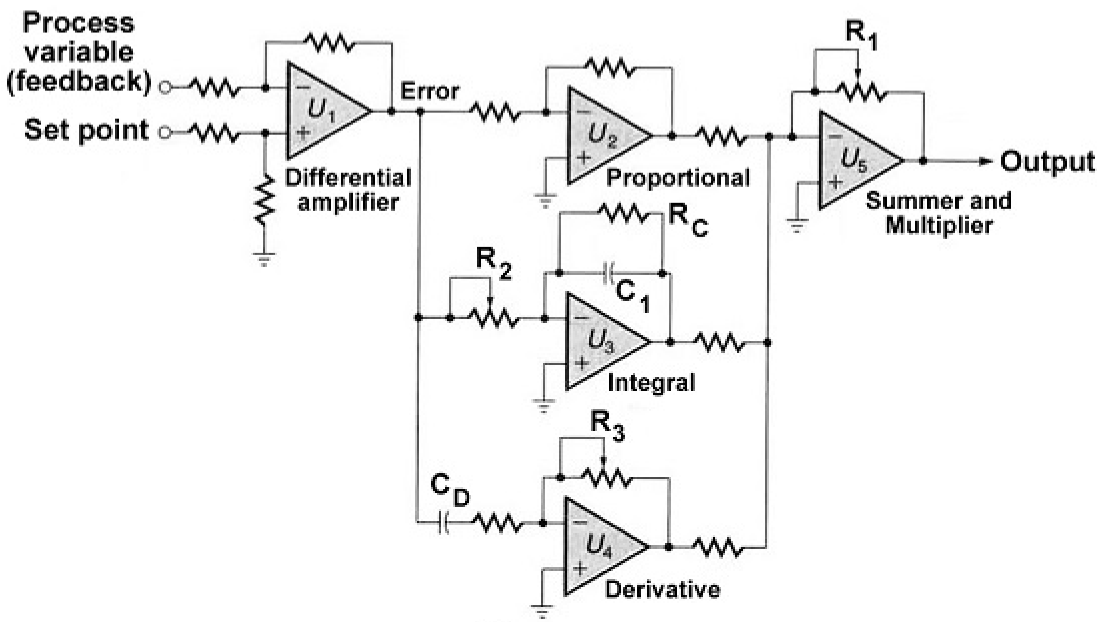
3

EL-0100



+5 V
Bias
1kΩ
Sensor
(0-5 V)
10kΩ
10kΩ
10kΩ
10kΩ
20kΩ
10kΩ
10kΩ
+5 V
10kΩ
Set point 1kΩ
10kΩ
Error
U1
Differential
amplifier
U2
Proportional
gain
amplifier
U3
Inverter
To valve
(0-5 V)

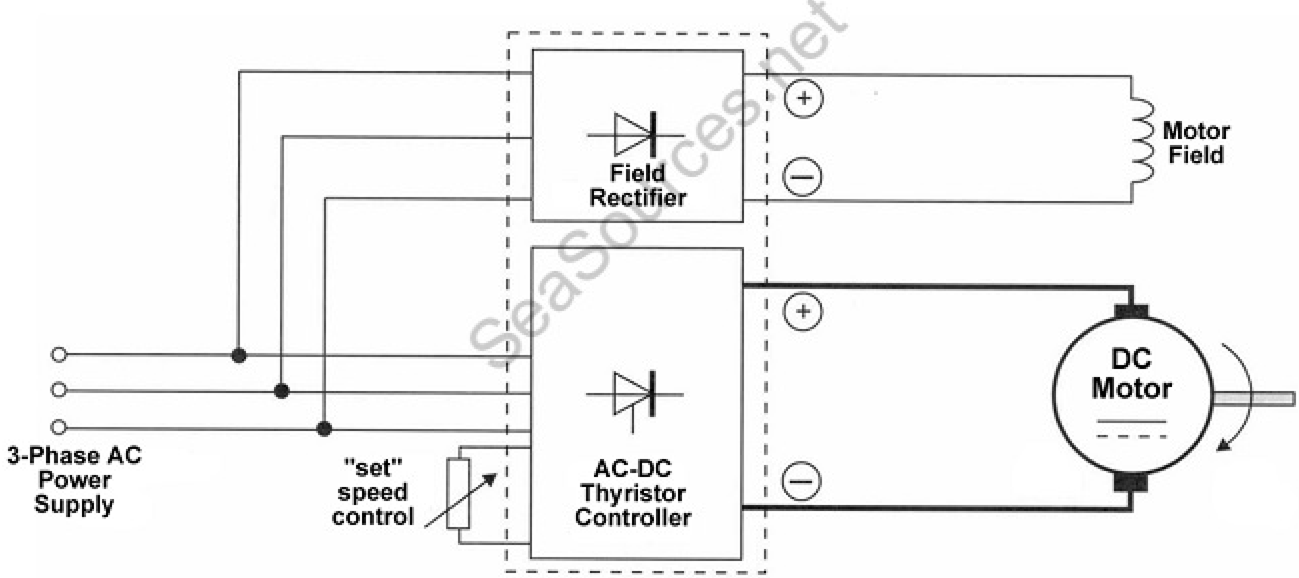
A



Process
variable
(feedback)
Set point
U1
Differential
amplifier
Error
U2
Proportional
R1
U5
Summer and
Multiplier
Output
RC
R2
C1
U3
Integral
R3
CD
U4
Derivative

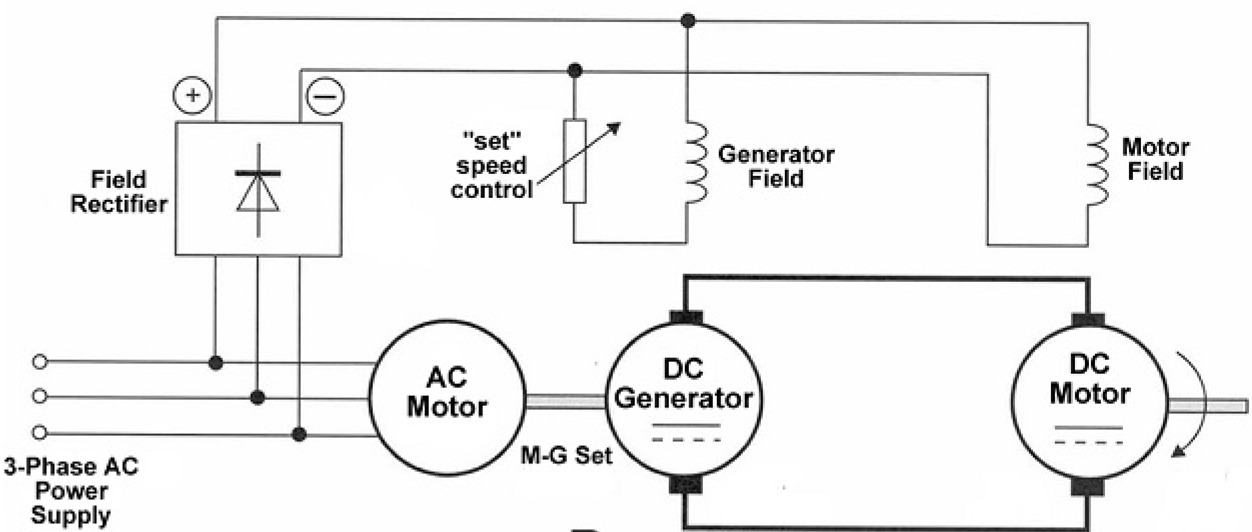
B

EL-0101



Field
Rectifier
Motor
Field
DC
Motor
3-Phase AC
Power
Supply
"set"
speed
control
AC-DC
Thyristor
Controller

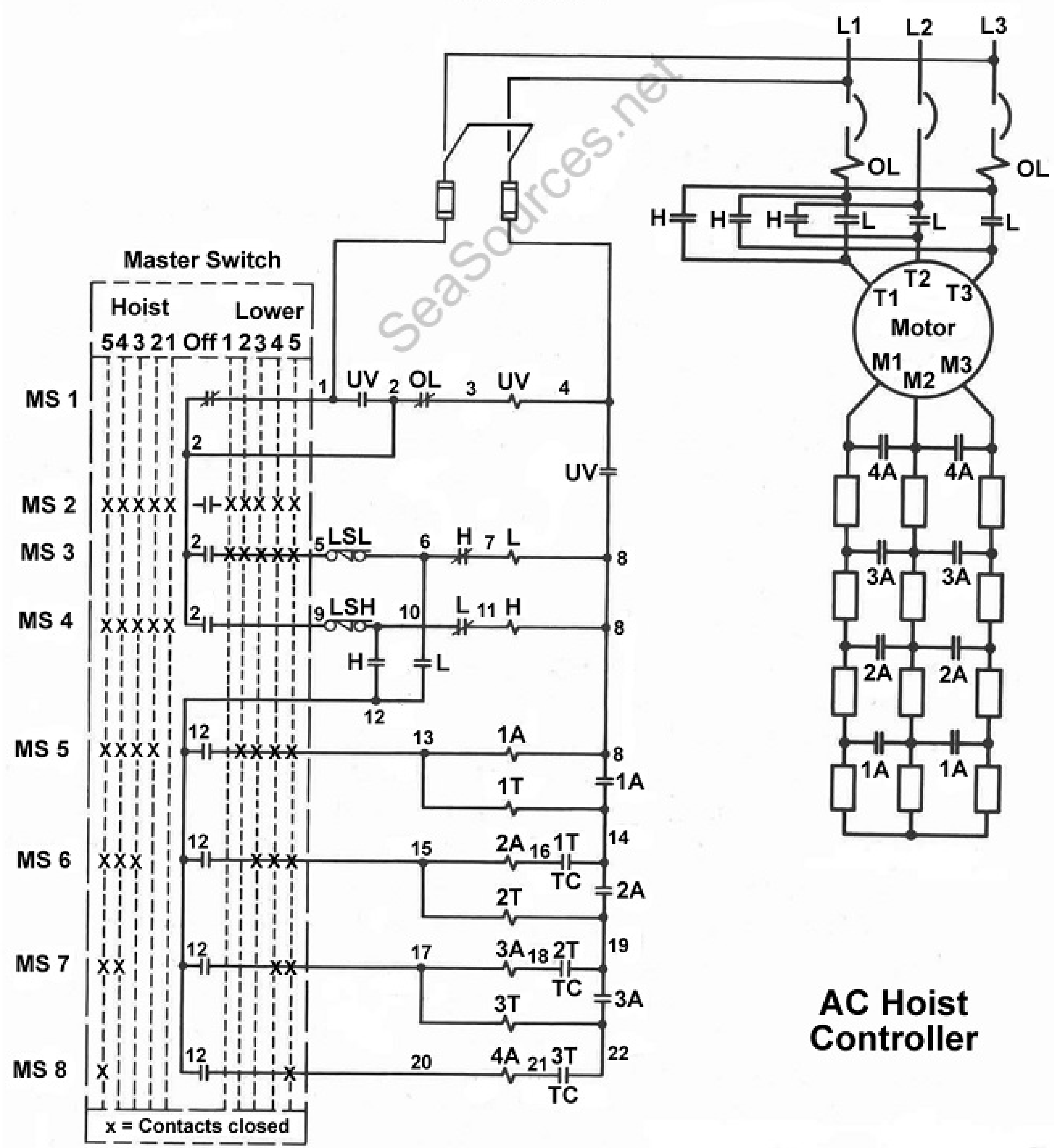
A



Field
Rectifier
"set"
speed
control
Generator
Field
Motor
Field
AC
Motor
DC
Generator
DC
Motor
M-G Set
3-Phase AC
Power
Supply

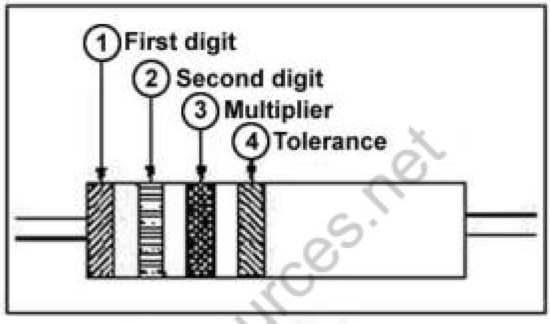
B

EL-0102



AC Hoist Controller

EL-0103

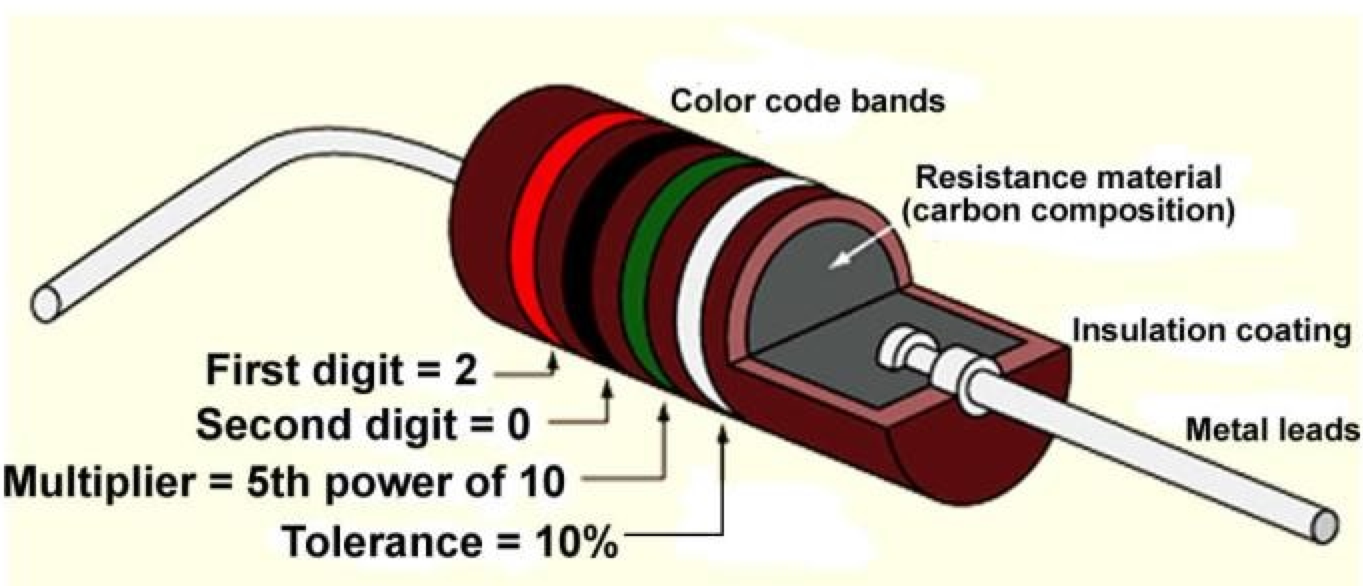


Color	1st Digit	2nd Digit	Multiplier	Tolerance (percent)
Black	0	0	1	
Brown	1	1	10	
Red	2	2	100	
Orange	3	3	1,000	
Yellow	4	4	10,000	
Green	5	5	100,000	
Blue	6	6	1,000,000	
Violet	7	7	10,000,000	
Gray	8	8	100,000,000	
White	9	9	1,000,000,000	
Gold			.1	5
Silver			.01	10
No color				20

Resistors for military use may have a fifth band to indicate reliability in terms of failure rate as follows:

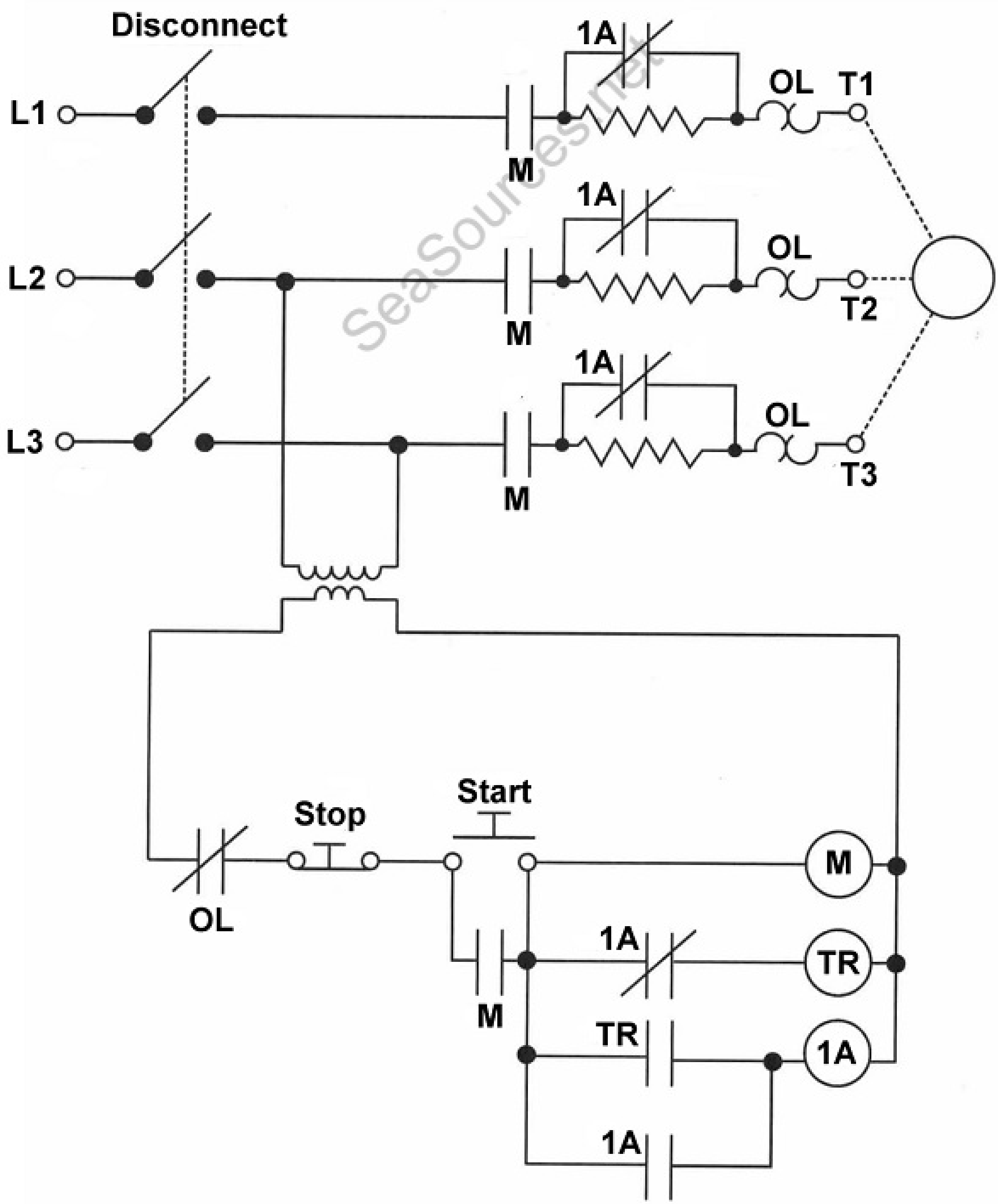
No color: No test made
Brown: 1.0 percent per 1000 hours
Red: 0.1 percent per 1000 hours
Orange: 0.01 percent per 1000 hours
Yellow: 0.001 percent per 1000 hours

A

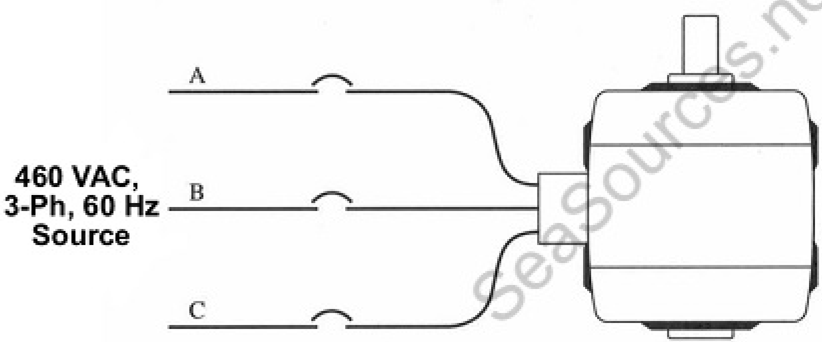


B

EL-0104

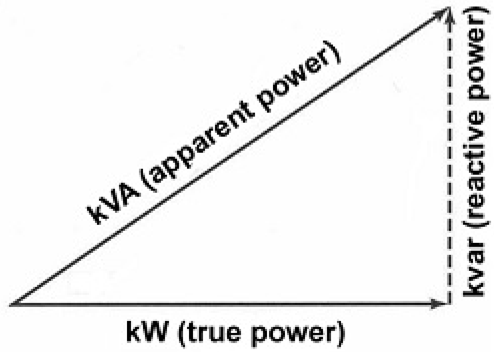

Disconnect
L1
L2
L3
1A
M
OL
T1
T2
T3
Stop
Start
OL
M
TR
1A
M
TR
1A
1A

EL-0105



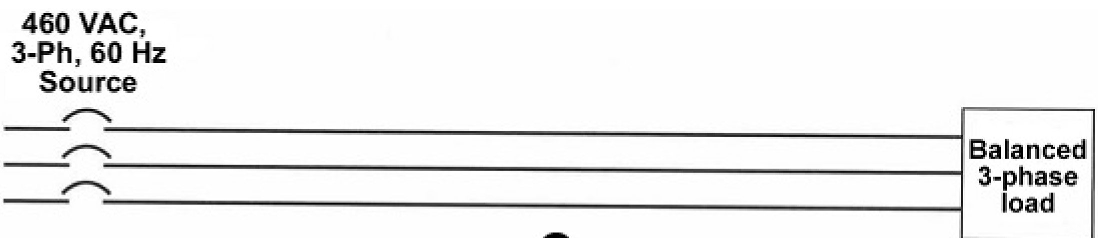
460 VAC,
3-Ph, 60 Hz
Source
A
B
C

A



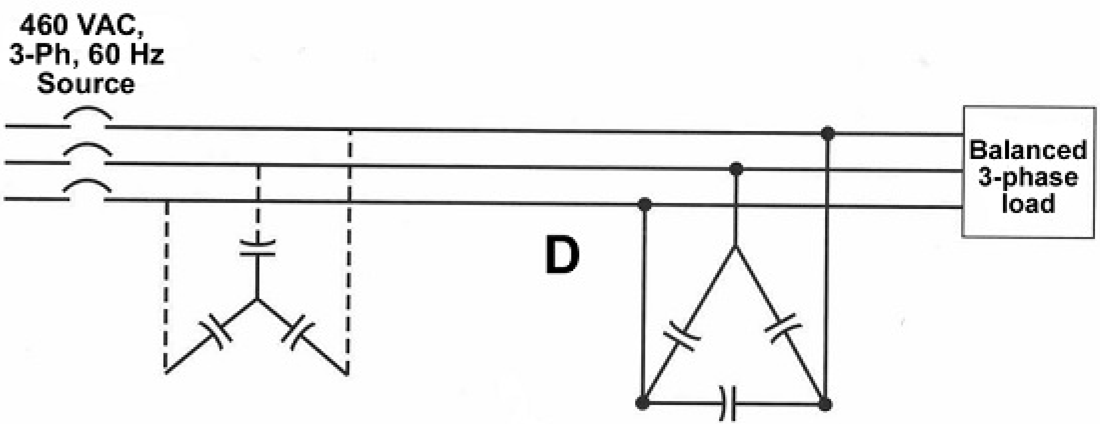
kVA (apparent power)
kvar (reactive power)
kW (true power)

B



460 VAC,
3-Ph, 60 Hz
Source
Balanced
3-phase
load

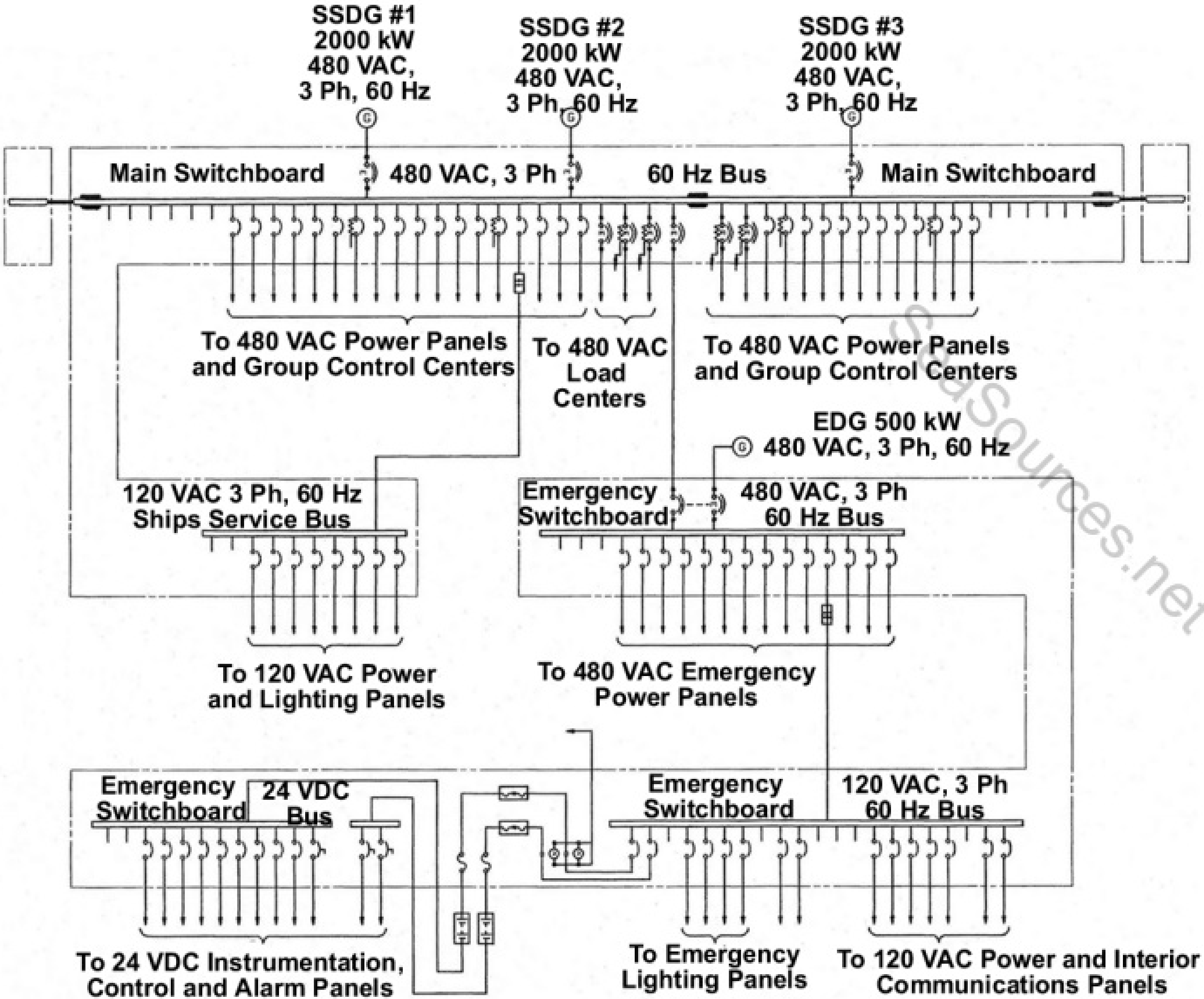
C



460 VAC,
3-Ph, 60 Hz
Source
Balanced
3-phase
load

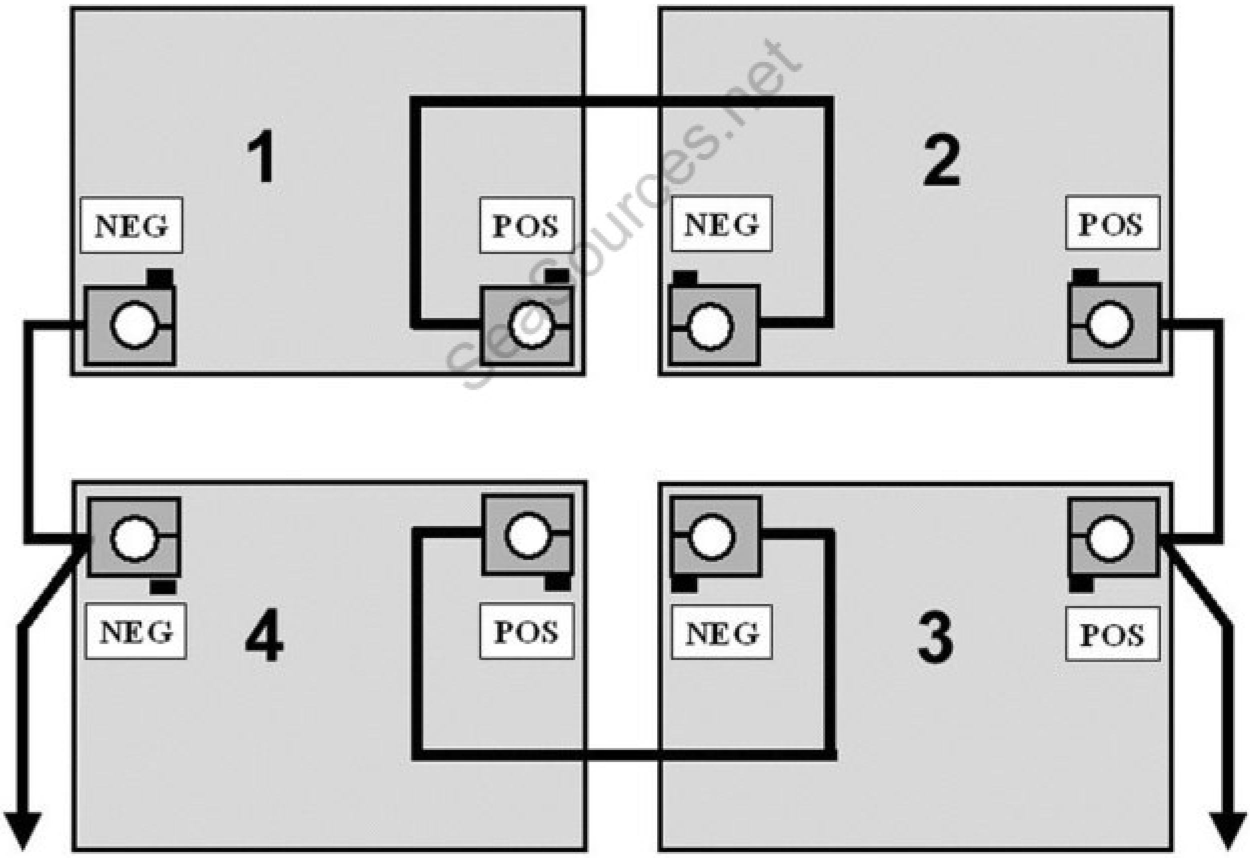
D

One Line Distribution Diagram

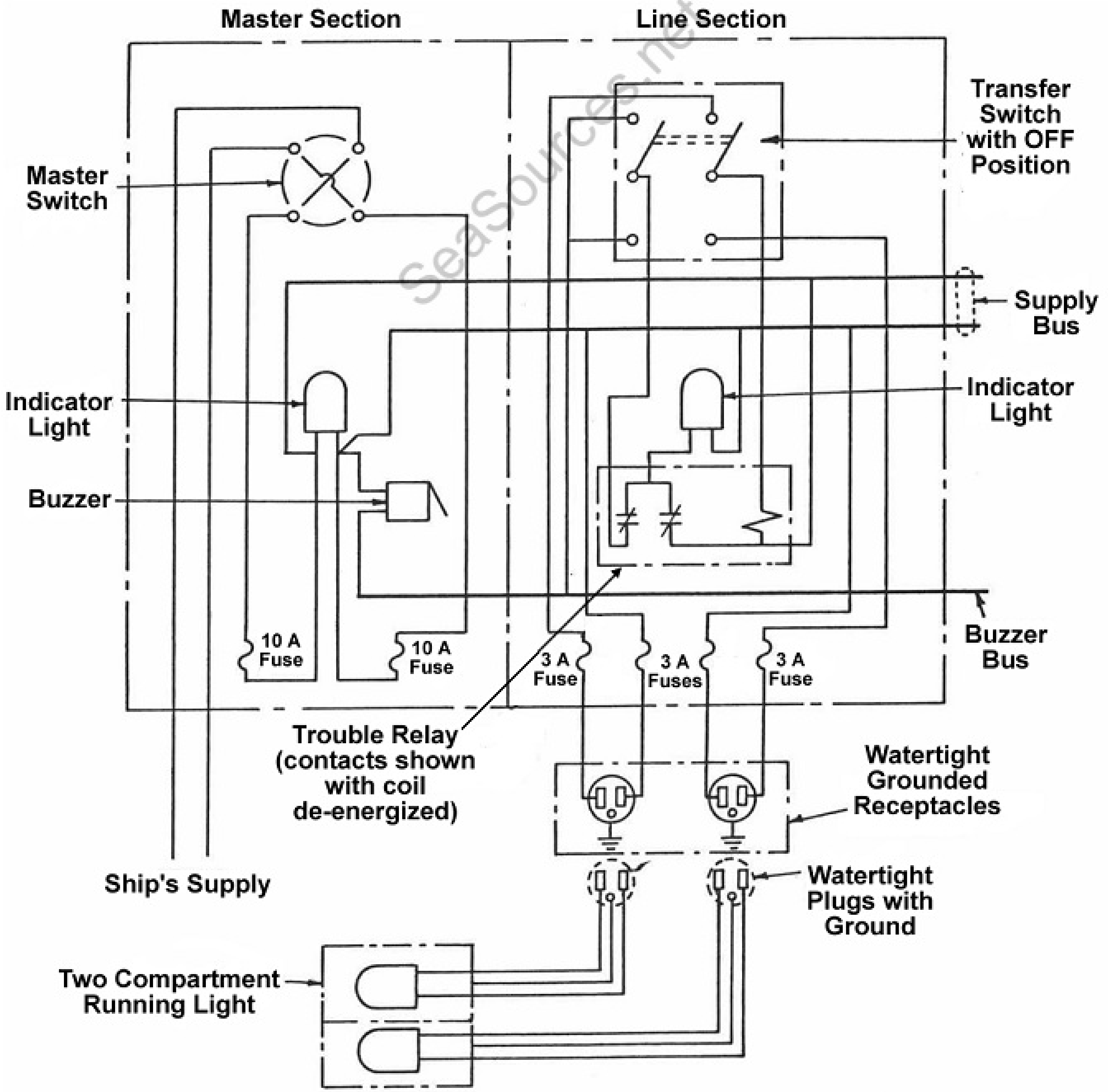


EL-0106

EL-0107

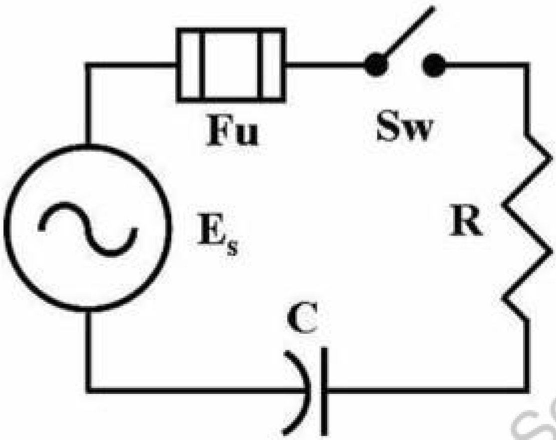


EL-0108

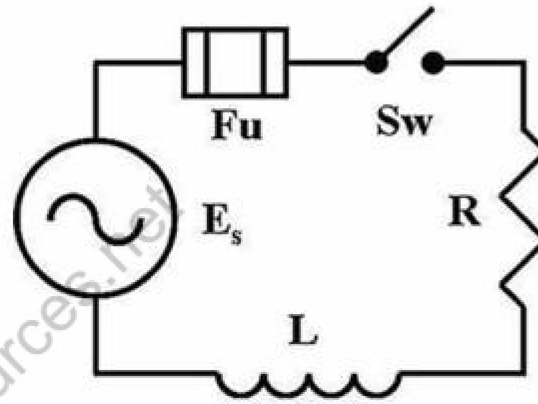


Master Section
Line Section
Master Switch
Transfer Switch with OFF Position
Supply Bus
Indicator Light
Indicator Light
Buzzer
Buzzer Bus
10 A Fuse
10 A Fuse
3 A Fuse
3 A Fuses
3 A Fuse
Trouble Relay (contacts shown with coil de-energized)
Watertight Grounded Receptacles
Ship's Supply
Watertight Plugs with Ground
Two Compartment Running Light

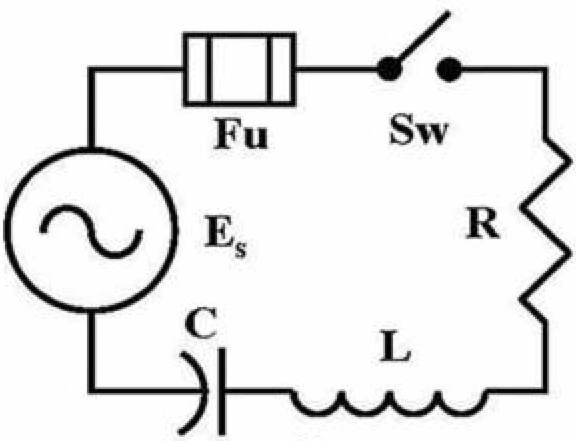
EL-0109



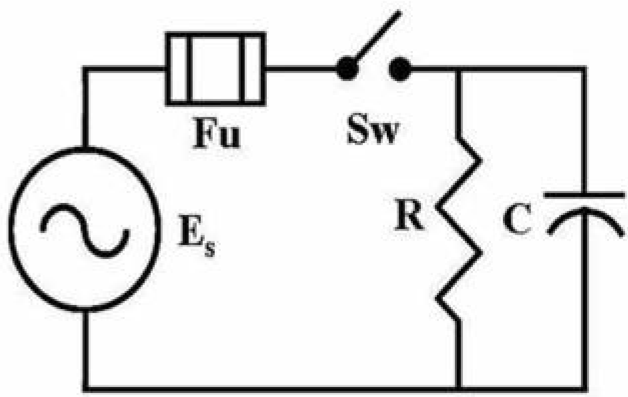
A



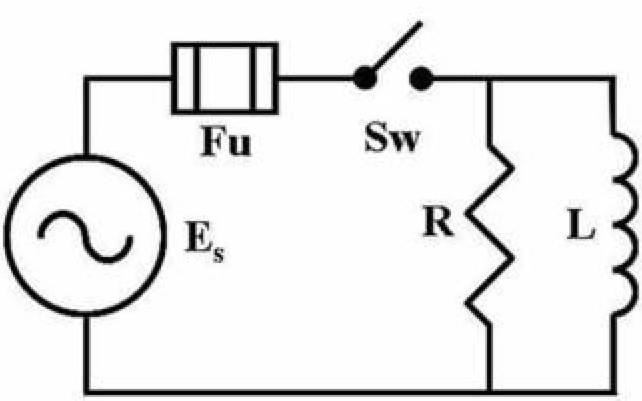
B



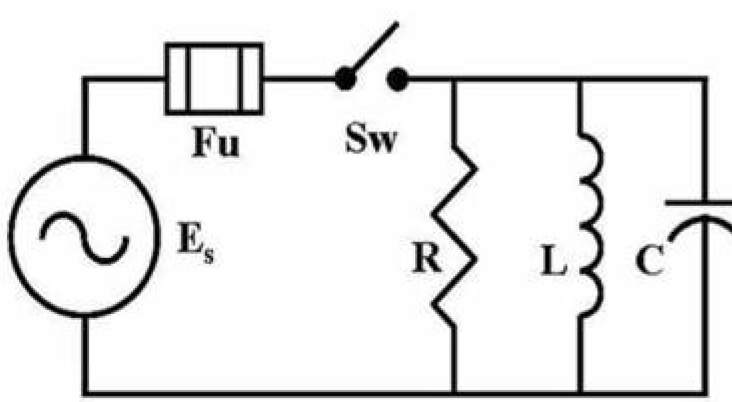
C



D



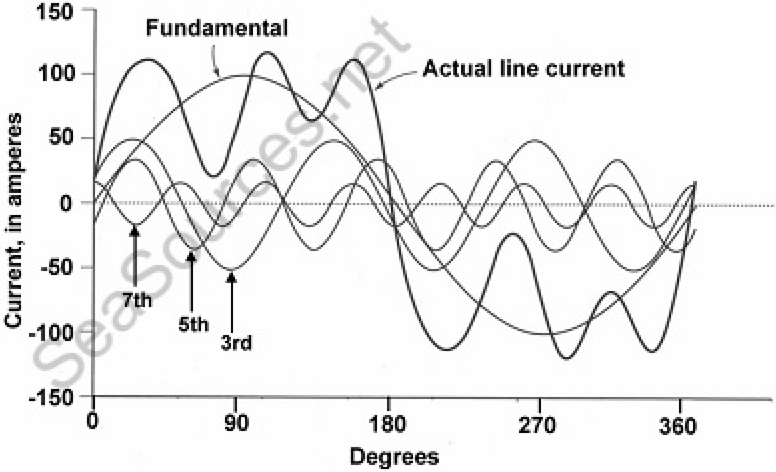
E



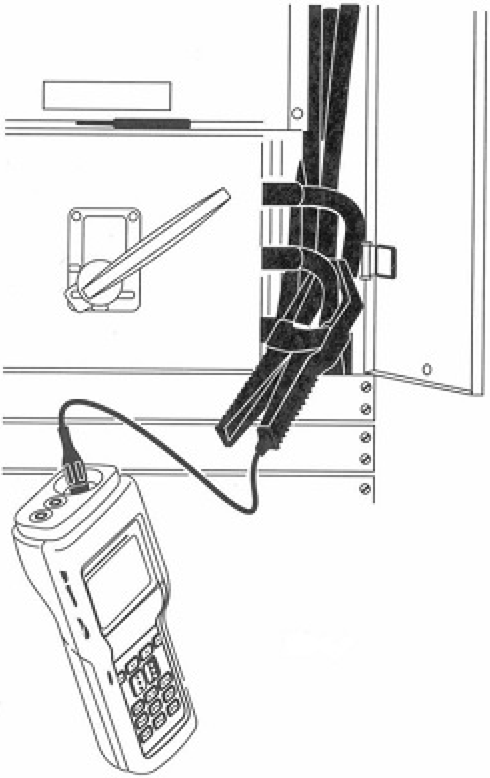
F

EL-0110

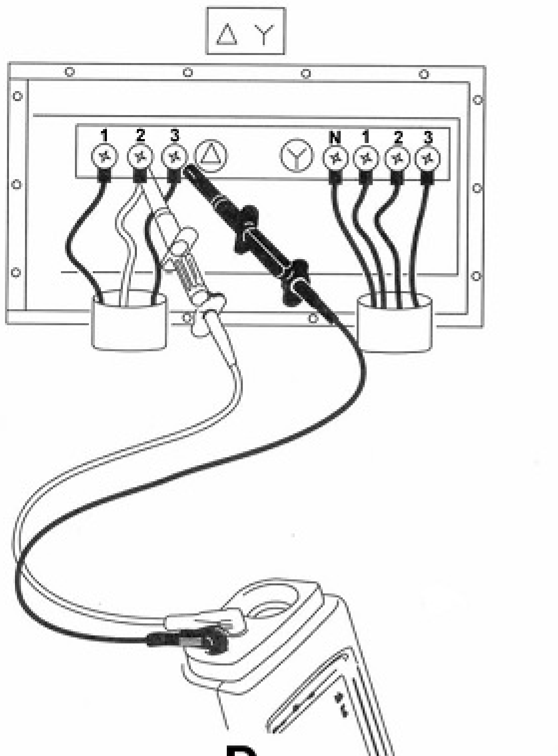
A


Fundamental
Actual line current
150
100
50
0
-50
-100
-150
Current, in amperes
7th
5th
3rd
0
90
180
270
360
Degrees

B

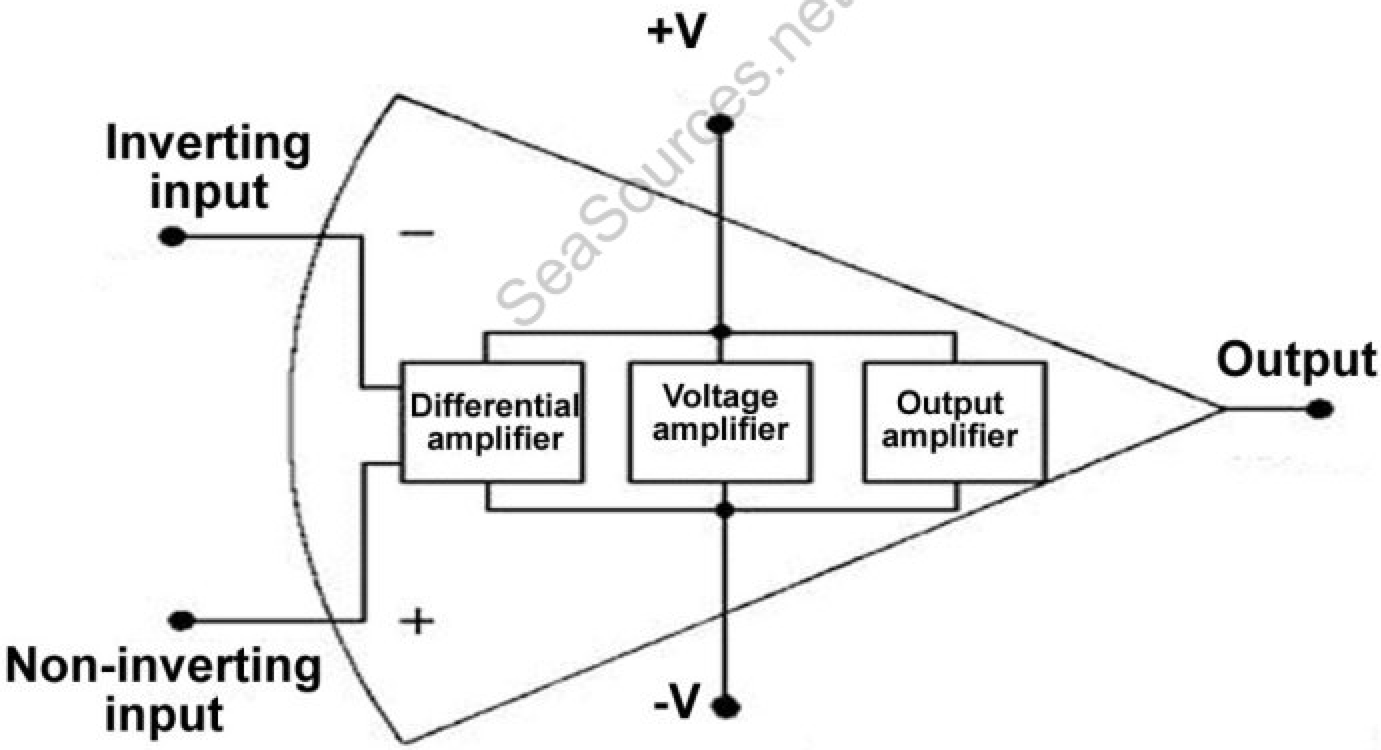


C


Δ Y
1 2 3
N 1 2 3

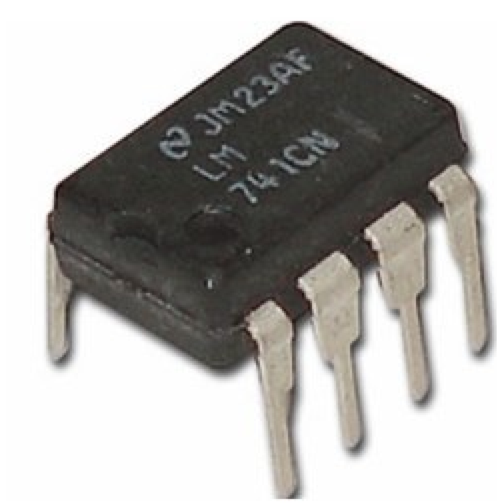
D

EL-0111

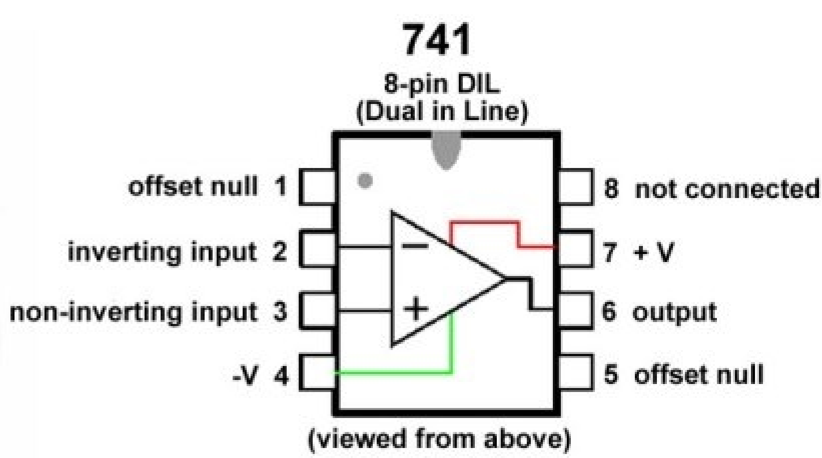


+V
Inverting input
−
Differential amplifier
Voltage amplifier
Output amplifier
Output
+
Non-inverting input
-V
SeaSources.net

A



LM
741CN



741
8-pin DIL
(Dual in Line)
offset null 1
inverting input 2
non-inverting input 3
-V 4
8 not connected
7 + V
6 output
5 offset null
(viewed from above)

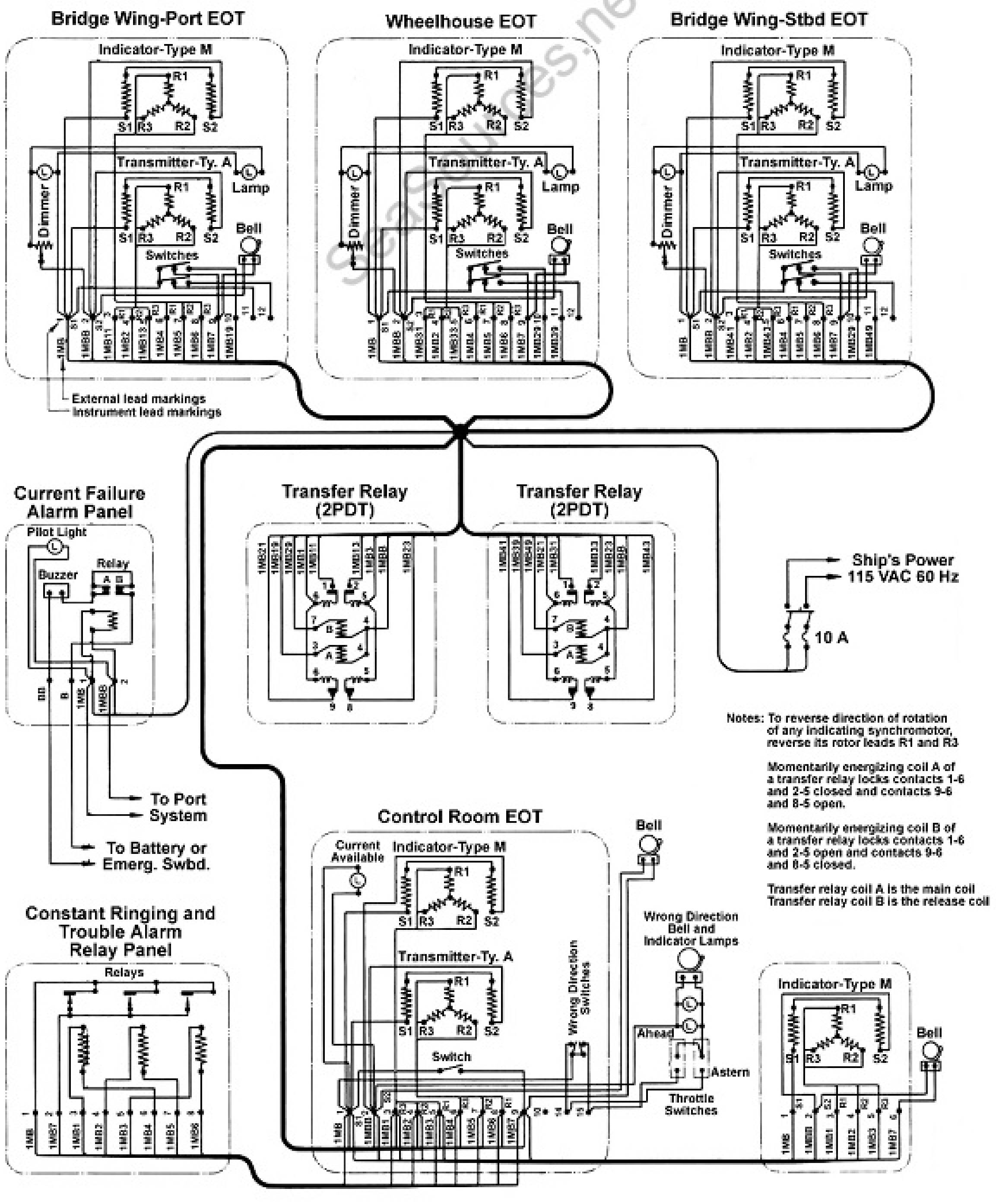
B

C

El-0112: The new Illustration associated with this question has not yet been made available to the public from the National Maritime Center even though they are already using them in the exam room. We hope to have them posted soon.

EL-0113

Engine Order Telegraph System



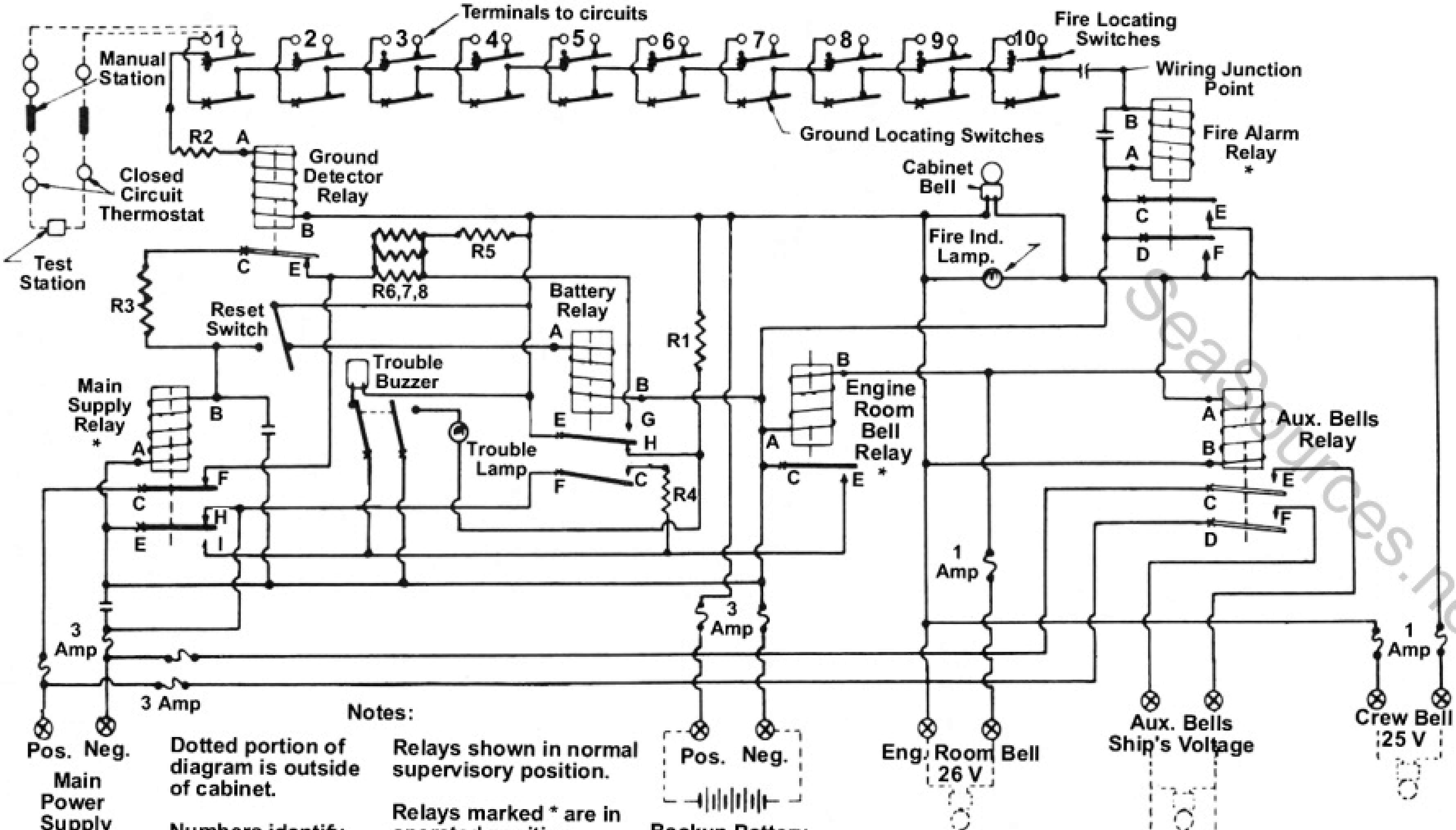
Notes: To reverse direction of rotation of any indicating synchromotor, reverse its rotor leads R1 and R3

Momentarily energizing coil A of a transfer relay locks contacts 1-6 and 2-5 closed and contacts 9-6 and 8-5 open.

Momentarily energizing coil B of a transfer relay locks contacts 1-6 and 2-5 open and contacts 9-6 and 8-5 closed.

Transfer relay coil A is the main coil
Transfer relay coil B is the release coil

EL-0114 Fire Detection and Alarm System



Notes:

Dotted portion of diagram is outside of cabinet.

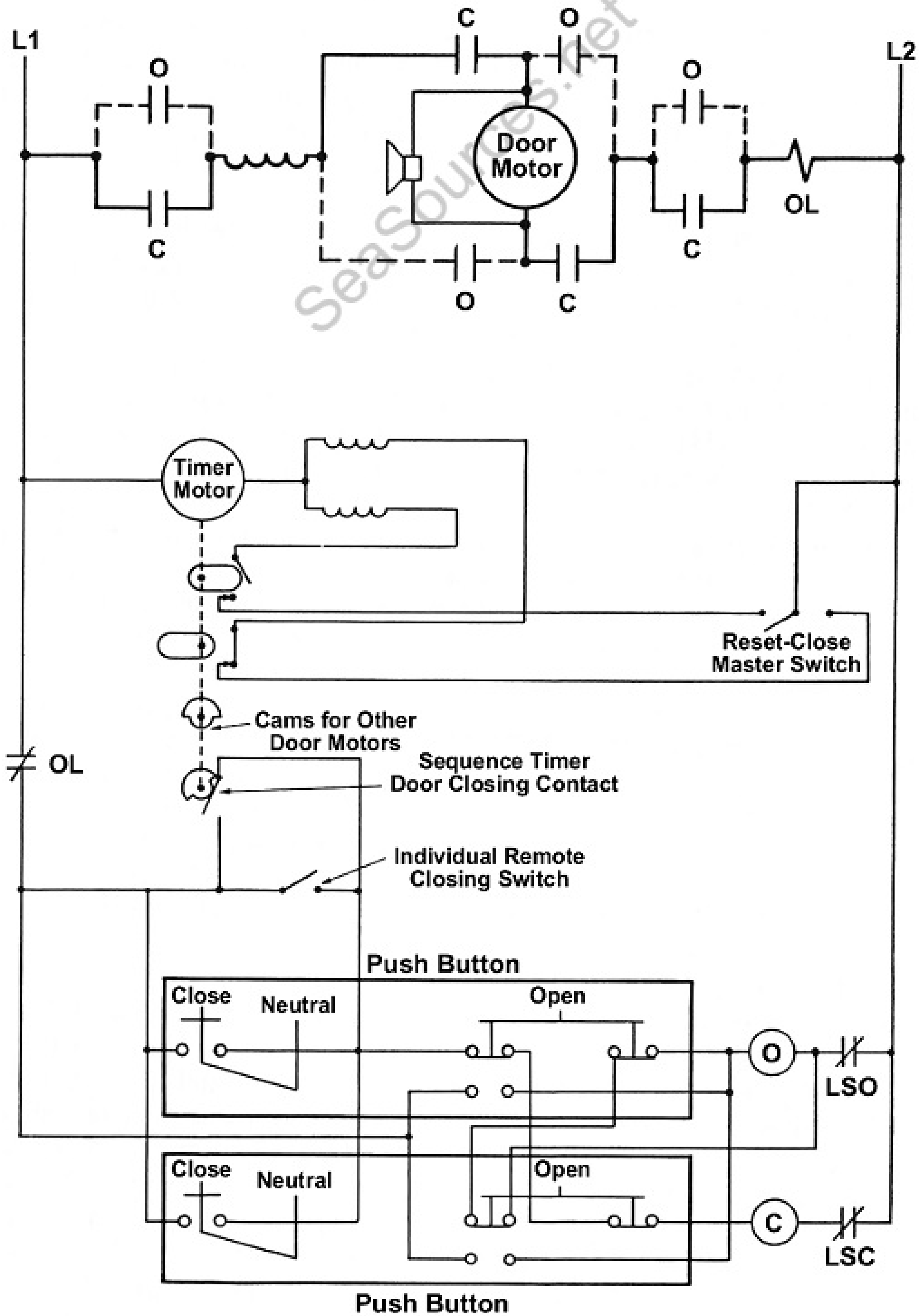
Numbers identify wire coloring.

Relays shown in normal supervisory position.

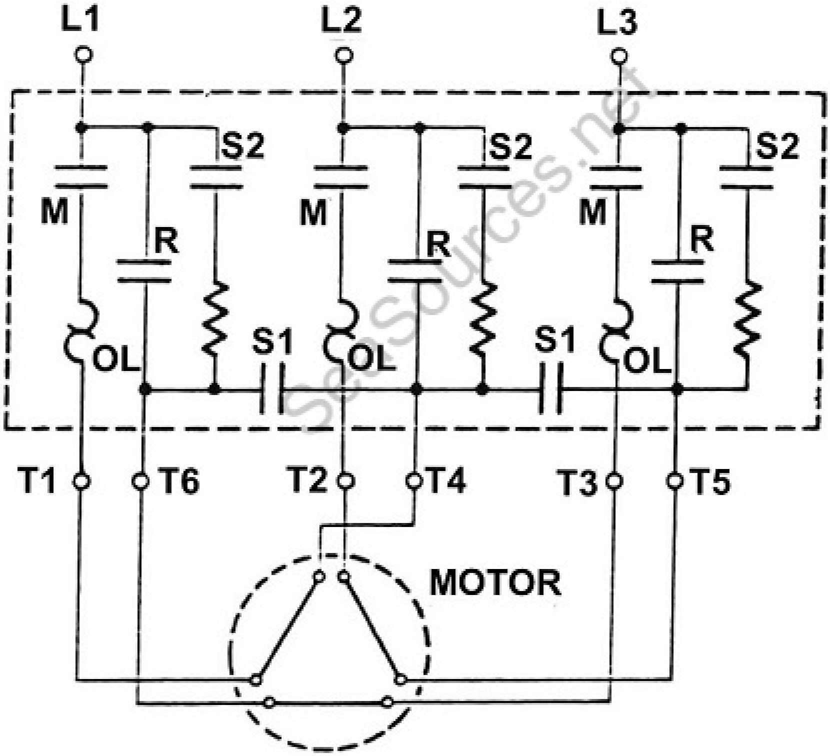
Relays marked * are in operated position.

Main panel terminal.

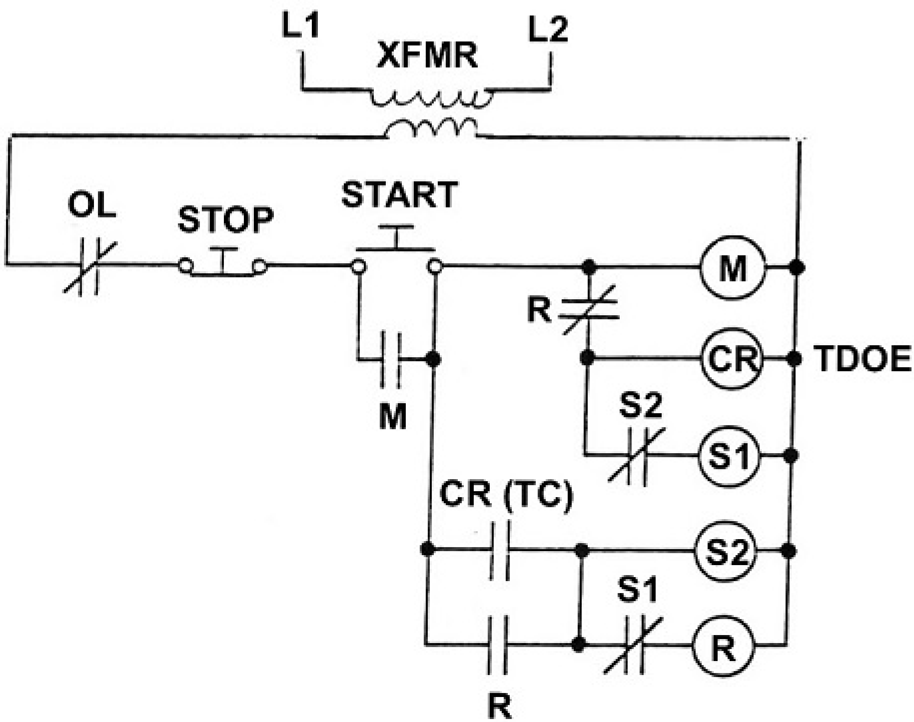
EL-0115
Watertight Door Controller



EL-0116

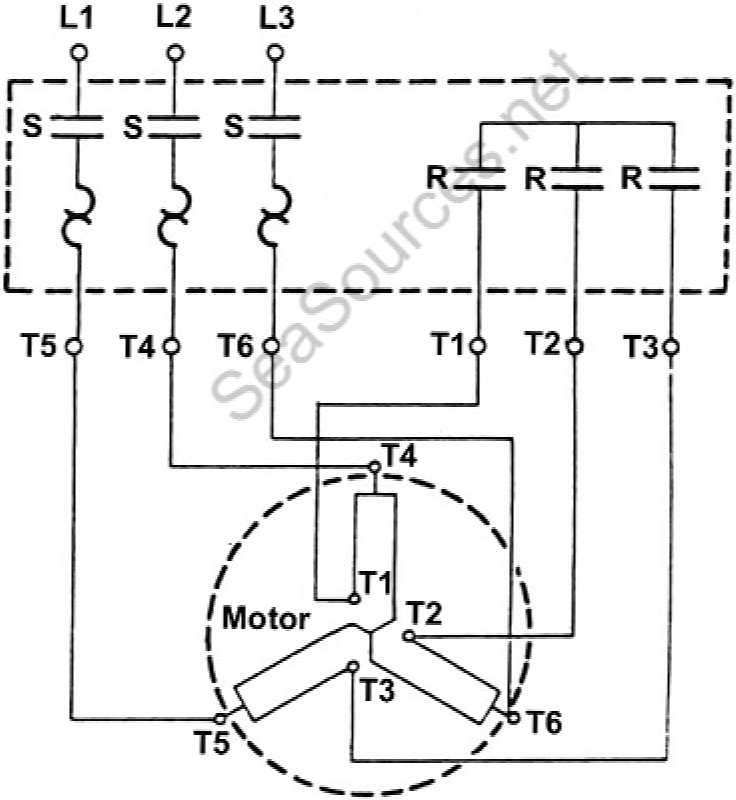


L1
L2
L3
S2
S2
S2
M
M
M
R
R
R
S1
S1
OL
OL
OL
T1
T6
T2
T4
T3
T5
MOTOR

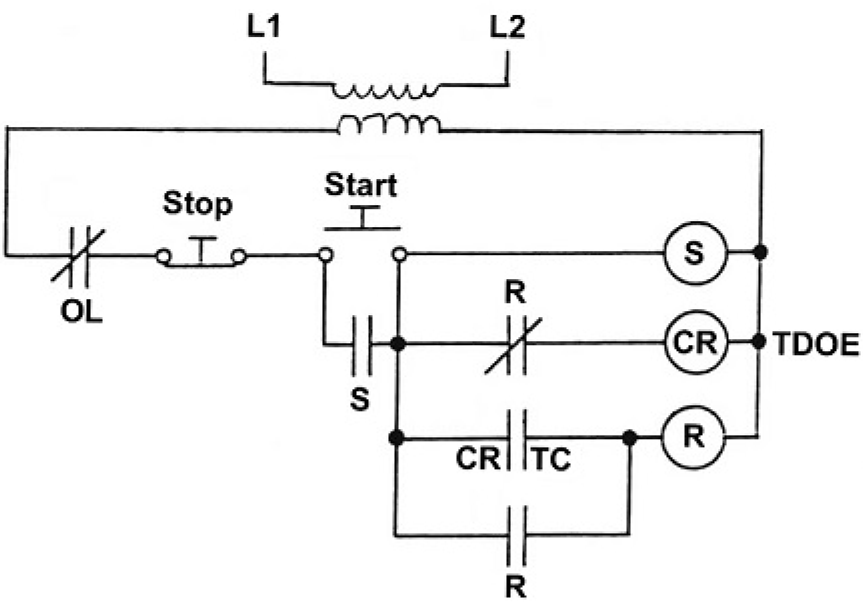


L1
XFMR
L2
OL
STOP
START
M
R
CR
TDOE
M
S2
S1
CR (TC)
S2
S1
R
R

EL-0117



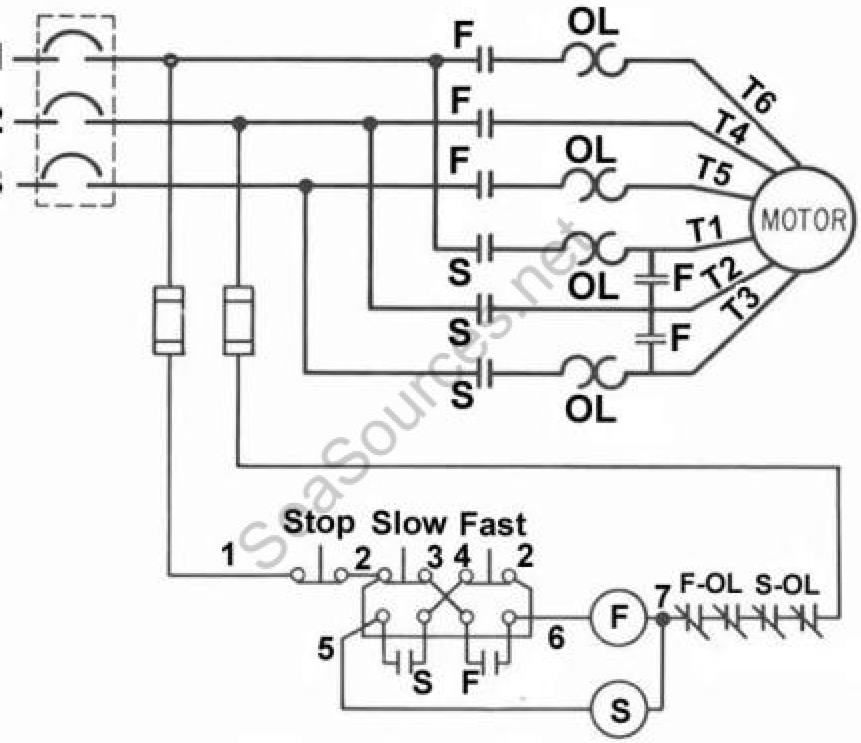
L1
L2
L3
S
S
S
R
R
R
T5
T4
T6
T1
T2
T3
T4
T1
Motor
T2
T3
T5
T6



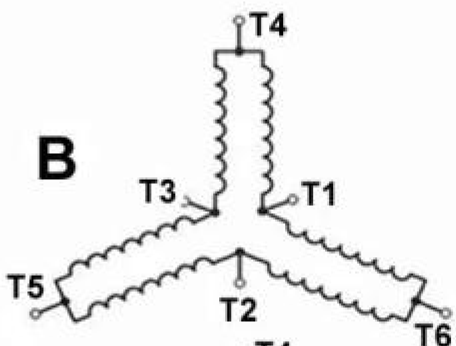
L1
L2
Stop
Start
S
OL
R
CR
TDOE
S
R
CR
TC
R

EL-0118

A



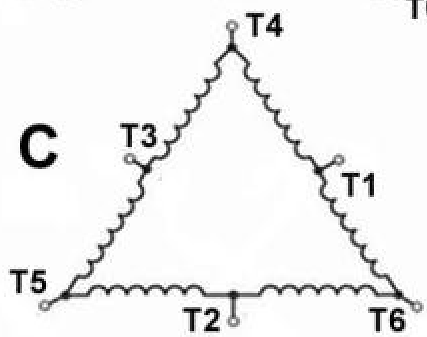
B



Two-speed single winding (constant torque)

Speed	L1	L2	L3	Tie together
Low	T1	T2	T3	-----------------
High	T6	T4	T5	T1 T2 T3

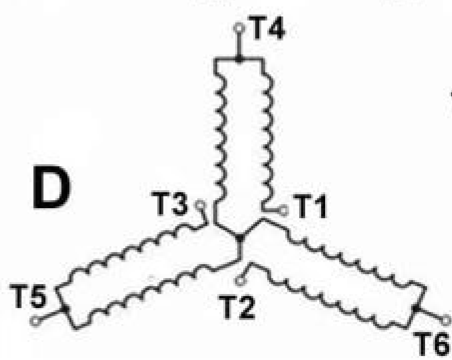
C



Two-speed single winding (variable torque)

Speed	L1	L2	L3	Tie together
Low	T1	T2	T3	-----------------
High	T6	T4	T5	T1 T2 T3

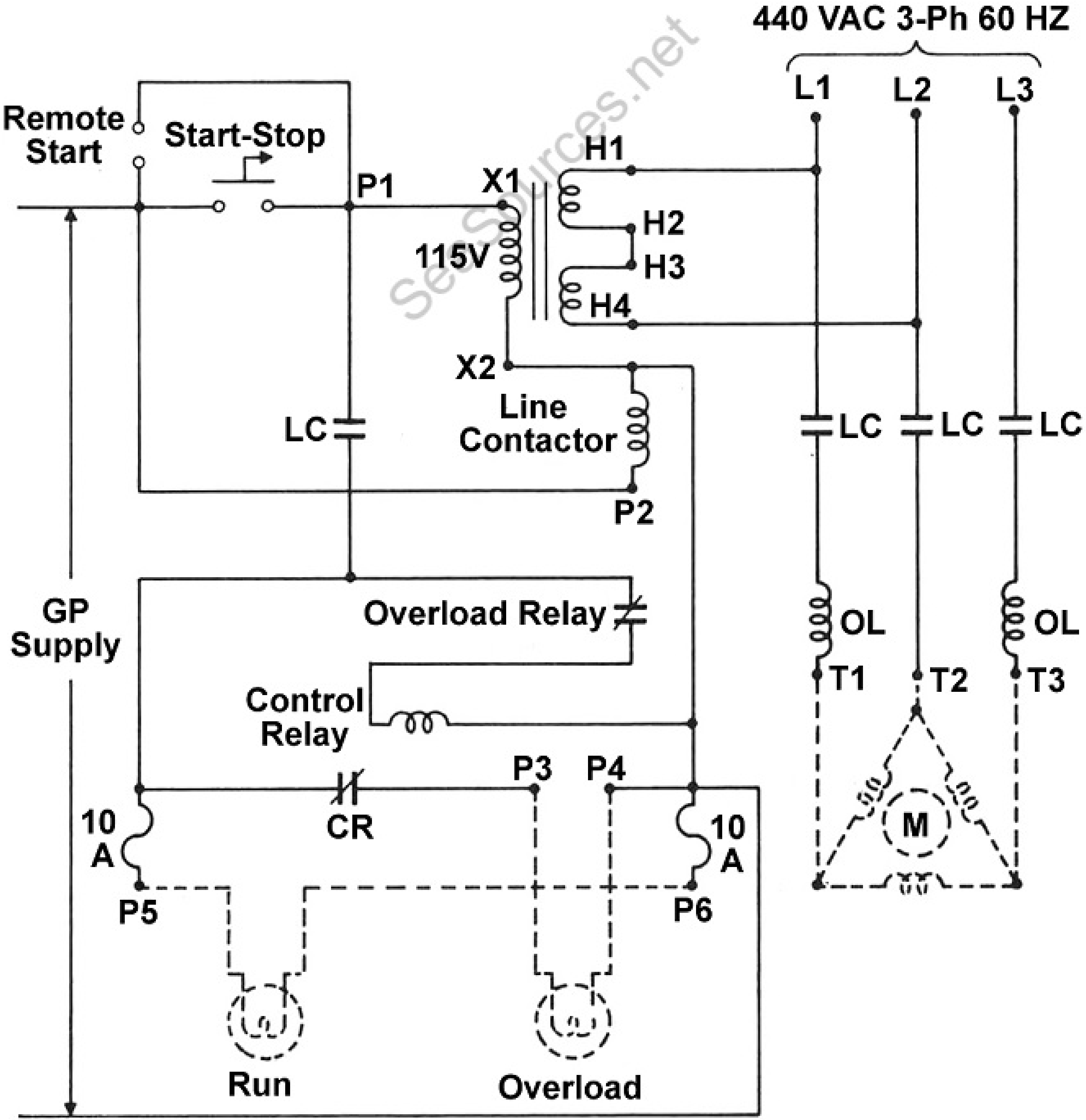
D



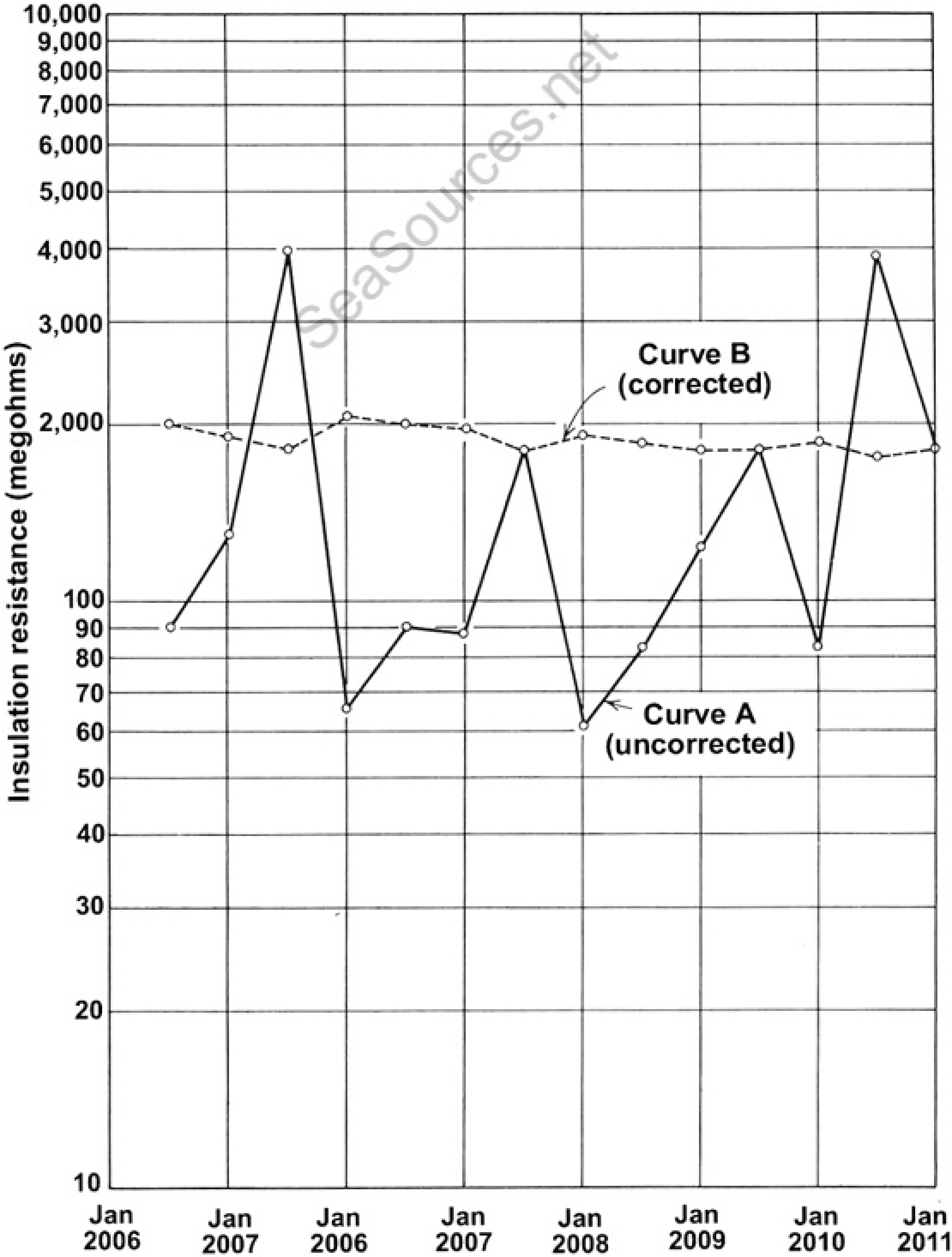
Two-speed single winding (constant horsepower)

Speed	L1	L2	L3	Tie together
Low	T1	T2	T3	T6 T4 T5
High	T6	T4	T5	-----------------

EL-0119


440 VAC 3-Ph 60 HZ
L1
L2
L3
Remote
Start
Start-Stop
P1
X1
H1
H2
H3
H4
115V
X2
Line
Contactor
LC
P2
LC
LC
LC
OL
OL
T1
T2
T3
M
GP
Supply
Overload Relay
Control
Relay
P3
P4
CR
10
A
10
A
P5
P6
Run
Overload

EL-0120



10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
100
90
80
70
60
50
40
30
20
10
Insulation resistance (megohms)
Curve B
(corrected)
Curve A
(uncorrected)
Jan 2006
Jan 2007
Jan 2006
Jan 2007
Jan 2008
Jan 2009
Jan 2010
Jan 2011

EL-0121

A

B

C

D

E

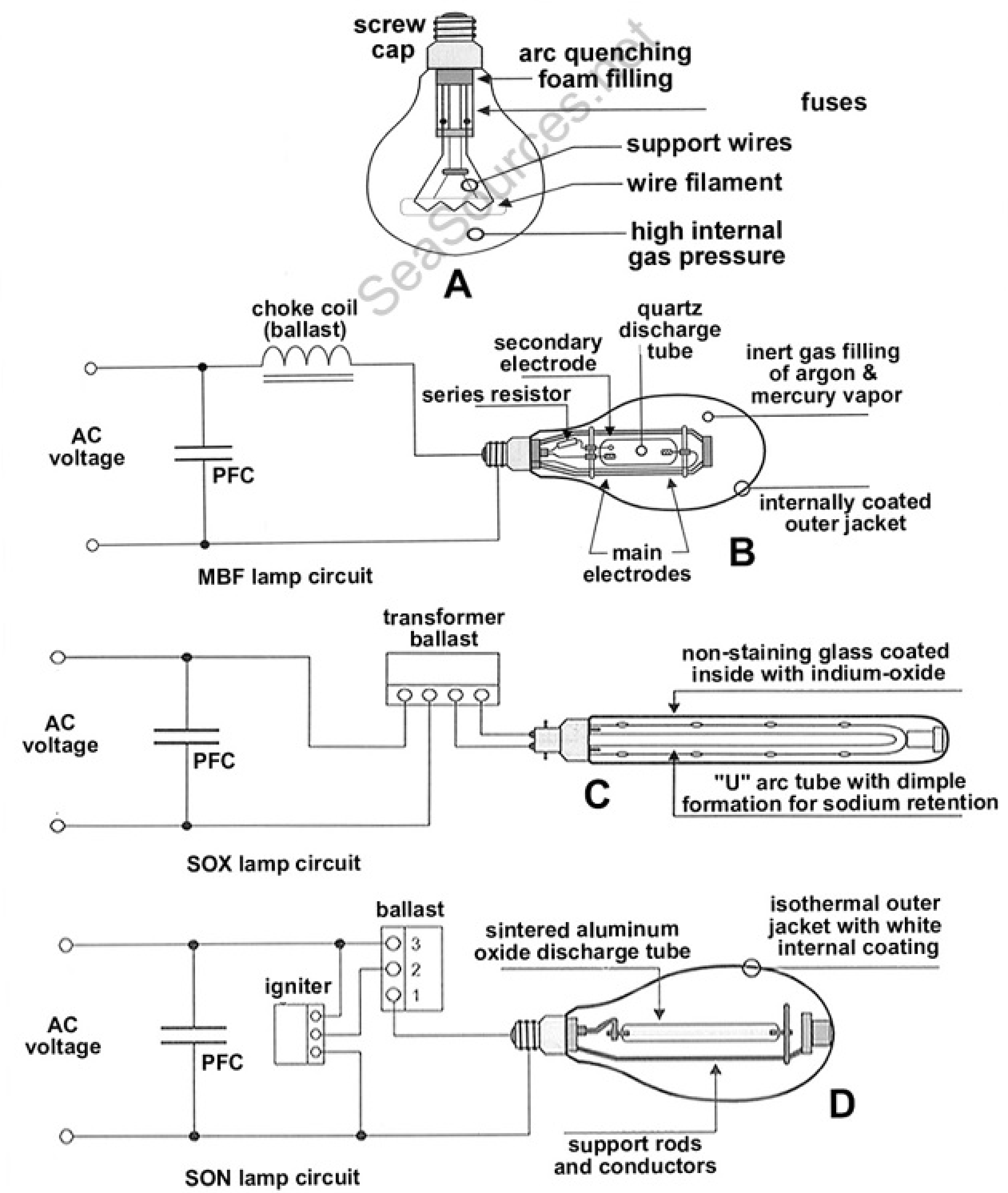
F

G

H

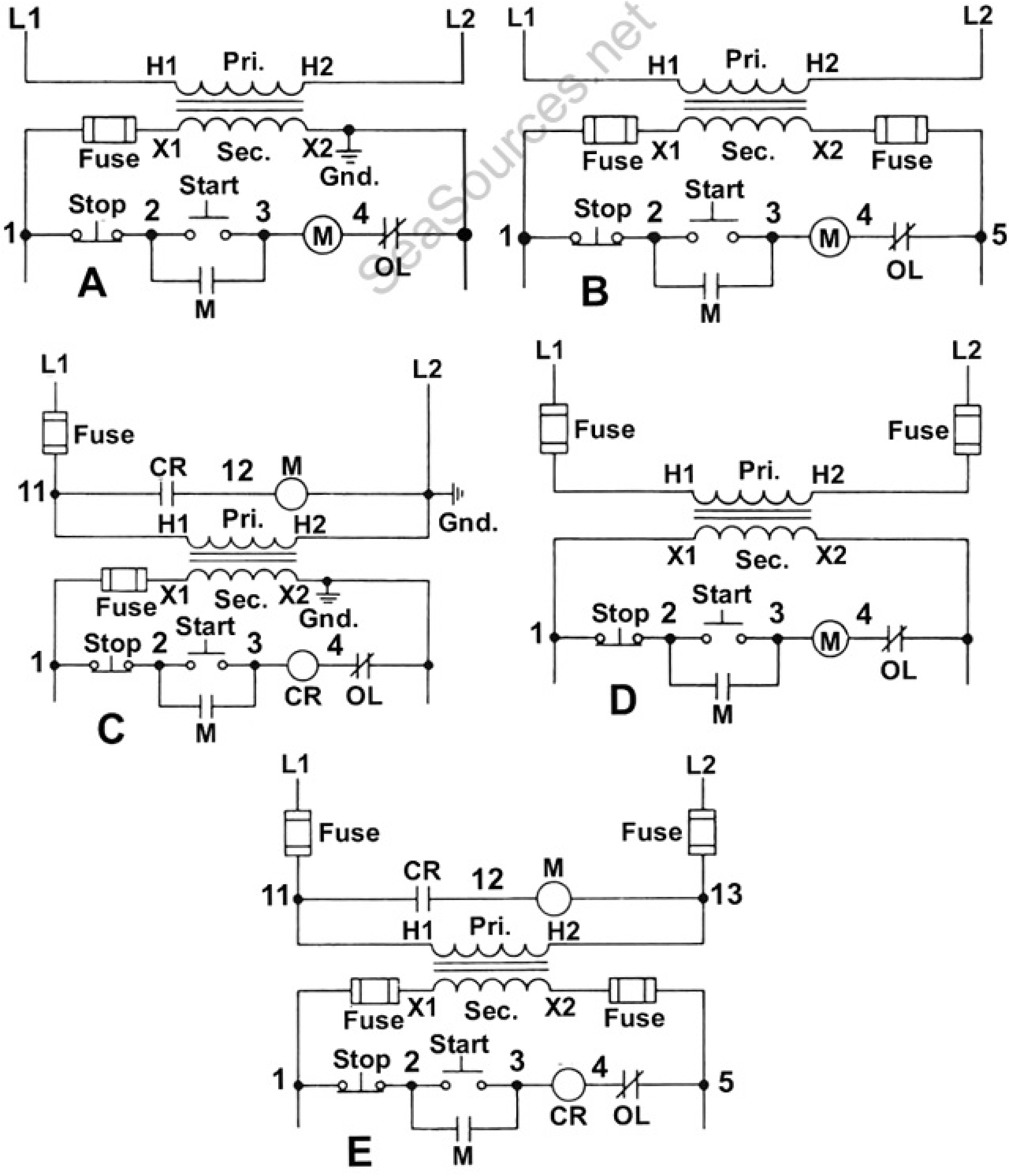
I

EL-0122

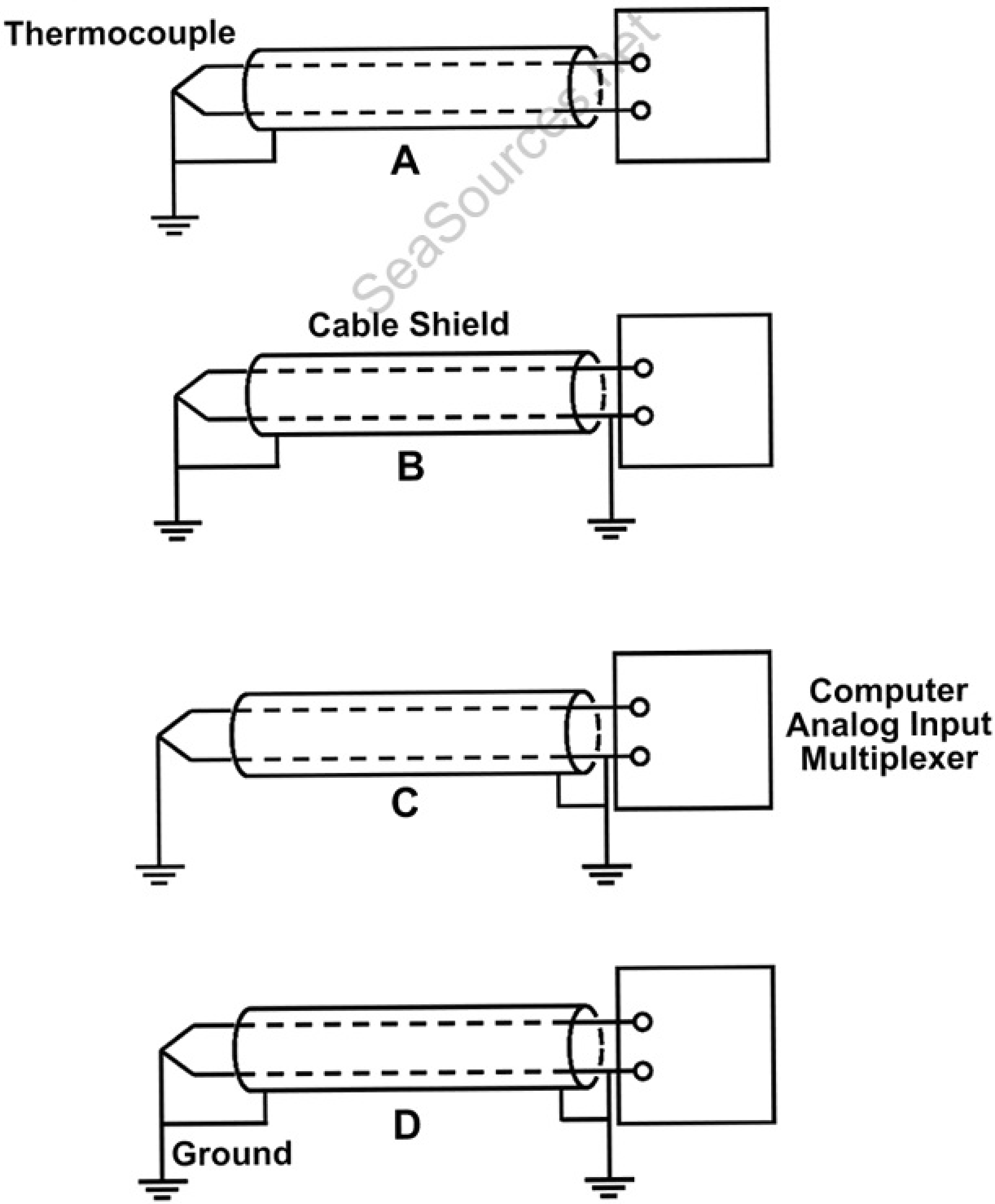


screw cap
arc quenching foam filling
fuses
support wires
wire filament
high internal gas pressure
A
choke coil (ballast)
AC voltage
PFC
series resistor
secondary electrode
quartz discharge tube
inert gas filling of argon & mercury vapor
internally coated outer jacket
main electrodes
B
MBF lamp circuit
transformer ballast
AC voltage
PFC
non-staining glass coated inside with indium-oxide
"U" arc tube with dimple formation for sodium retention
C
SOX lamp circuit
ballast
3
2
1
igniter
AC voltage
PFC
sintered aluminum oxide discharge tube
isothermal outer jacket with white internal coating
support rods and conductors
D
SON lamp circuit

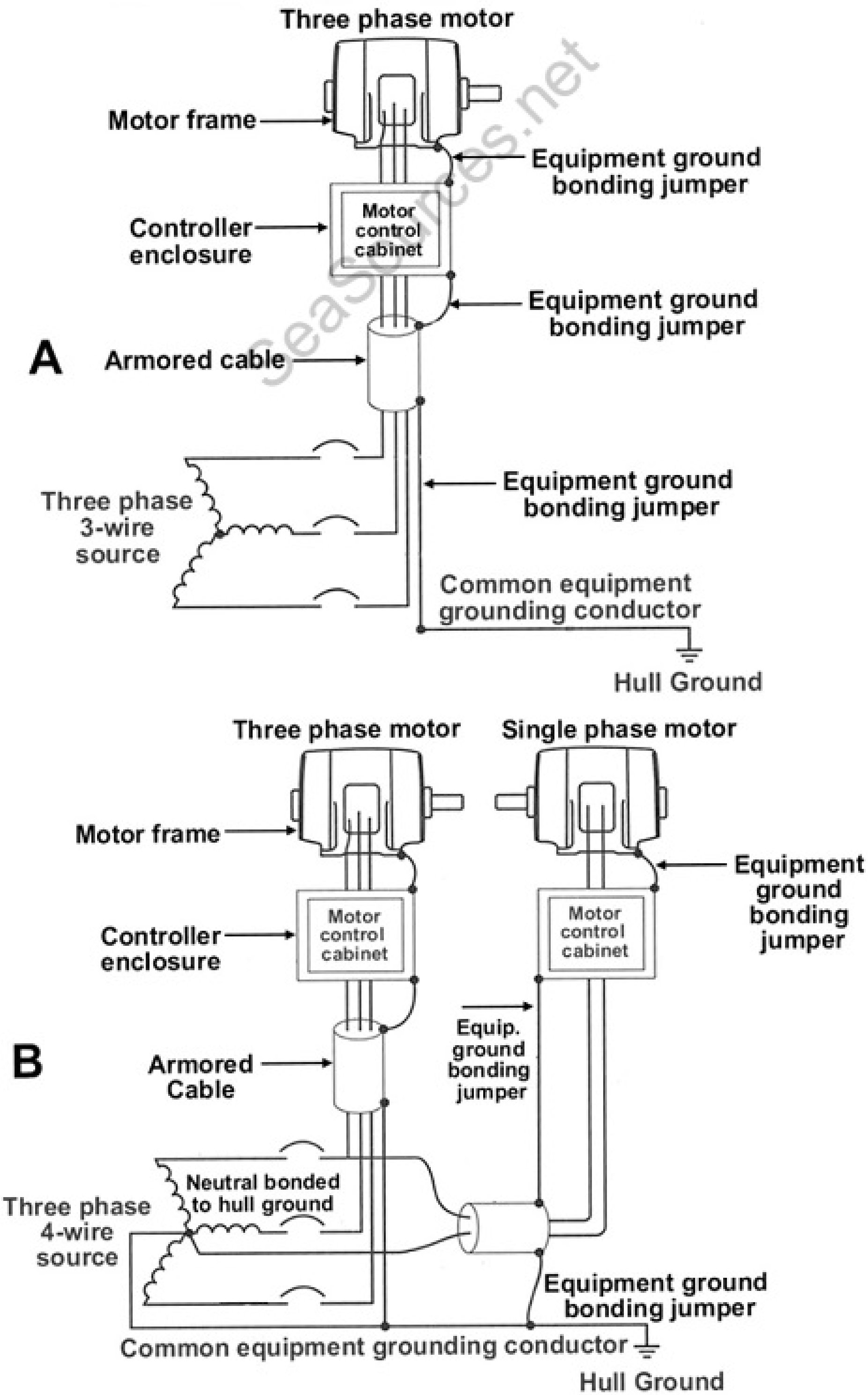
EL-0123


A
L1
L2
H1
Pri.
H2
Fuse
X1
Sec.
X2
Gnd.
Stop
Start
1
2
3
4
M
OL
B
L1
L2
H1
Pri.
H2
Fuse
X1
Sec.
X2
Fuse
Stop
Start
1
2
3
4
5
M
OL
C
L1
L2
Fuse
CR
12
M
11
Gnd.
H1
Pri.
H2
Fuse
X1
Sec.
X2
Gnd.
Stop
Start
1
2
3
4
CR
OL
M
D
L1
L2
Fuse
Fuse
H1
Pri.
H2
X1
Sec.
X2
Stop
Start
1
2
3
4
M
OL
E
L1
L2
Fuse
Fuse
CR
12
M
11
13
H1
Pri.
H2
Fuse
X1
Sec.
X2
Fuse
Stop
Start
1
2
3
4
5
CR
OL
M

EL-0124

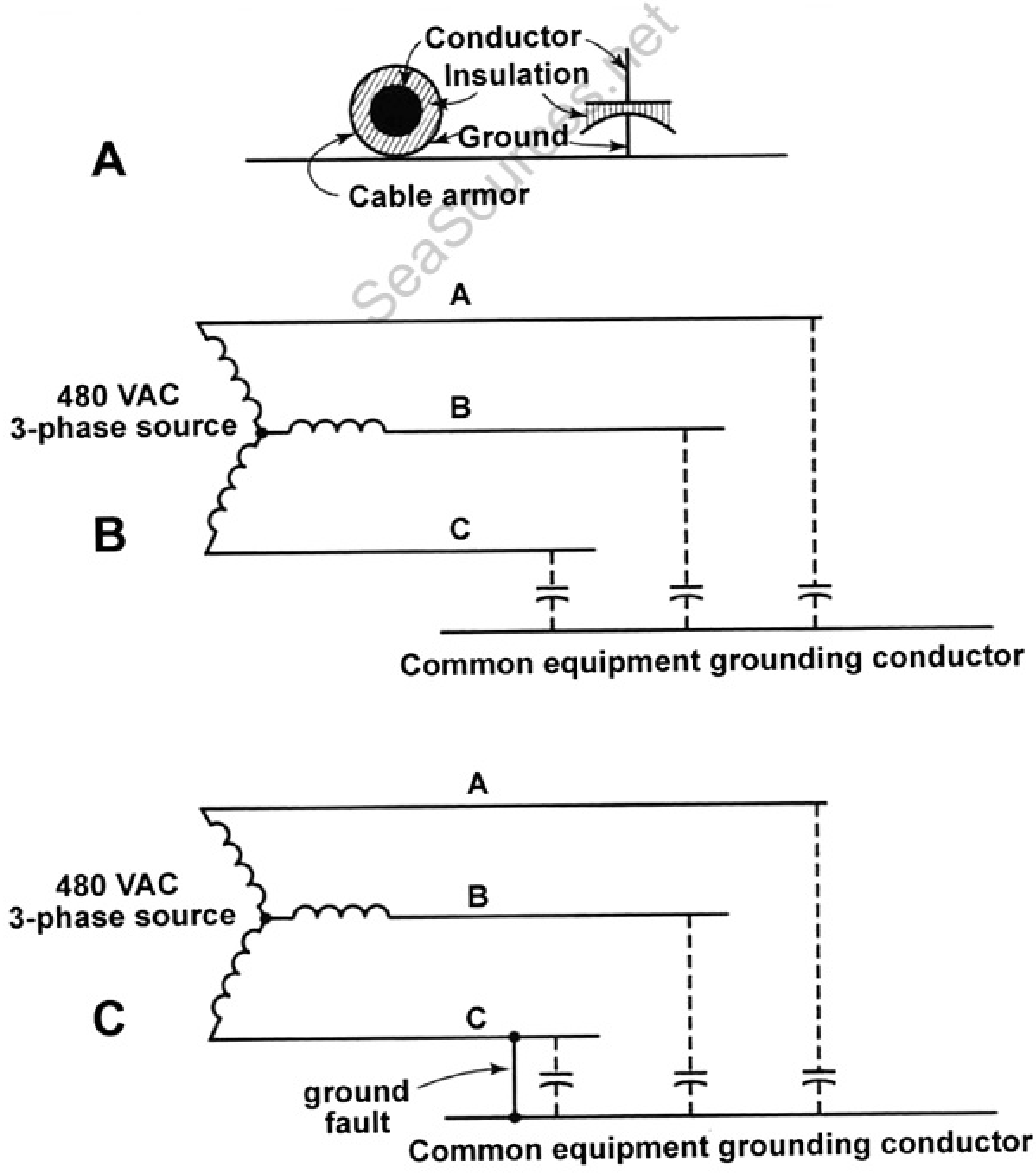

Thermocouple
A
Cable Shield
B
Computer
Analog Input
Multiplexer
C
D
Ground

EL-0125



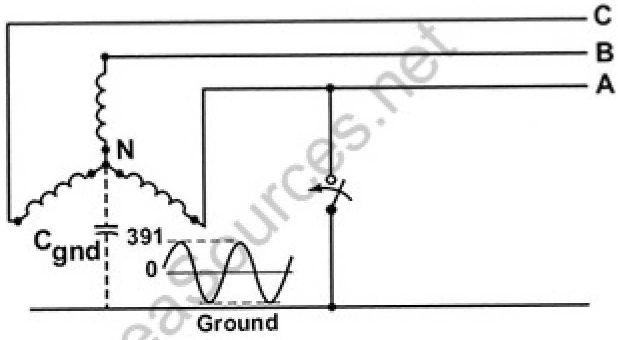
Three phase motor
Motor frame
Equipment ground bonding jumper
Controller enclosure
Motor control cabinet
Equipment ground bonding jumper
A
Armored cable
Three phase 3-wire source
Equipment ground bonding jumper
Common equipment grounding conductor
Hull Ground
Three phase motor
Single phase motor
Motor frame
Equipment ground bonding jumper
Controller enclosure
Motor control cabinet
Motor control cabinet
Equip. ground bonding jumper
B
Armored Cable
Neutral bonded to hull ground
Three phase 4-wire source
Equipment ground bonding jumper
Common equipment grounding conductor
Hull Ground

EL-0126


A
Conductor
Insulation
Ground
Cable armor
B
A
B
C
480 VAC
3-phase source
Common equipment grounding conductor
C
A
B
C
480 VAC
3-phase source
ground
fault
Common equipment grounding conductor

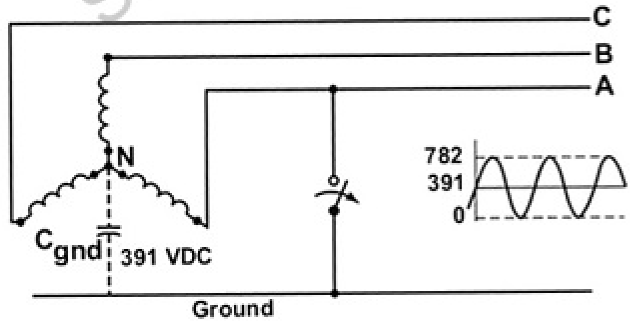
EL-0127

A



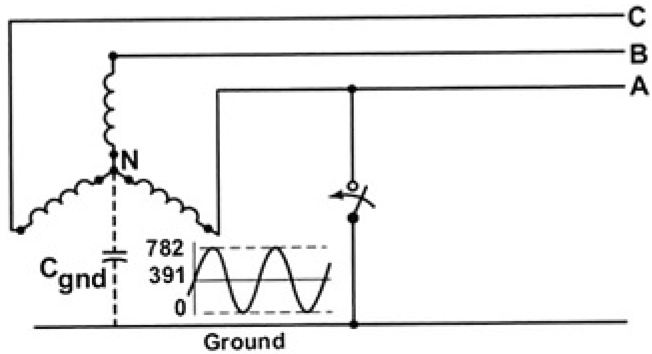
C
B
A
N
Cgnd
391
0
Ground

B



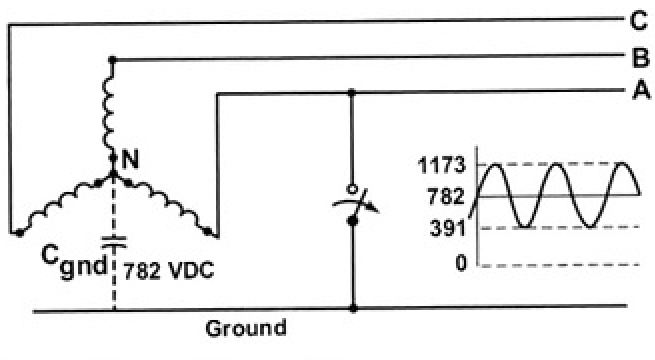
C
B
A
N
782
391
0
Cgnd
391 VDC
Ground

C



C
B
A
N
782
391
0
Cgnd
Ground

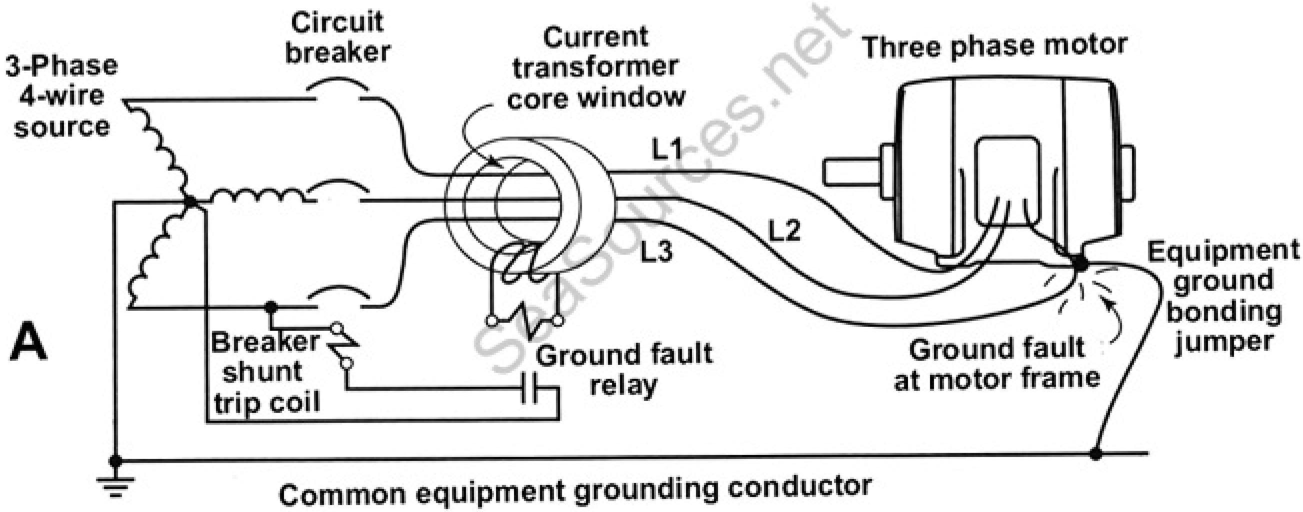
D



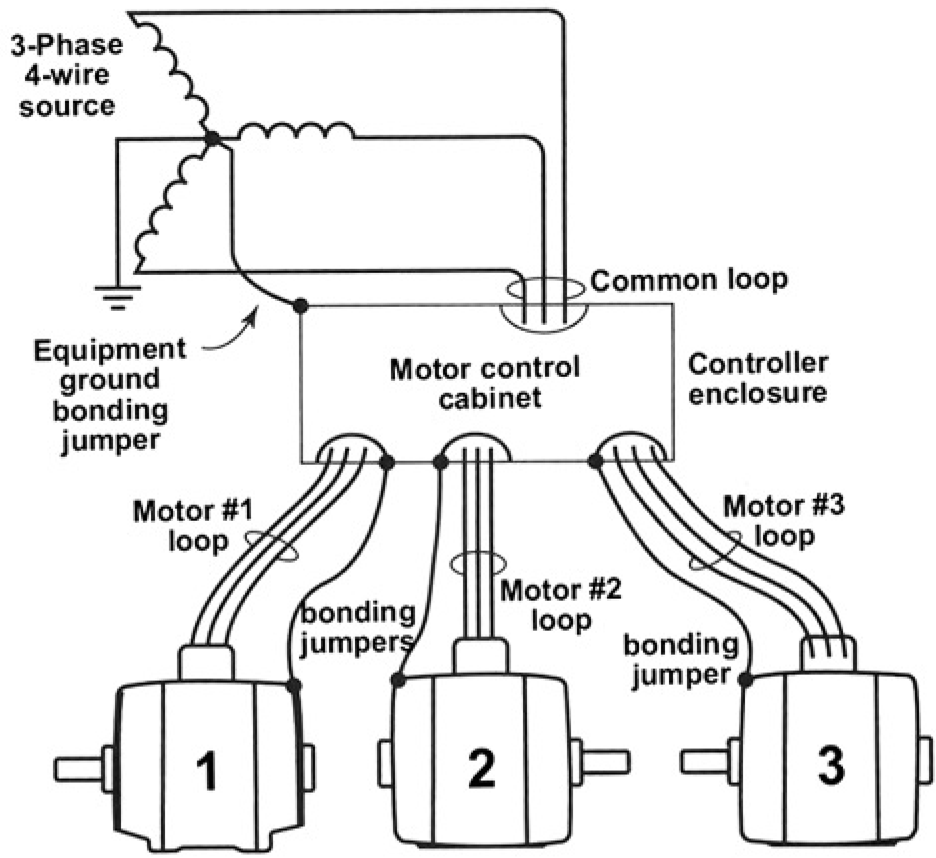
C
B
A
N
1173
782
391
0
Cgnd
782 VDC
Ground

EL-0128

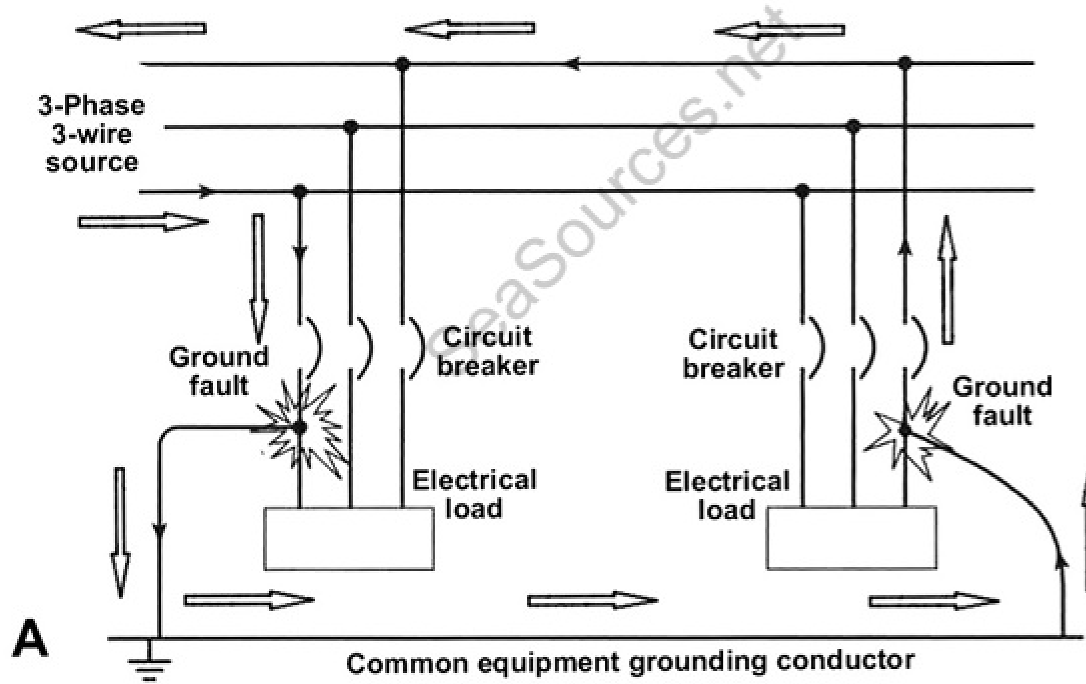
A

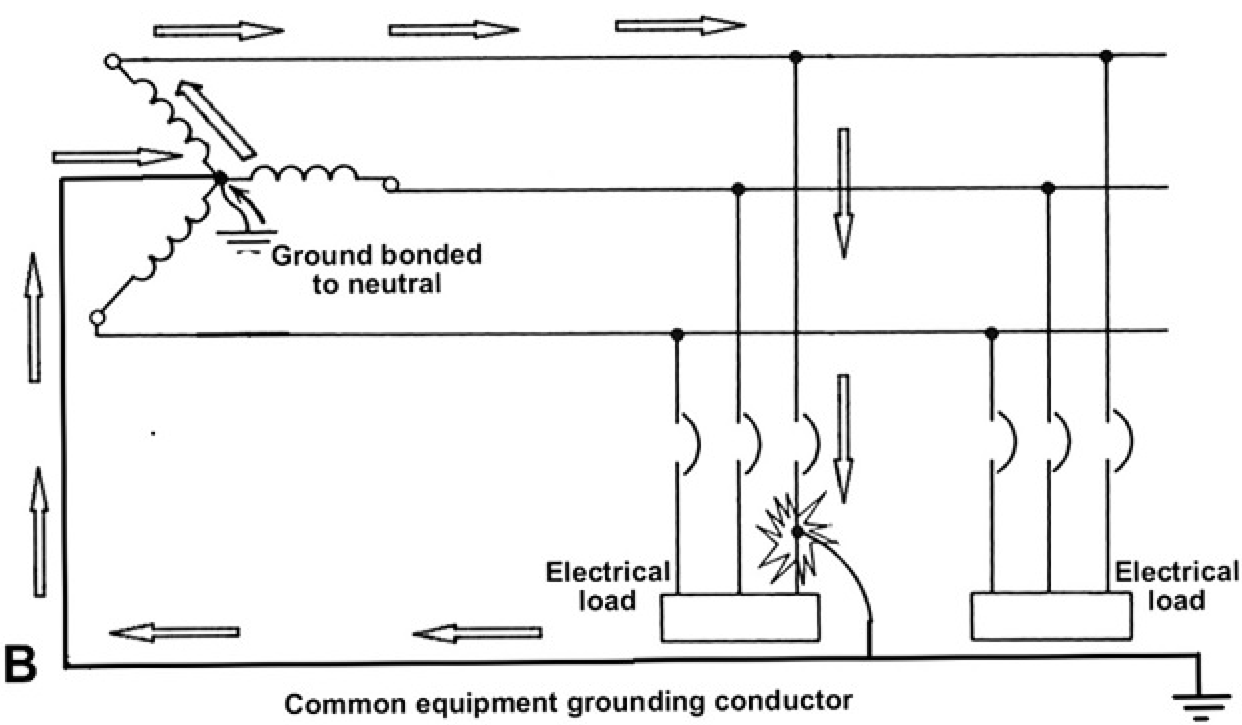

3-Phase
4-wire
source
Circuit
breaker
Current
transformer
core window
Three phase motor
L1
L2
L3
Equipment
ground
bonding
jumper
Breaker
shunt
trip coil
Ground fault
relay
Ground fault
at motor frame
Common equipment grounding conductor

B

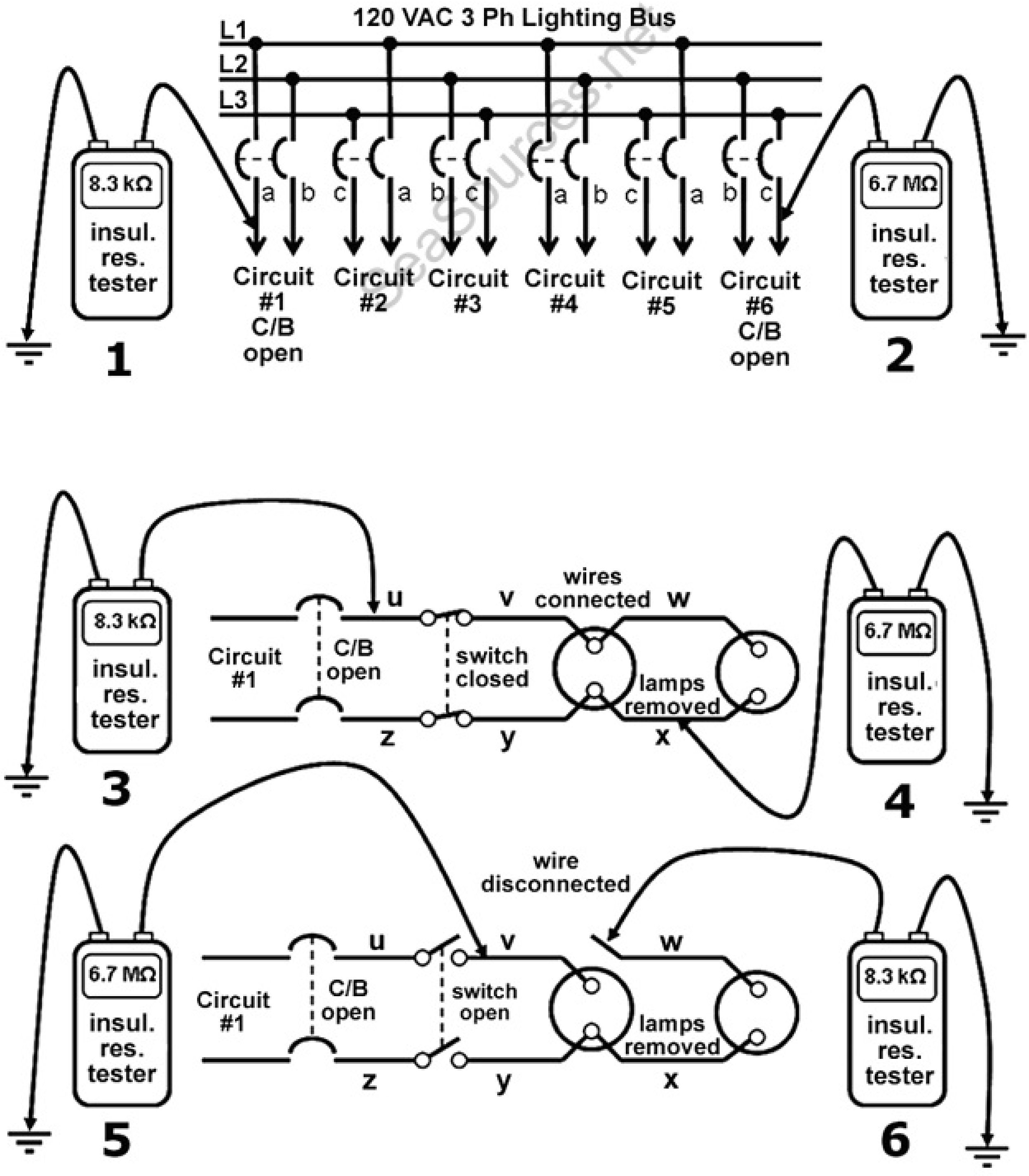

3-Phase
4-wire
source
Common loop
Equipment
ground
bonding
jumper
Motor control
cabinet
Controller
enclosure
Motor #1
loop
bonding
jumpers
Motor #2
loop
bonding
jumper
Motor #3
loop
1
2
3

EL-0129


3-Phase
3-wire
source
Ground
fault
Circuit
breaker
Electrical
load
Circuit
breaker
Ground
fault
Electrical
load
A
Common equipment grounding conductor
SeaSources.net

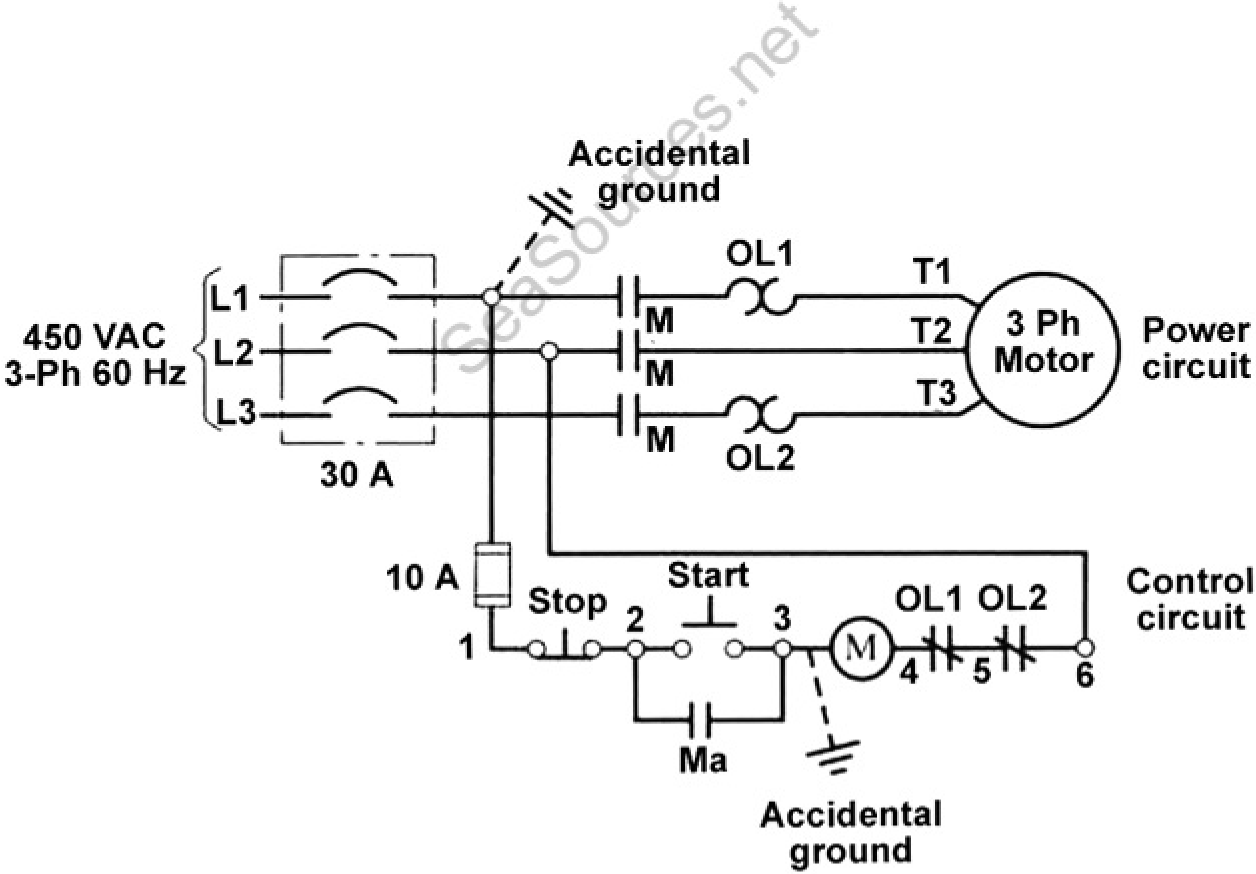

Ground bonded
to neutral
Electrical
load
Electrical
load
B
Common equipment grounding conductor

EL-0130

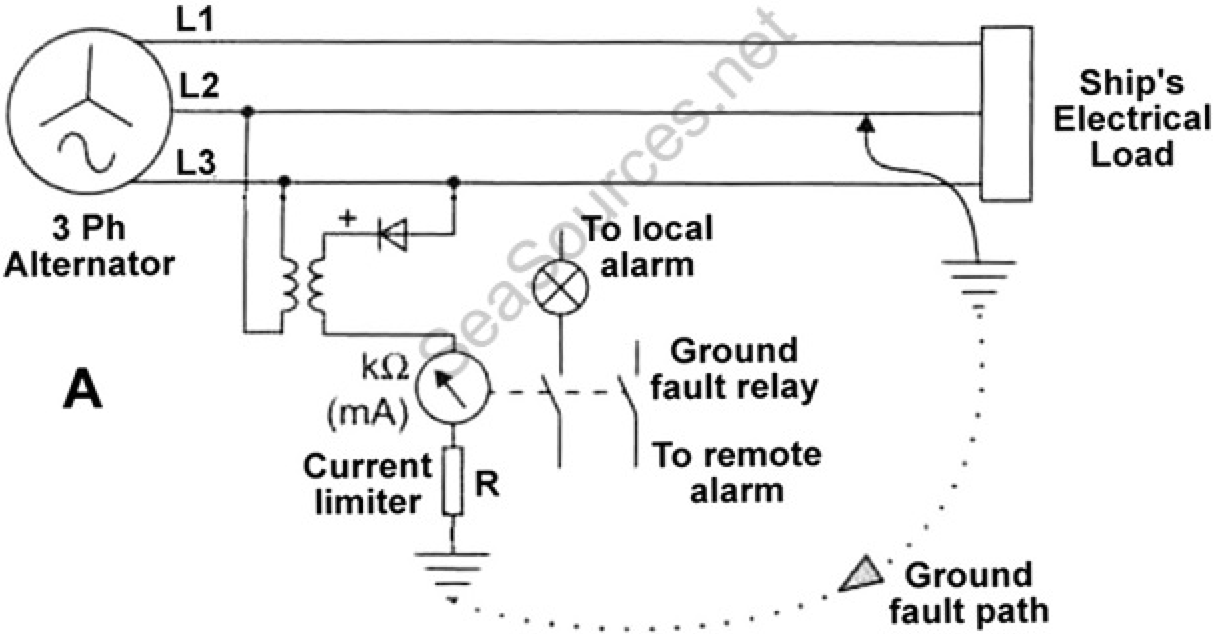


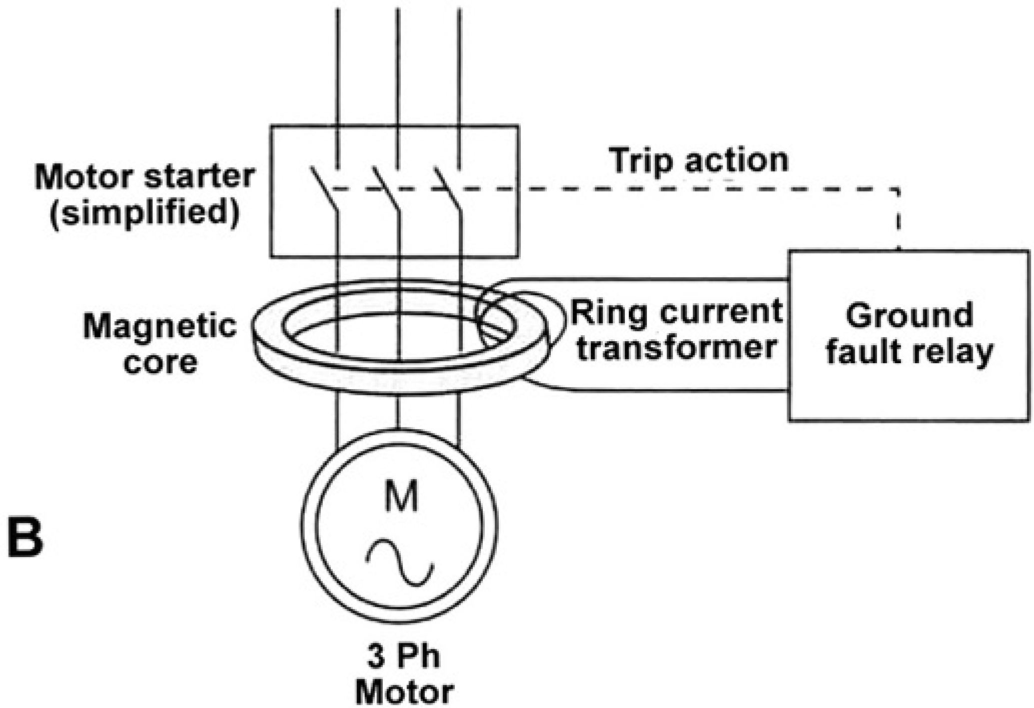
120 VAC 3 Ph Lighting Bus
L1
L2
L3
8.3 kΩ
insul. res. tester
1
a
b
c
a
b
c
a
b
c
a
b
c
Circuit #1 C/B open
Circuit #2
Circuit #3
Circuit #4
Circuit #5
Circuit #6 C/B open
6.7 MΩ
insul. res. tester
2
8.3 kΩ
insul. res. tester
3
u
v
wires connected
w
Circuit #1
C/B open
switch closed
lamps removed
z
y
x
6.7 MΩ
insul. res. tester
4
6.7 MΩ
insul. res. tester
5
wire disconnected
u
v
w
Circuit #1
C/B open
switch open
lamps removed
z
y
x
8.3 kΩ
insul. res. tester
6

EL-0131

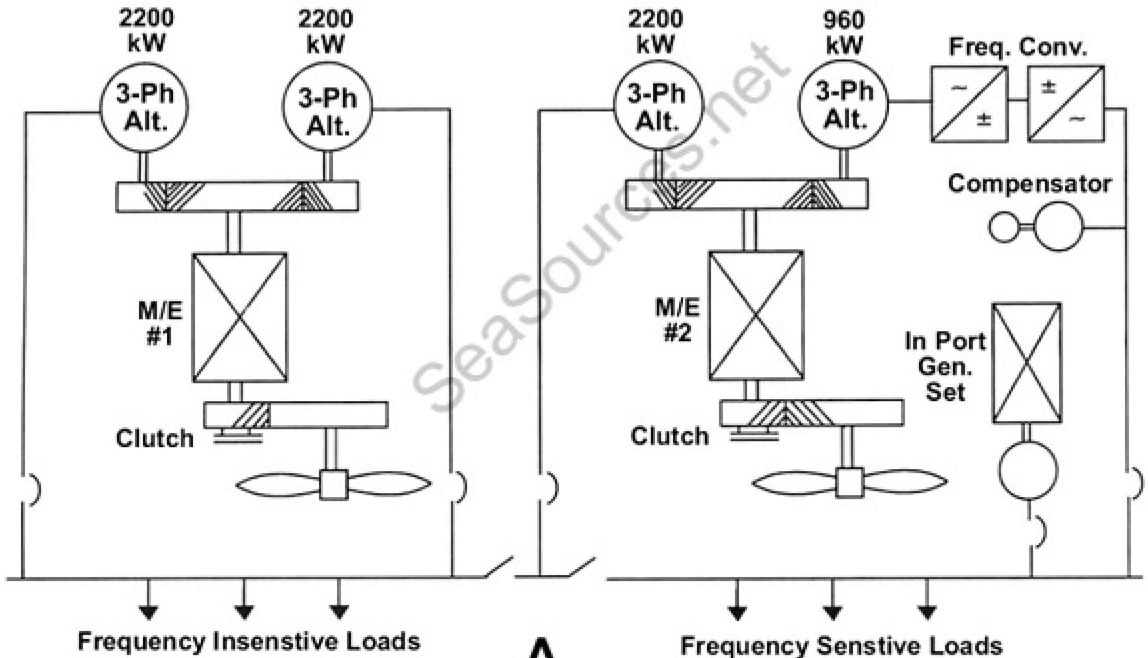

Accidental ground
450 VAC
3-Ph 60 Hz
L1
L2
L3
30 A
M
M
M
OL1
OL2
T1
T2
T3
3 Ph Motor
Power circuit
10 A
Stop
Start
1
2
3
M
4
5
6
OL1 OL2
Control circuit
Ma
Accidental ground

EL-0132

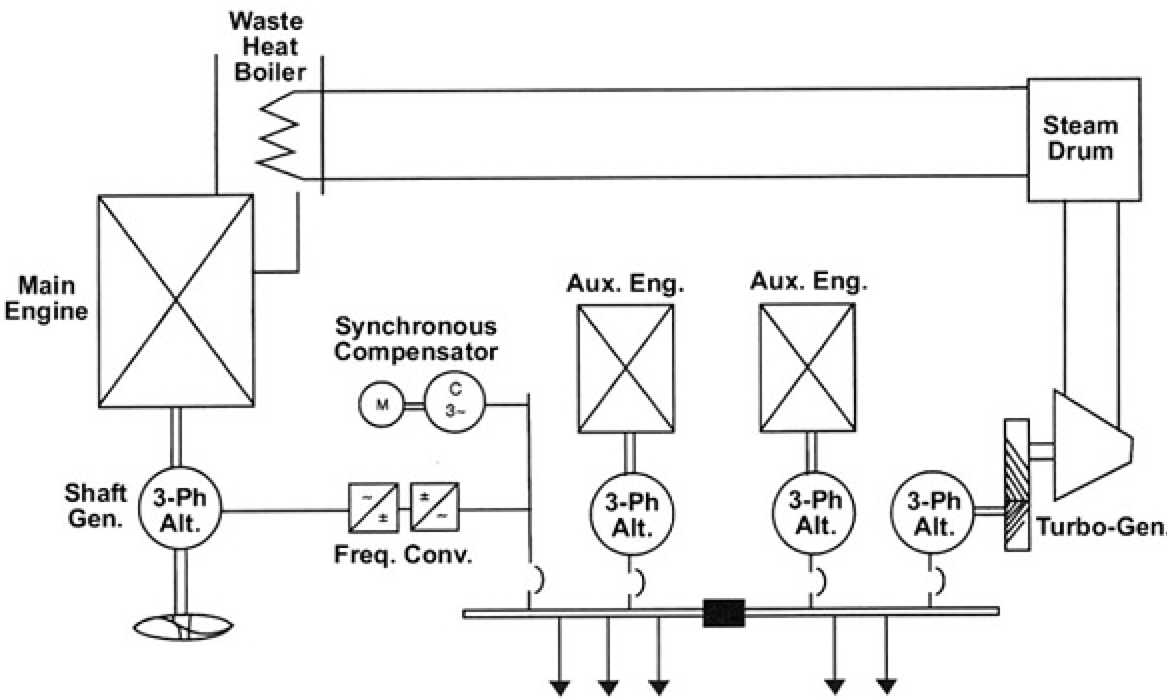

L1
L2
L3
Ship's Electrical Load
3 Ph Alternator
+
To local alarm
Ground fault relay
kΩ
(mA)
To remote alarm
Current limiter
R
Ground fault path
A


Motor starter (simplified)
Trip action
Magnetic core
Ring current transformer
Ground fault relay
M
3 Ph Motor
B

EL-0133

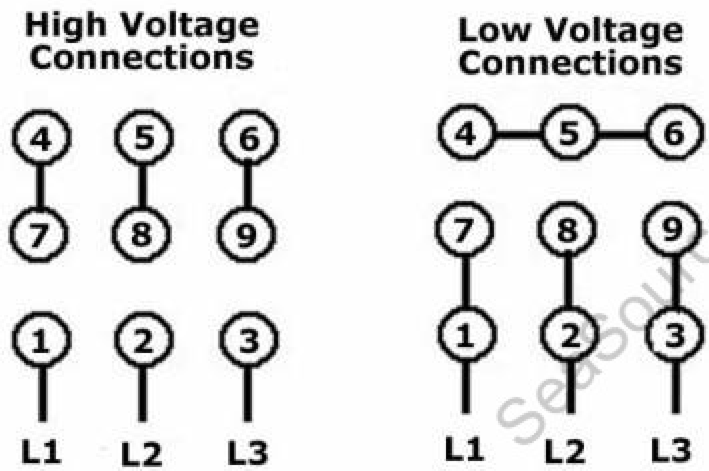

2200 kW
3-Ph Alt.
2200 kW
3-Ph Alt.
M/E #1
Clutch
Frequency Insenstive Loads
2200 kW
3-Ph Alt.
960 kW
3-Ph Alt.
Freq. Conv.
Compensator
M/E #2
In Port Gen. Set
Clutch
Frequency Senstive Loads

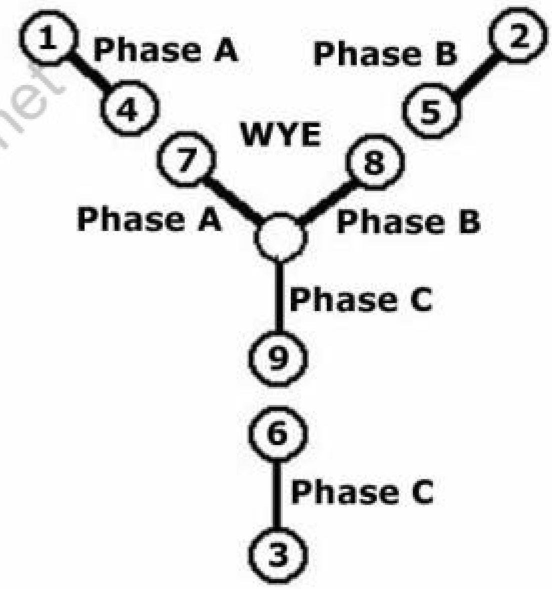
A


Waste Heat Boiler
Steam Drum
Main Engine
Synchronous Compensator
M
C 3~
Aux. Eng.
Aux. Eng.
Shaft Gen.
3-Ph Alt.
Freq. Conv.
3-Ph Alt.
3-Ph Alt.
3-Ph Alt.
Turbo-Gen.

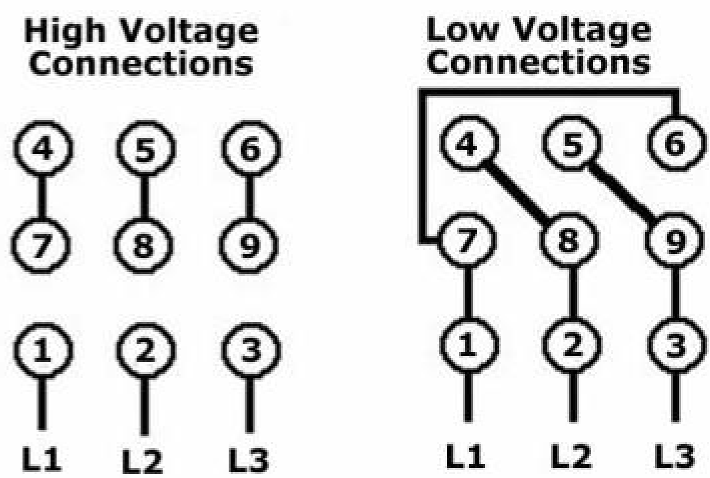
B

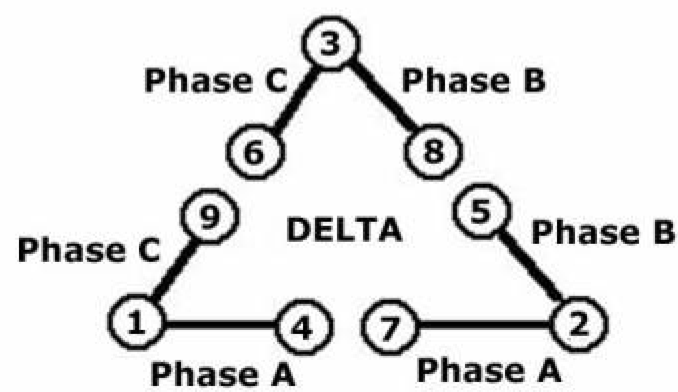
EL-0134





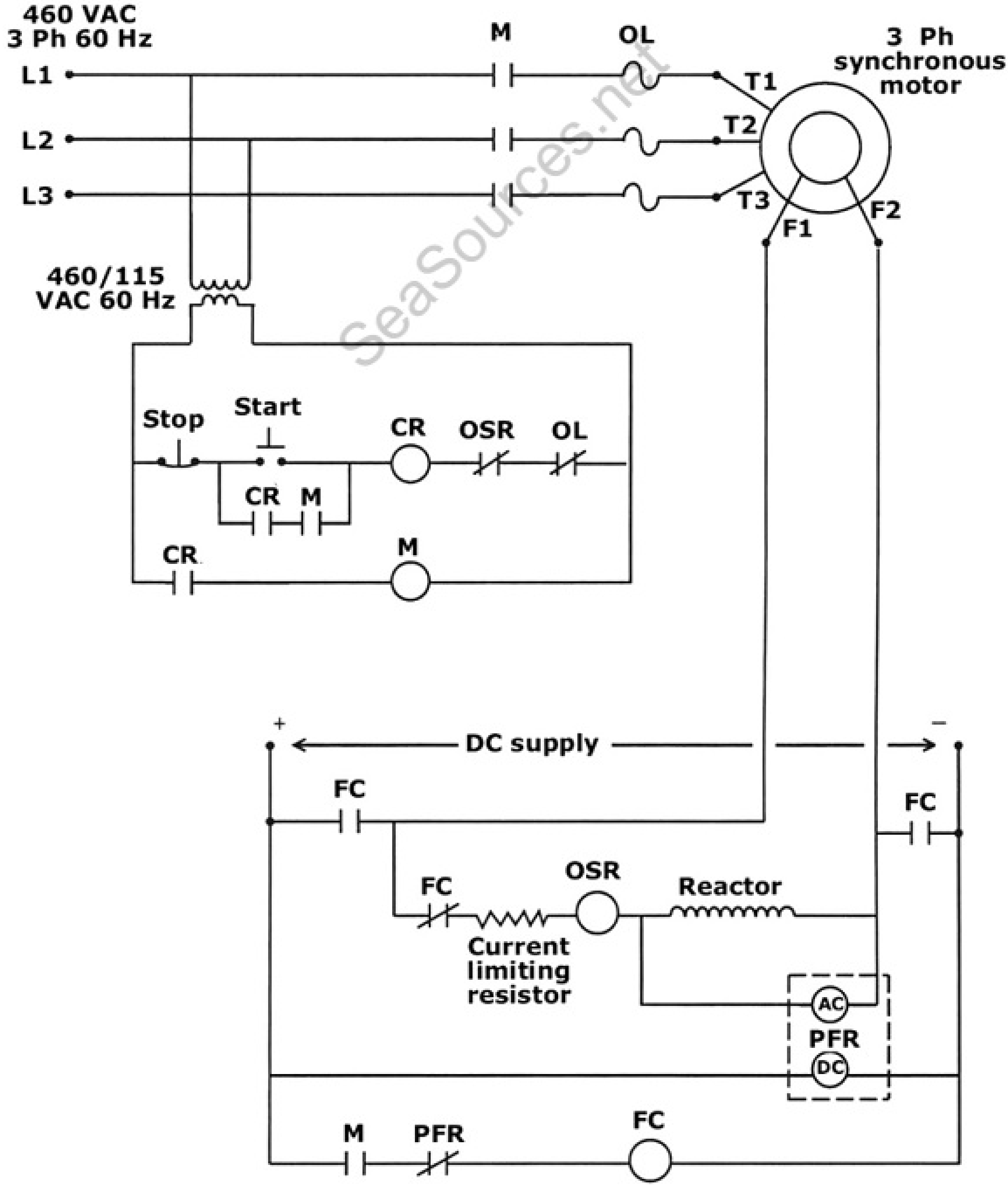
Dual Voltage Wye Connected Motor





Dual Voltage Delta Connected Motor

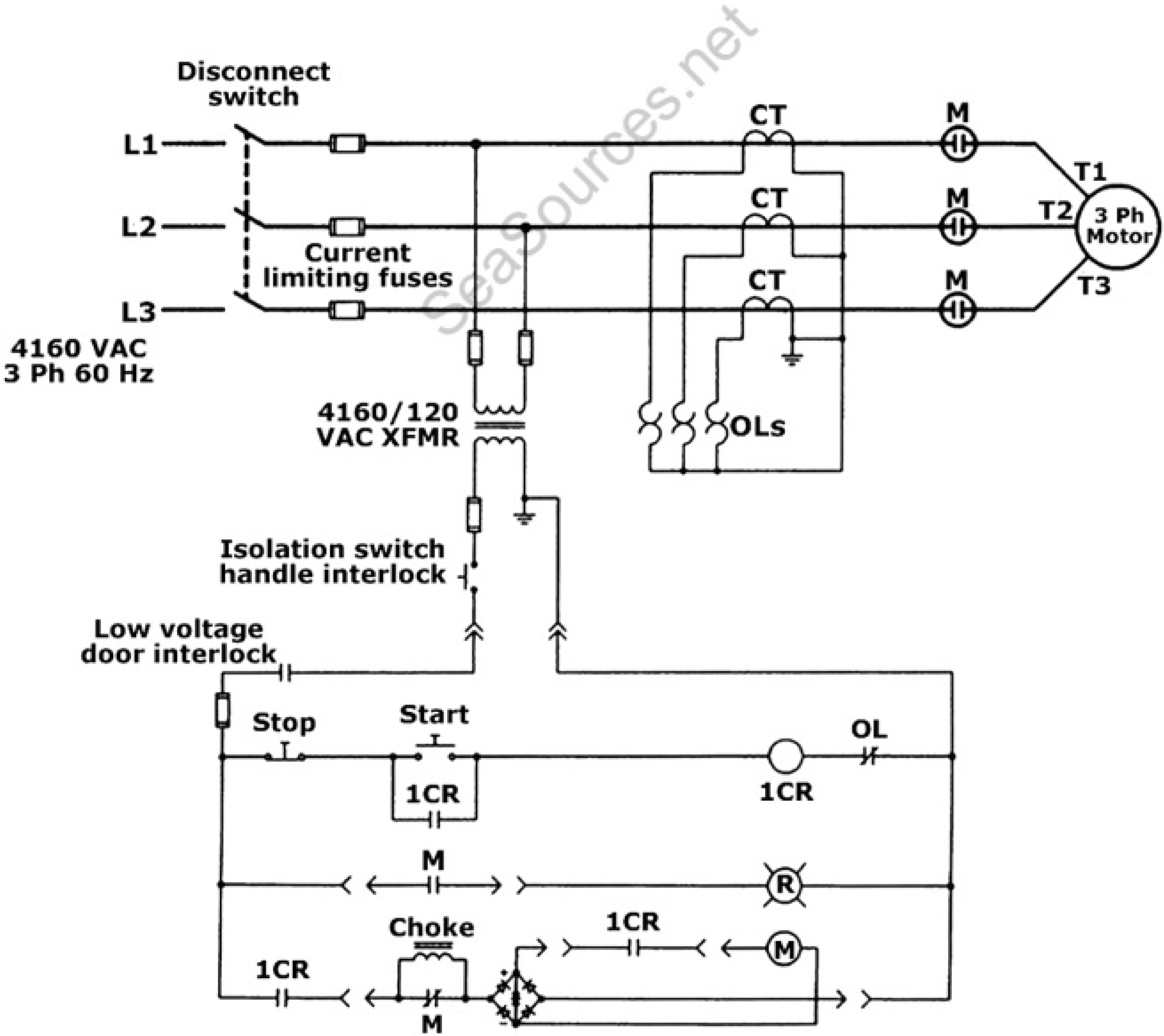
EL-0135



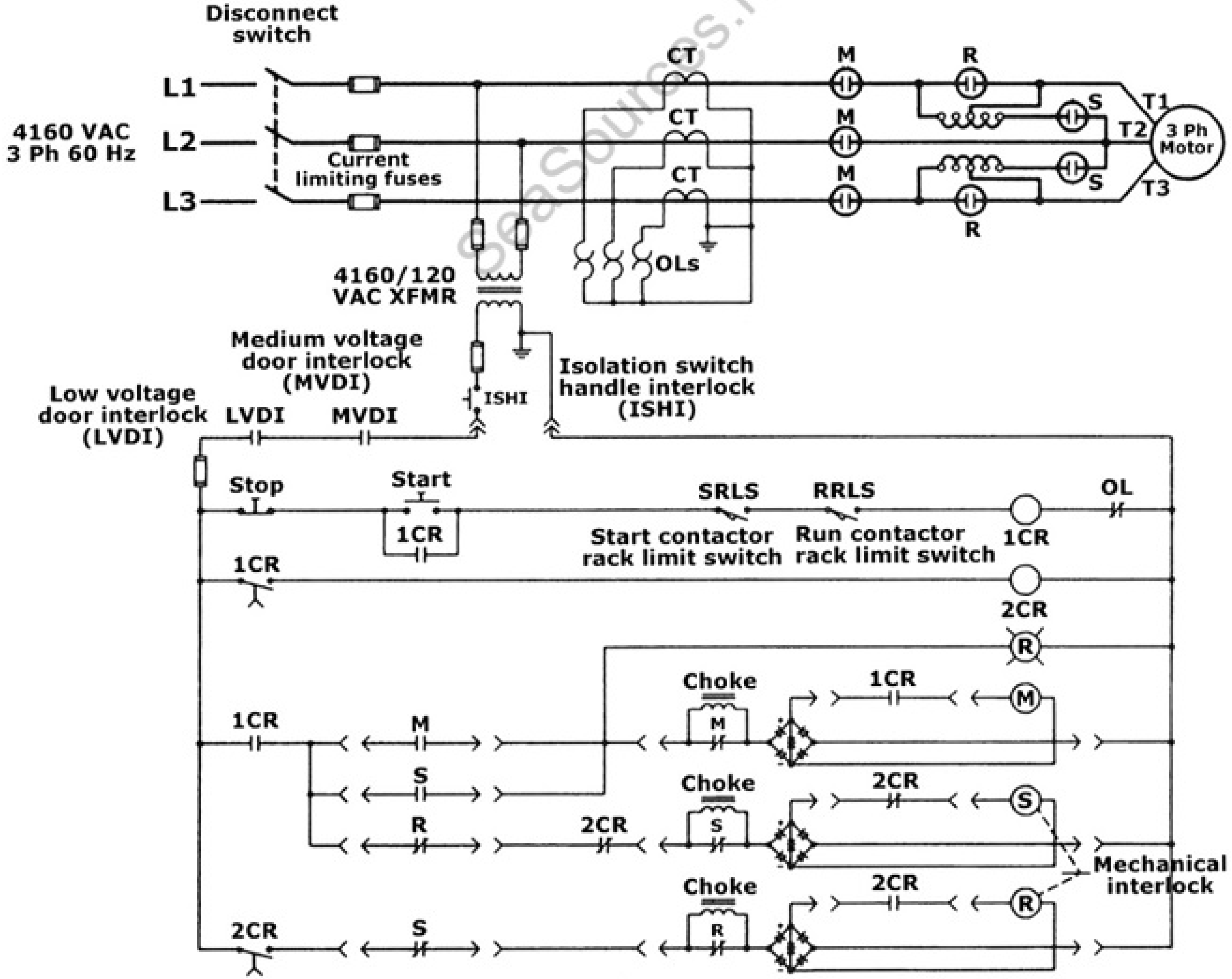
CR: control relay
PFR: polarized frequency relay
OSR: out-of-step relay

FC: field contactor
M: main contactor

EL-0136

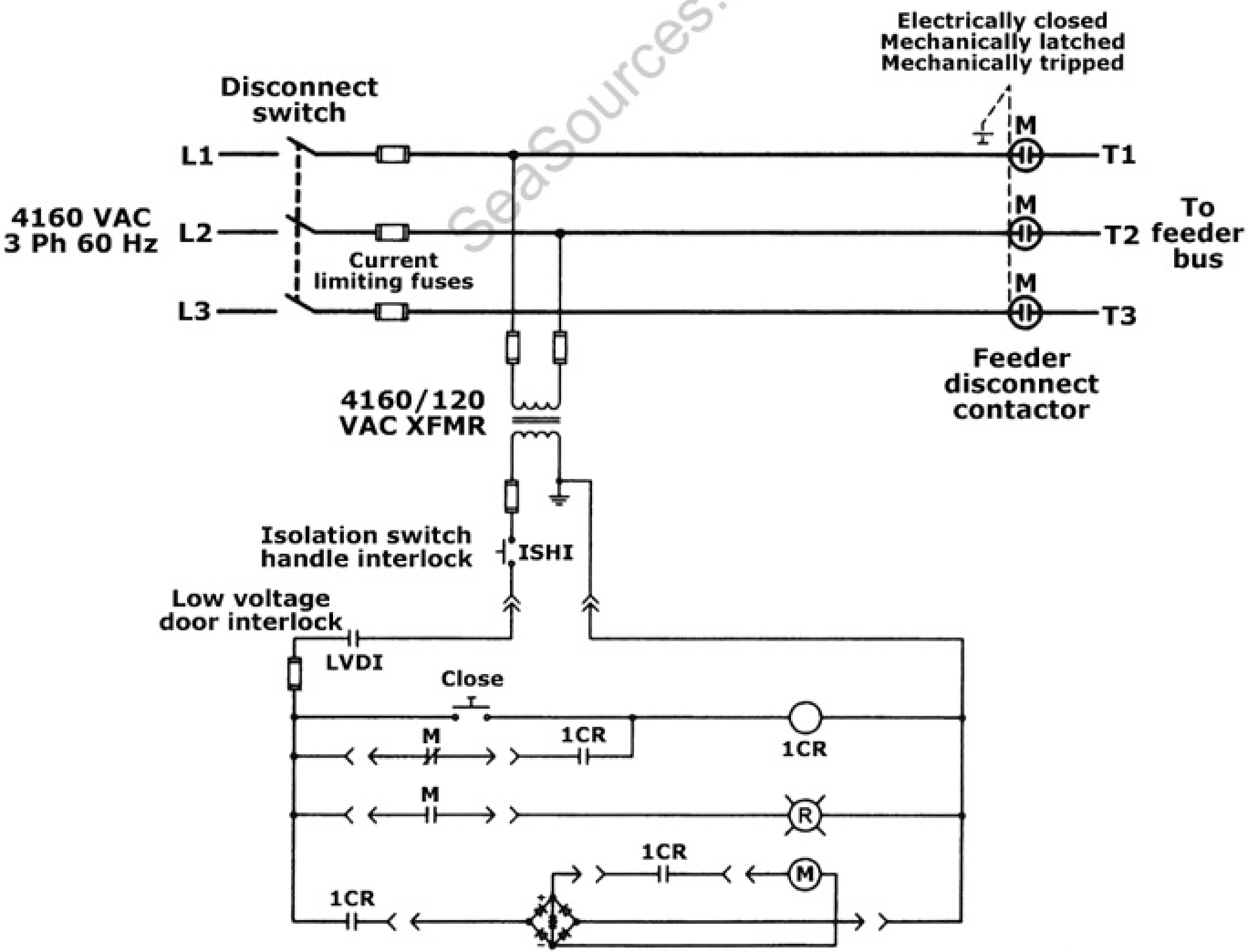

Disconnect switch
L1
L2
L3
4160 VAC
3 Ph 60 Hz
Current limiting fuses
CT
CT
CT
M
M
M
T1
T2
T3
3 Ph Motor
4160/120 VAC XFMR
OLs
Isolation switch handle interlock
Low voltage door interlock
Stop
Start
1CR
1CR
OL
M
R
Choke
1CR
M
1CR
M

EL-0137



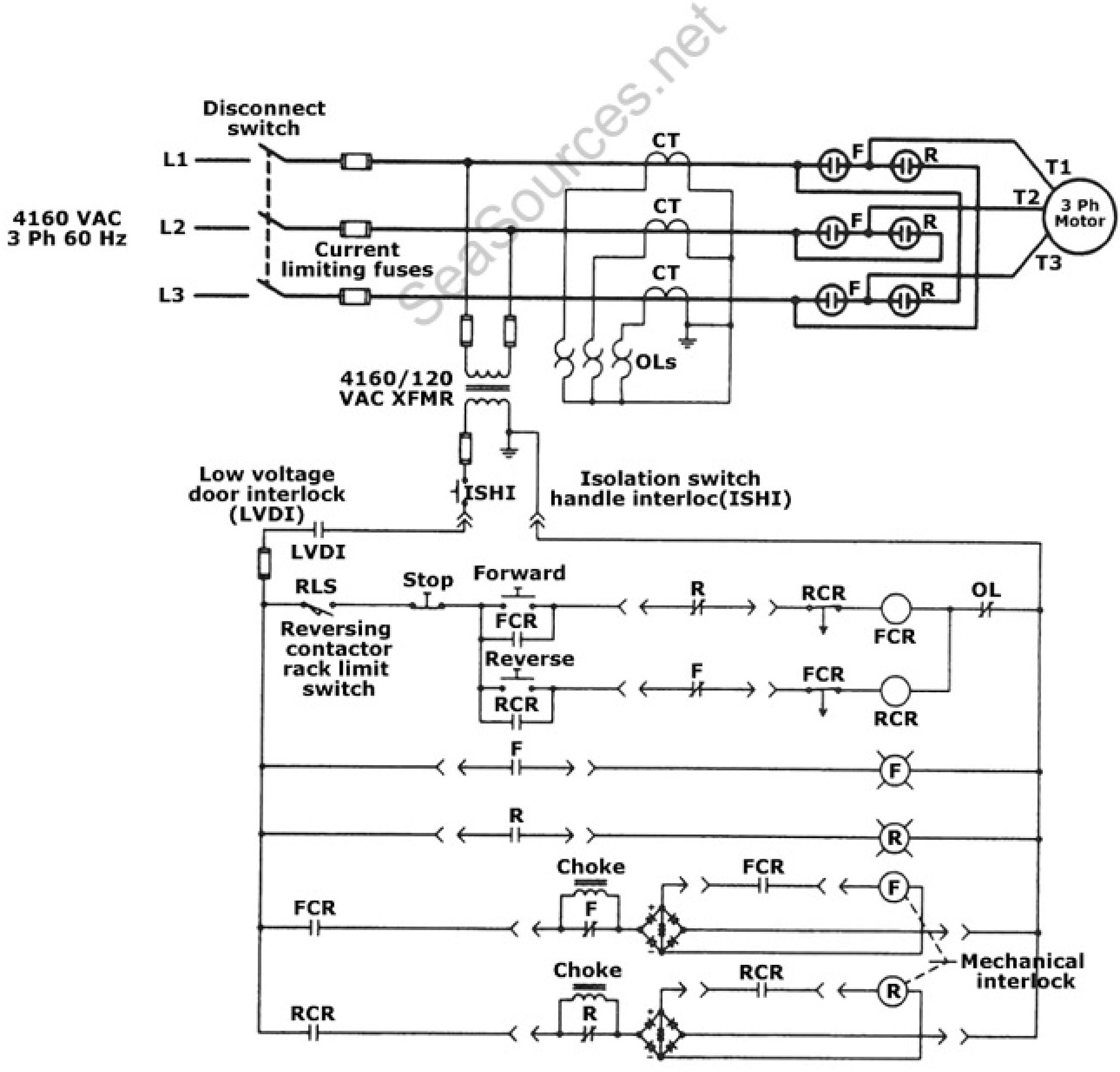
Disconnect switch
L1
L2
L3
4160 VAC 3 Ph 60 Hz
Current limiting fuses
CT
CT
CT
M
M
M
R
R
S
S
T1
T2
T3
3 Ph Motor
OLs
4160/120 VAC XFMR
Medium voltage door interlock (MVDI)
ISHI
Isolation switch handle interlock (ISHI)
Low voltage door interlock (LVDI)
LVDI
MVDI
Stop
Start
1CR
SRLS
RRLS
OL
Start contactor rack limit switch
Run contactor rack limit switch
1CR
1CR
2CR
R
Choke
M
1CR
M
1CR
S
R
2CR
Choke
S
2CR
S
Mechanical interlock
Choke
R
2CR
R
2CR
S

EL-0138



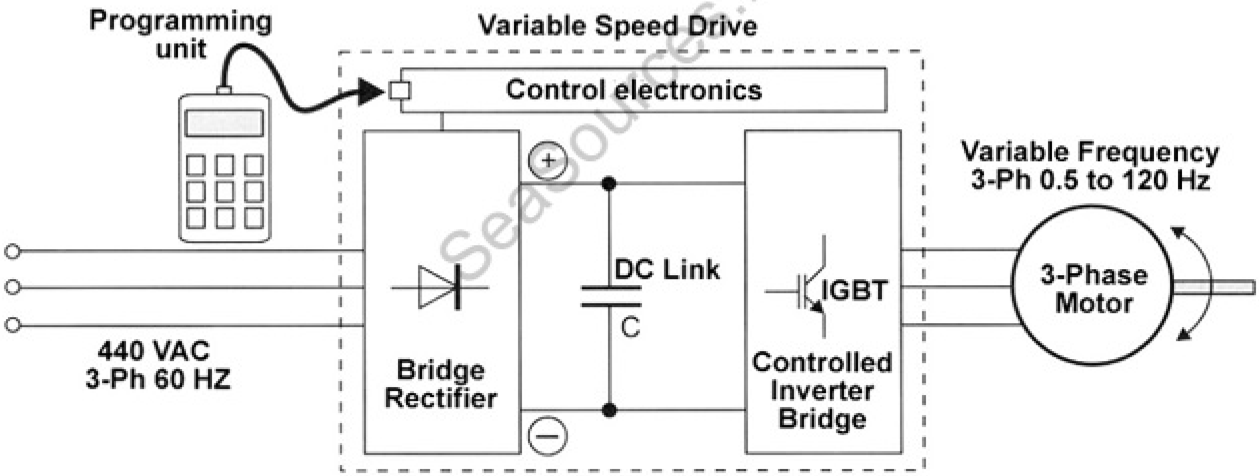
Electrically closed
Mechanically latched
Mechanically tripped
Disconnect switch
L1
L2
L3
4160 VAC 3 Ph 60 Hz
Current limiting fuses
M
T1
T2
T3
To feeder bus
Feeder disconnect contactor
4160/120 VAC XFMR
Isolation switch handle interlock
ISHI
Low voltage door interlock
LVDI
Close
1CR
M
R

EL-0139



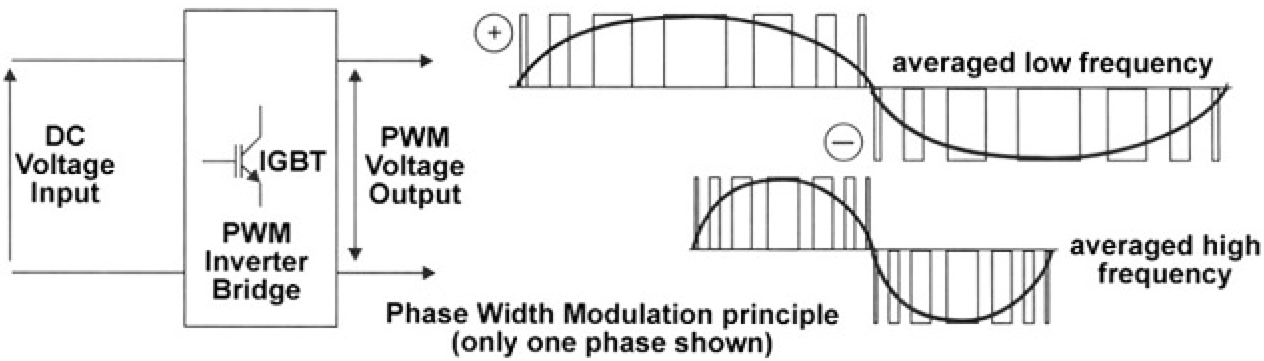
Disconnect switch
L1
L2
L3
4160 VAC 3 Ph 60 Hz
Current limiting fuses
CT
CT
CT
F
R
F
R
F
R
T1
T2
T3
3 Ph Motor
OLs
4160/120 VAC XFMR
ISHI
Low voltage door interlock (LVDI)
Isolation switch handle interloc(ISHI)
LVDI
RLS
Reversing contactor rack limit switch
Stop
Forward
FCR
R
RCR
FCR
OL
Reverse
RCR
F
FCR
RCR
F
F
R
R
Choke
F
FCR
F
FCR
Mechanical interlock
Choke
R
RCR
R
RCR

EL-0140



Programming unit
Variable Speed Drive
Control electronics
Variable Frequency 3-Ph 0.5 to 120 Hz
DC Link
C
IGBT
3-Phase Motor
440 VAC 3-Ph 60 HZ
Bridge Rectifier
Controlled Inverter Bridge

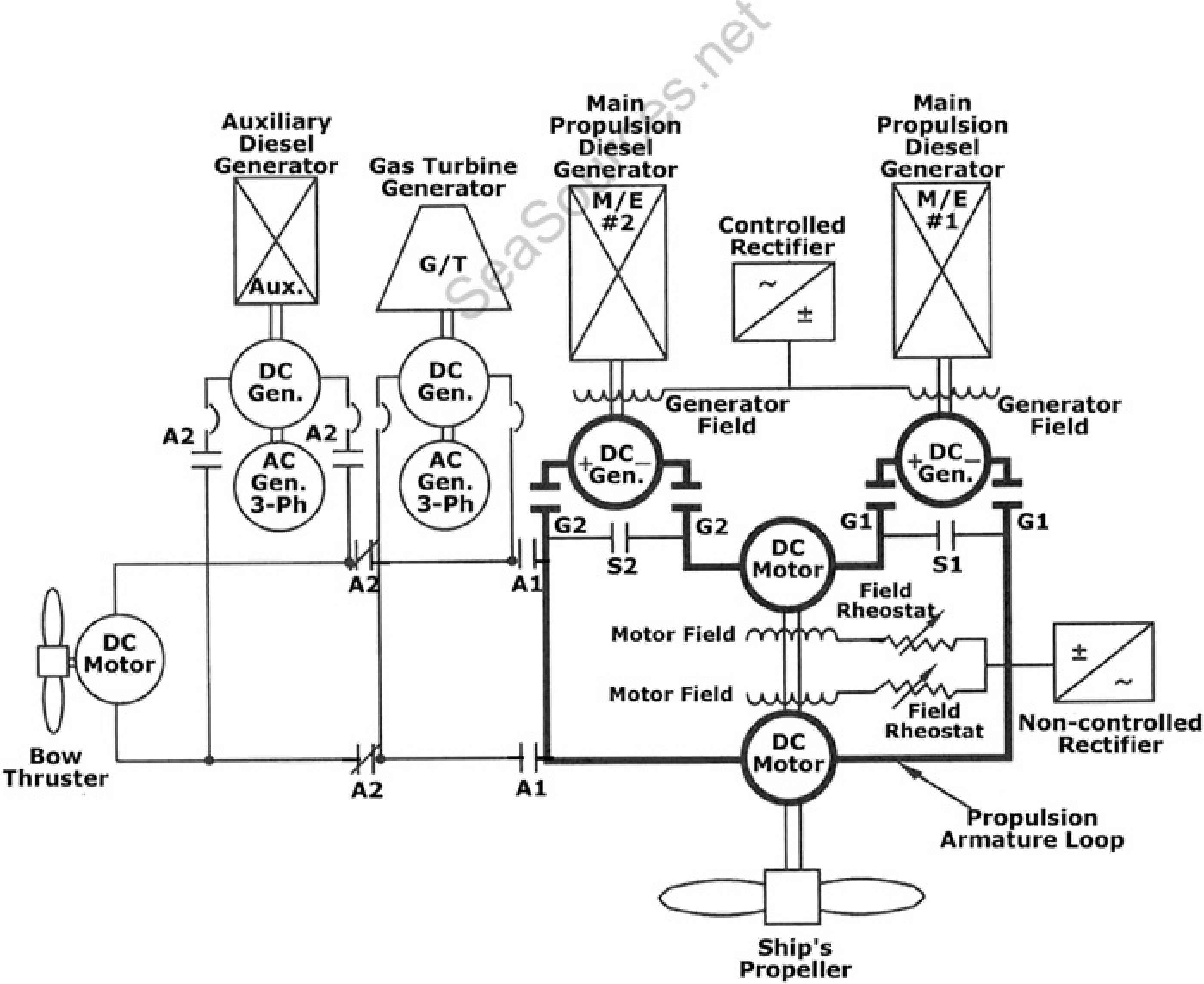
A



averaged low frequency
DC Voltage Input
IGBT
PWM Inverter Bridge
PWM Voltage Output
averaged high frequency
Phase Width Modulation principle (only one phase shown)

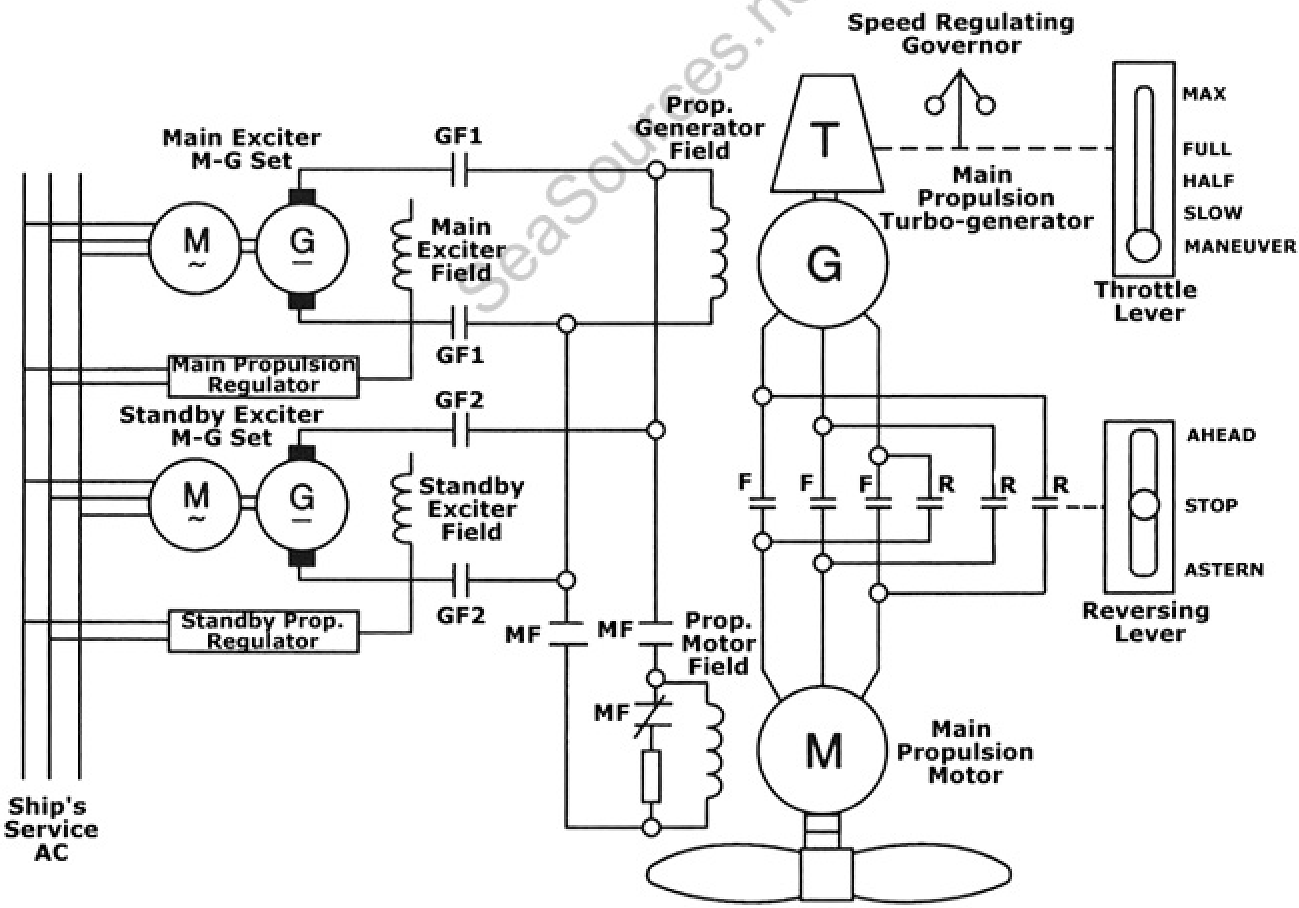
B

EL-0141



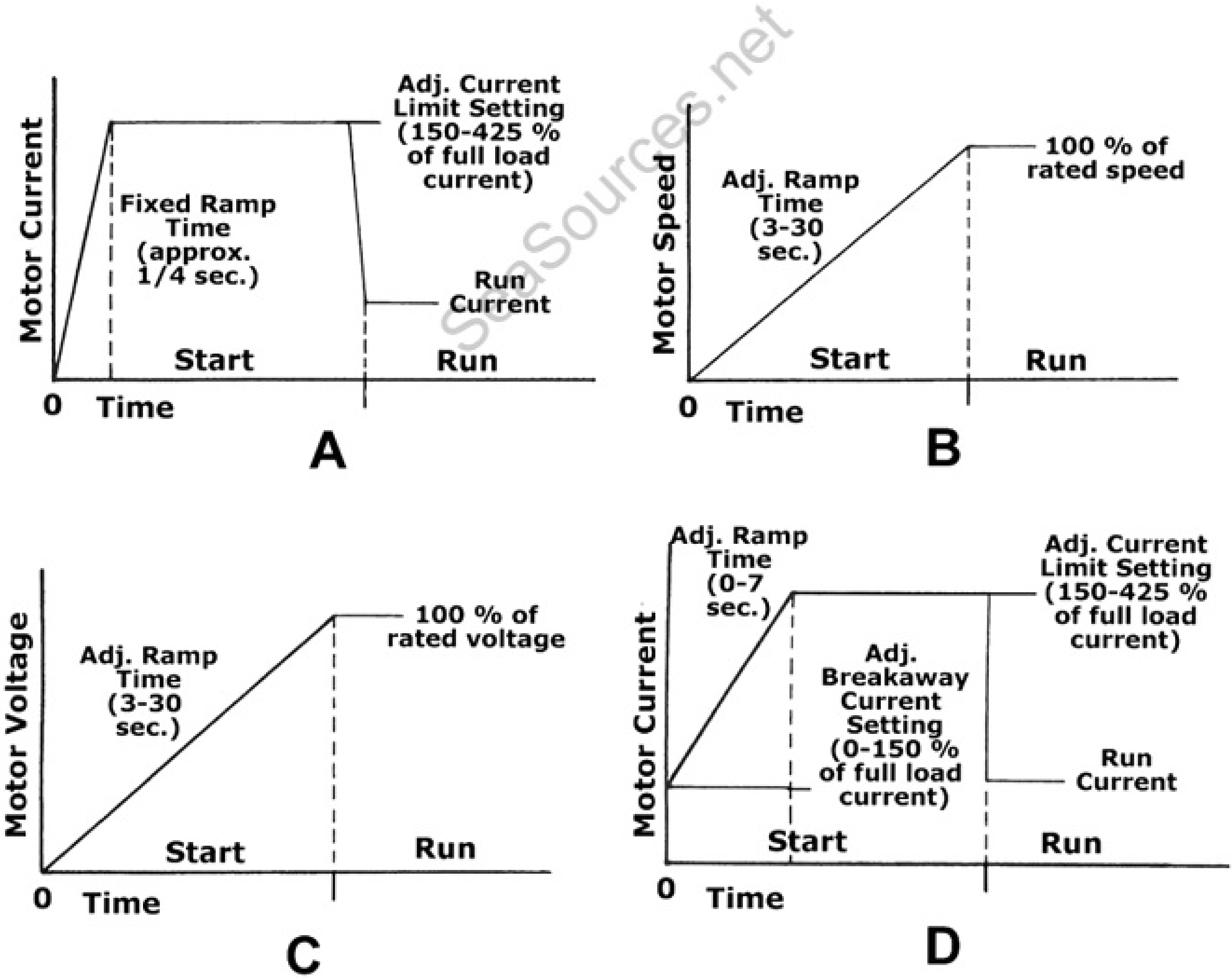
Auxiliary Diesel Generator
Aux.
Gas Turbine Generator
G/T
Main Propulsion Diesel Generator
M/E #2
Controlled Rectifier
Main Propulsion Diesel Generator
M/E #1
DC Gen.
AC Gen. 3-Ph
DC Gen.
AC Gen. 3-Ph
Generator Field
Generator Field
DC Gen.
DC Gen.
A2
A2
G2
G2
G1
G1
DC Motor
S2
S1
A2
A1
Field Rheostat
Motor Field
Motor Field
Field Rheostat
Non-controlled Rectifier
DC Motor
Bow Thruster
DC Motor
A2
A1
Propulsion Armature Loop
Ship's Propeller

EL-0142

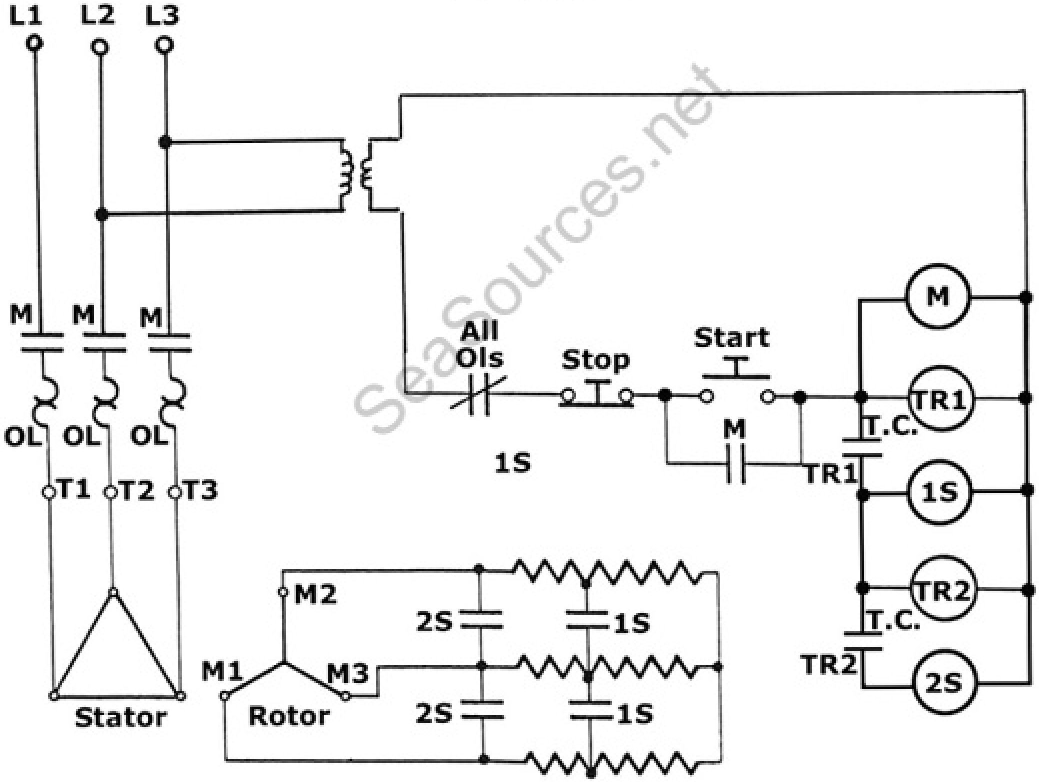


Speed Regulating Governor
MAX
FULL
HALF
SLOW
MANEUVER
Throttle Lever
T
Main Propulsion Turbo-generator
G
Prop. Generator Field
Main Exciter M-G Set
GF1
M
G
Main Exciter Field
GF1
Main Propulsion Regulator
Standby Exciter M-G Set
GF2
M
G
Standby Exciter Field
GF2
Standby Prop. Regulator
MF
MF
Prop. Motor Field
MF
F
F
F
R
R
R
AHEAD
STOP
ASTERN
Reversing Lever
M
Main Propulsion Motor
Ship's Service AC

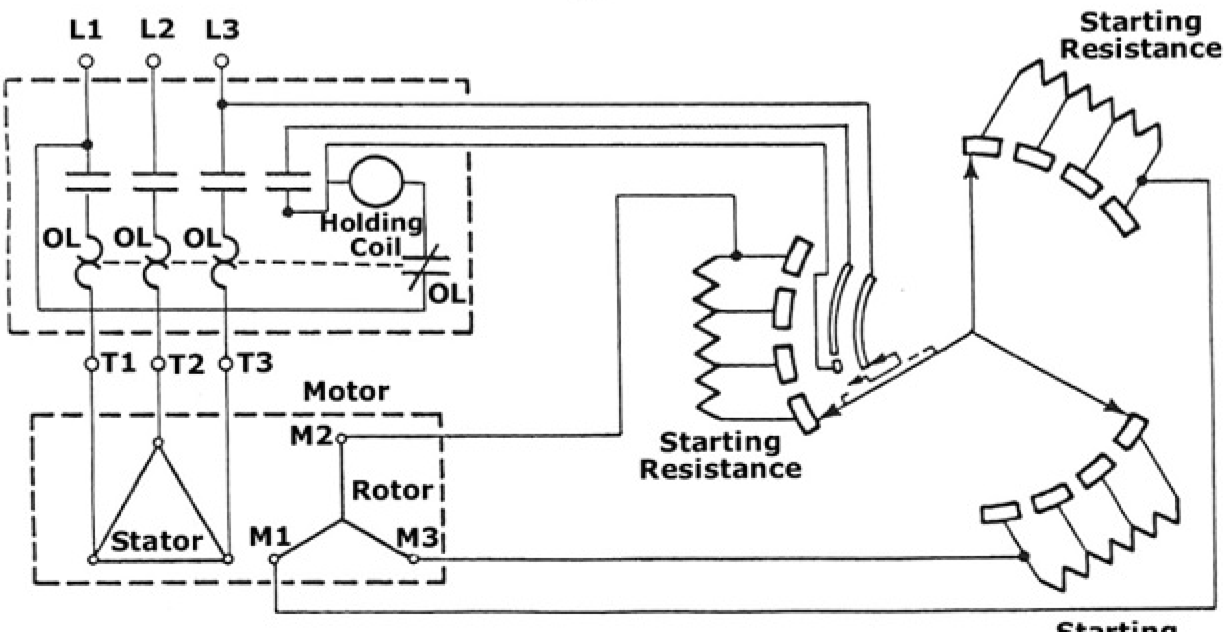
EL-0143


Motor Current
Adj. Current Limit Setting (150-425 % of full load current)
Fixed Ramp Time (approx. 1/4 sec.)
Run Current
Start
Run
0
Time
A
Motor Speed
Adj. Ramp Time (3-30 sec.)
100 % of rated speed
Start
Run
0
Time
B
Motor Voltage
Adj. Ramp Time (3-30 sec.)
100 % of rated voltage
Start
Run
0
Time
C
Motor Current
Adj. Ramp Time (0-7 sec.)
Adj. Current Limit Setting (150-425 % of full load current)
Adj. Breakaway Current Setting (0-150 % of full load current)
Run Current
Start
Run
0
Time
D

EL-0144

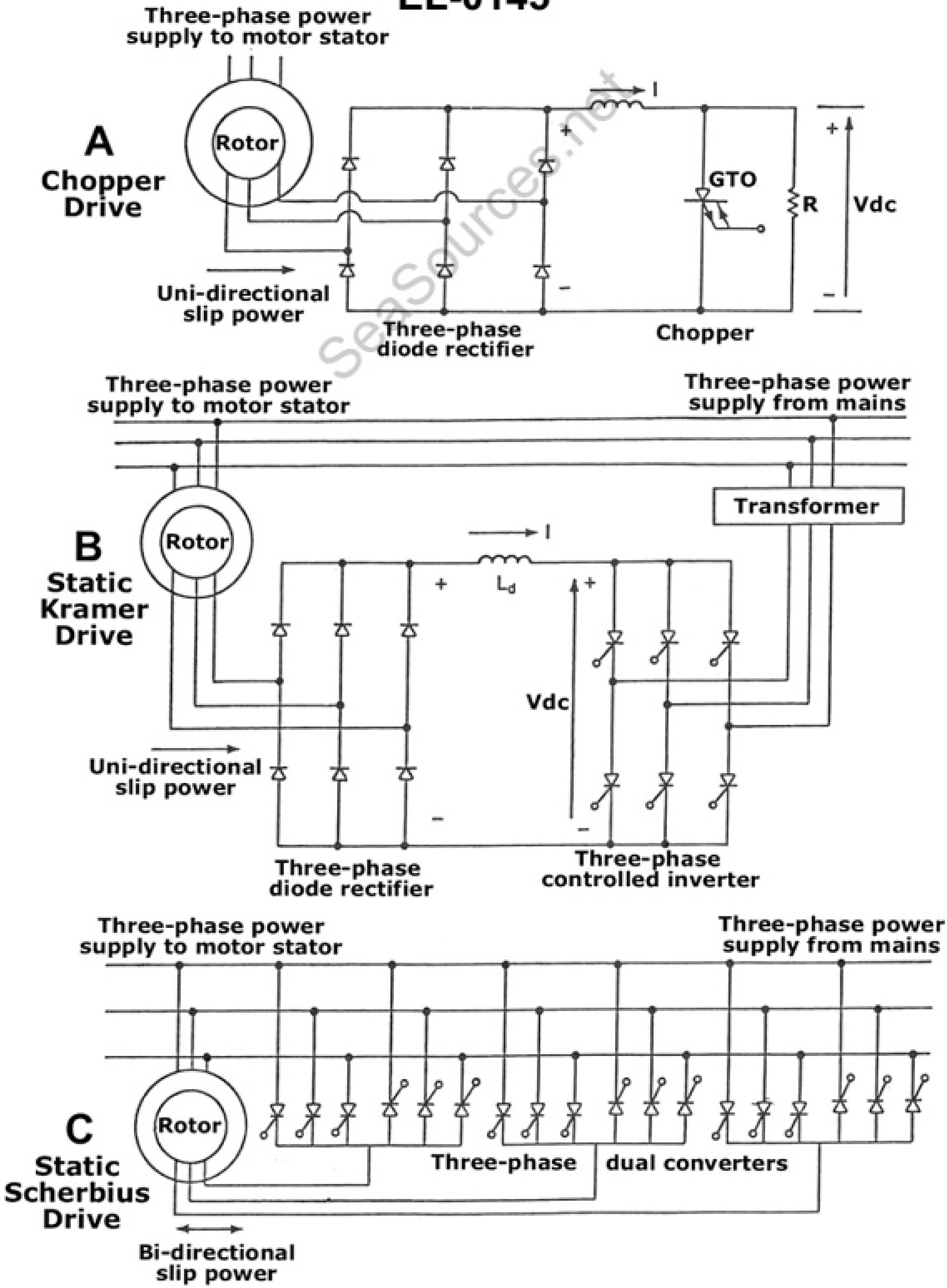

L1
L2
L3
M
M
M
OL
OL
OL
T1
T2
T3
Stator
All
Ols
Stop
Start
M
1S
M
TR1
T.C.
TR1
1S
TR2
T.C.
TR2
2S
M2
M1
M3
Rotor
2S
1S
2S
1S

A


L1
L2
L3
OL
OL
OL
Holding
Coil
OL
T1
T2
T3
Motor
M2
Rotor
Stator
M1
M3
Starting
Resistance
Starting
Resistance
Starting
Resistance

B

EL-0145

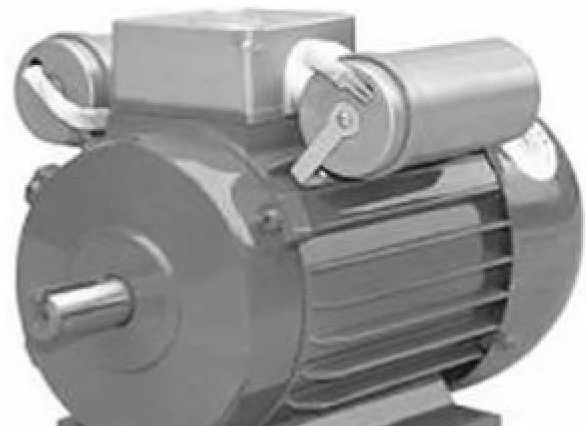

Three-phase power supply to motor stator
A
Chopper Drive
Rotor
I
GTO
R
Vdc
Uni-directional slip power
Three-phase diode rectifier
Chopper
Three-phase power supply to motor stator
Three-phase power supply from mains
Transformer
B
Static Kramer Drive
Rotor
I
L_d
Vdc
Uni-directional slip power
Three-phase diode rectifier
Three-phase controlled inverter
Three-phase power supply to motor stator
Three-phase power supply from mains
C
Static Scherbius Drive
Rotor
Three-phase dual converters
Bi-directional slip power

EL-0146

A

B

C

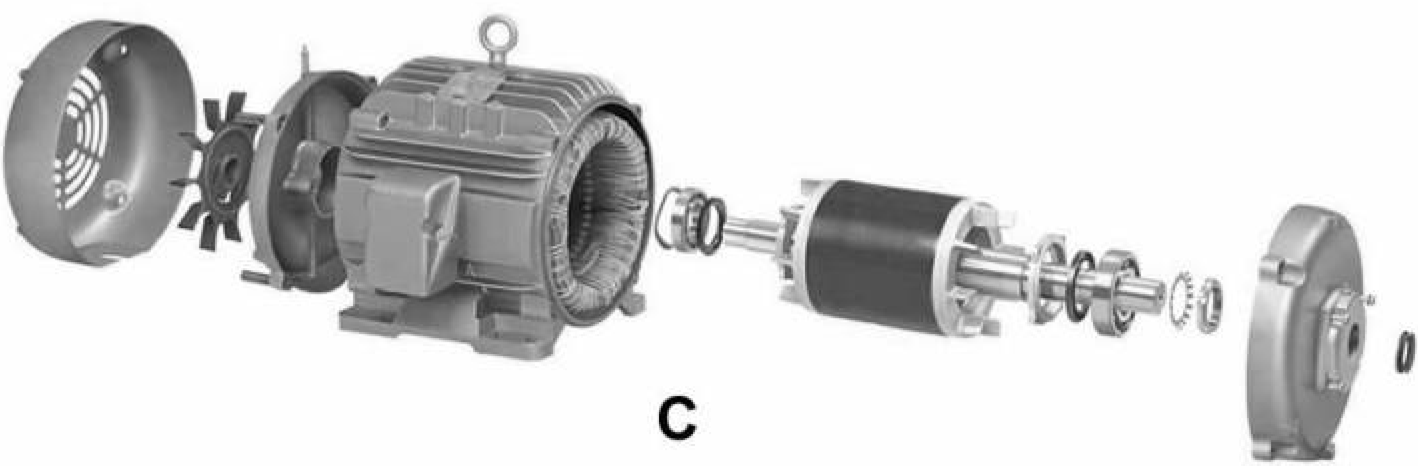


D

EL-0147

A

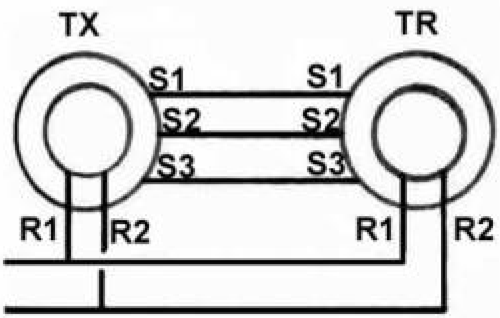
B



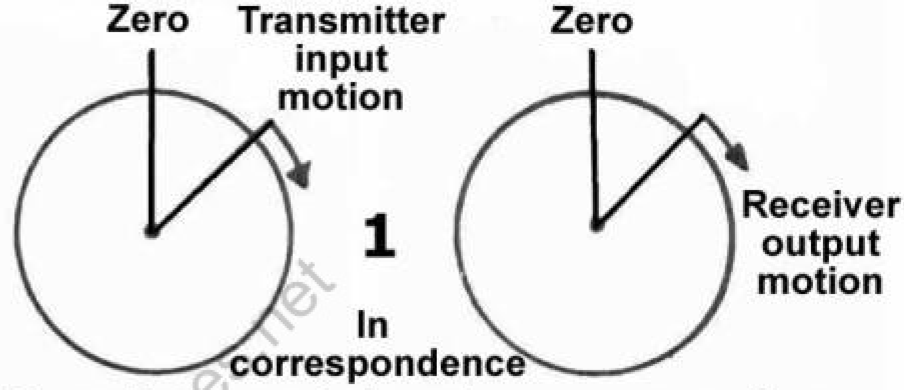
C

EL-0148: The new Illustration associated with this question has not yet been made available to the public from the National Maritime Center even though they are already using them in the exam room. We hope to have them posted soon.

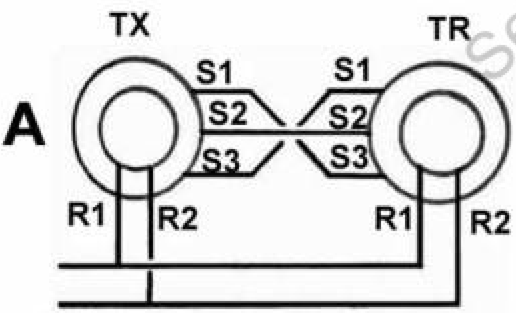
EL-0149



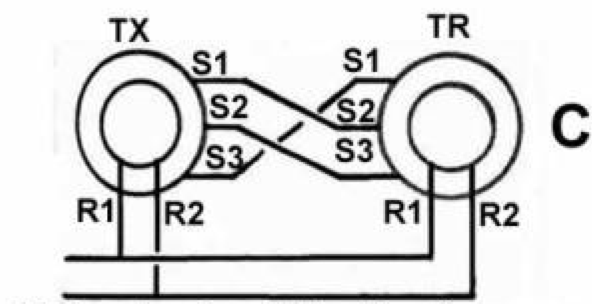
Correctly connected



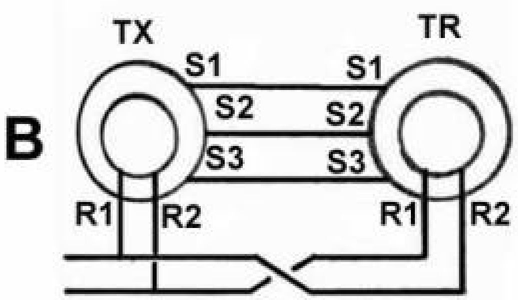
Correctly connected system causes receiver to be in correspondence with the transmitter



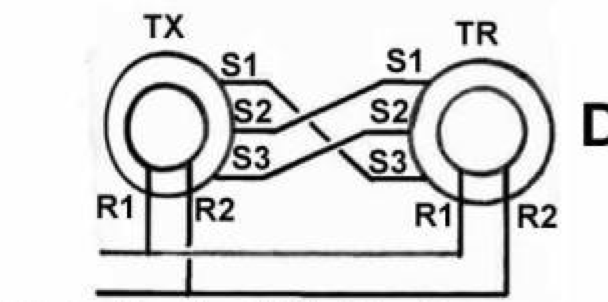
S1 and S3 leads reversed



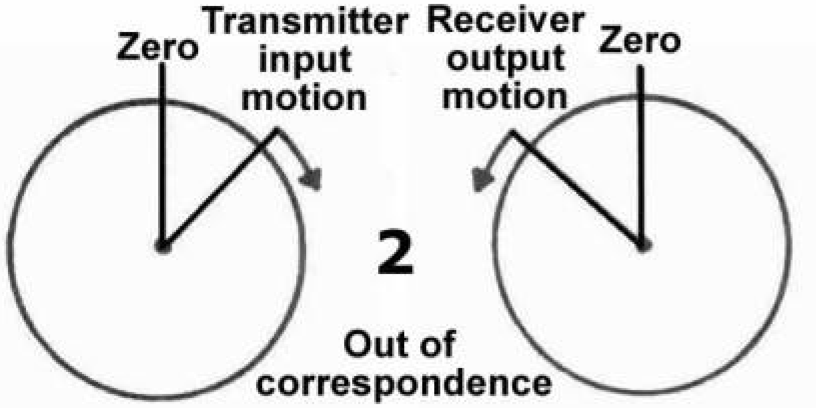
Stator leads shifted by 1 group



R1 and R2 leads reversed

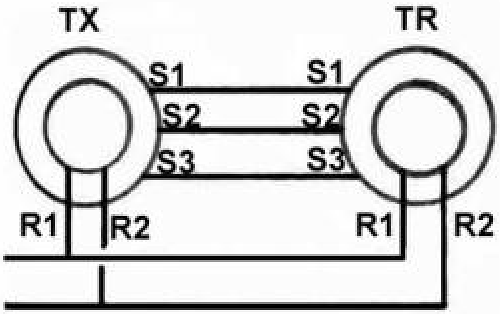


Stator leads shifted by 2 groups

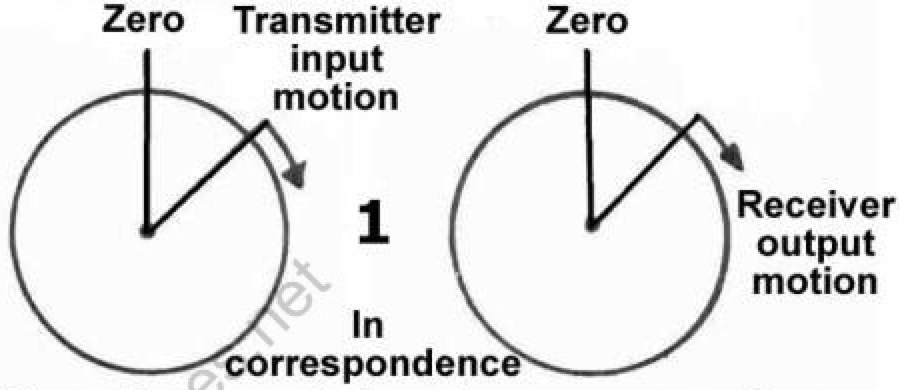


Incorrect connections:
properly zeroed,
but torque direction reversed

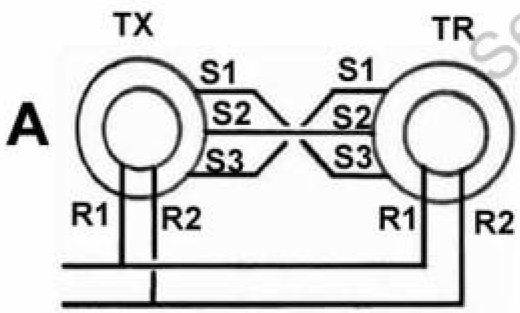
EL-0150



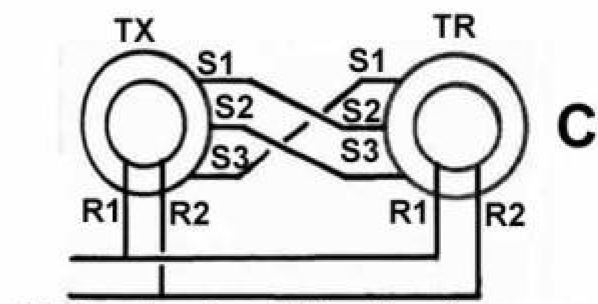
Correctly connected



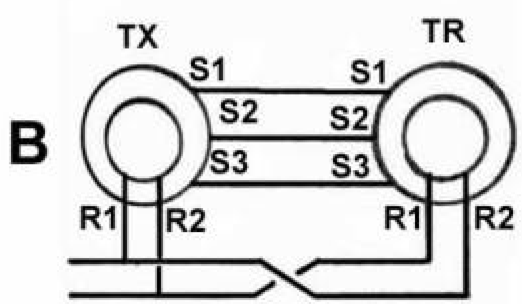
Correctly connected system causes receiver to be in correspondence with the transmitter



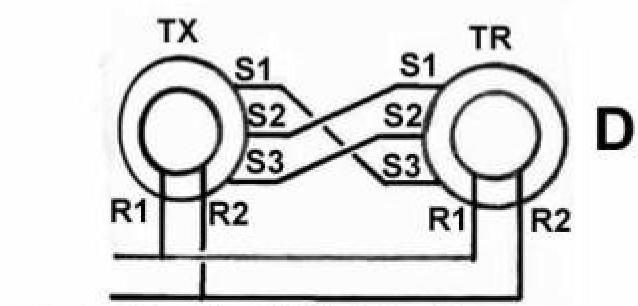
S1 and S3 leads reversed



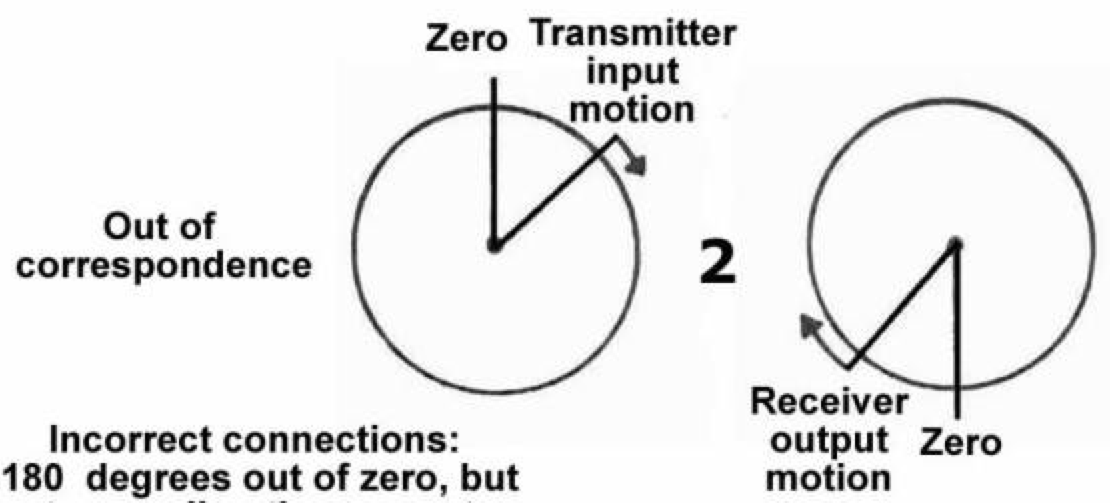
Stator leads shifted by 1 group



R1 and R2 leads reversed

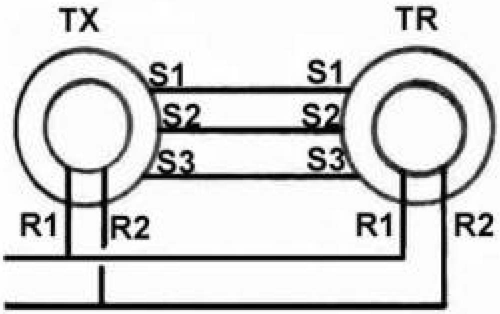


Stator leads shifted by 2 groups

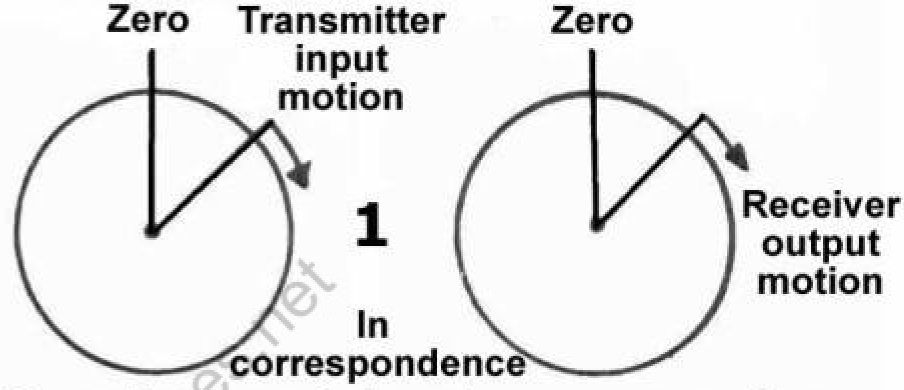


Incorrect connections:
180 degrees out of zero, but torque direction correct

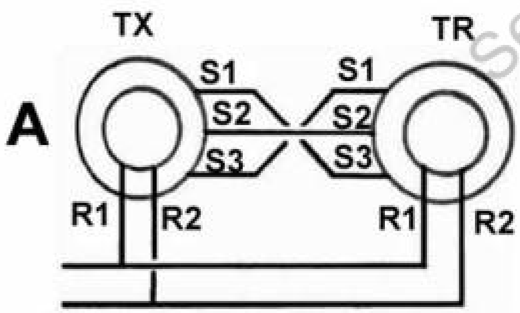
EL-0151



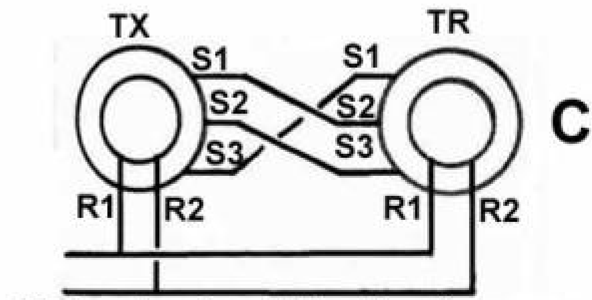
Correctly connected



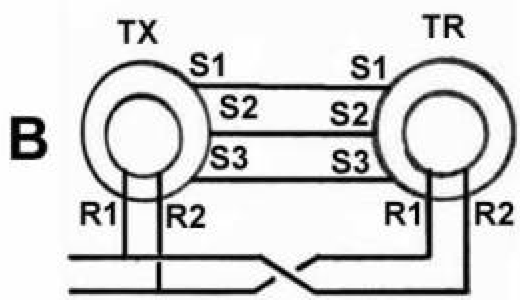
Correctly connected system causes receiver to be in correspondence with the transmitter



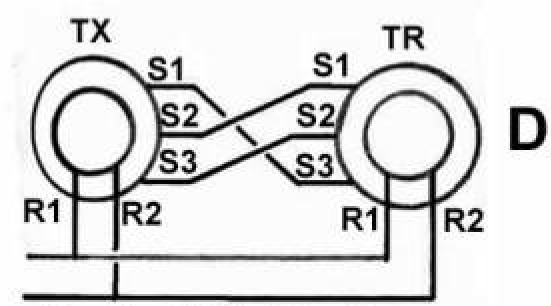
S1 and S3 leads reversed



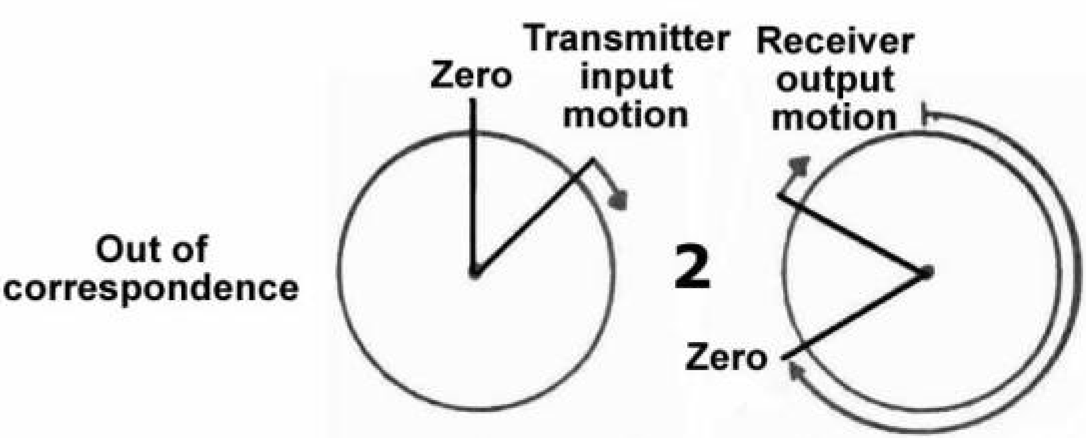
Stator leads shifted by 1 group



R1 and R2 leads reversed

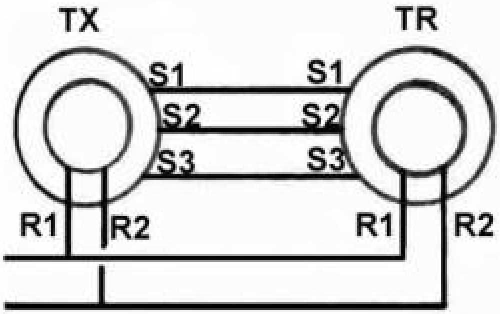


Stator leads shifted by 2 groups

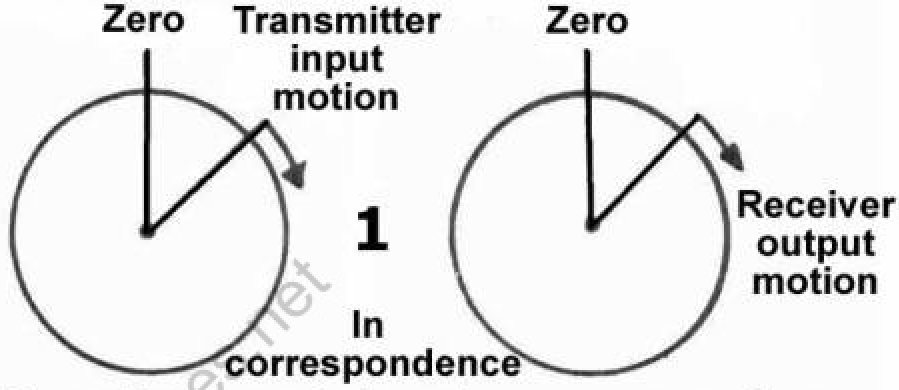


Incorrect connections:
240 degrees out of zero, but torque direction correct

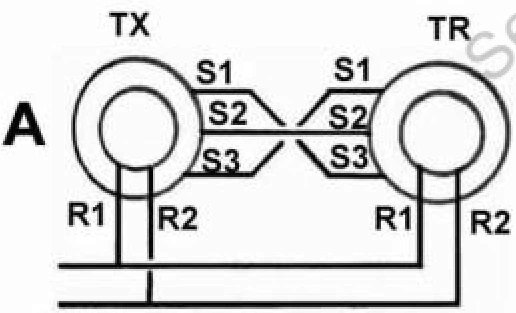
EL-0152



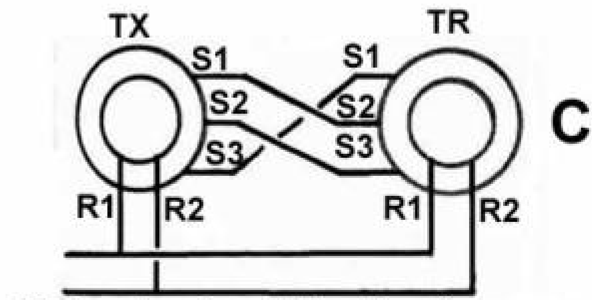
Correctly connected



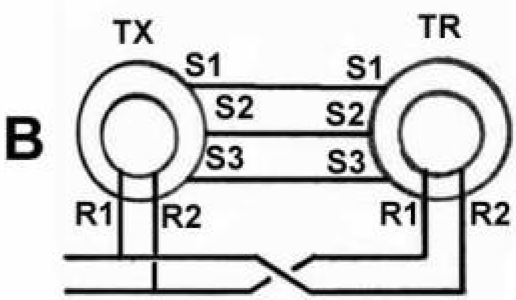
Correctly connected system causes receiver to be in correspondence with the transmitter



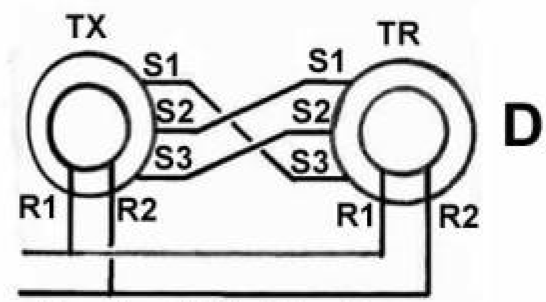
S1 and S3 leads reversed



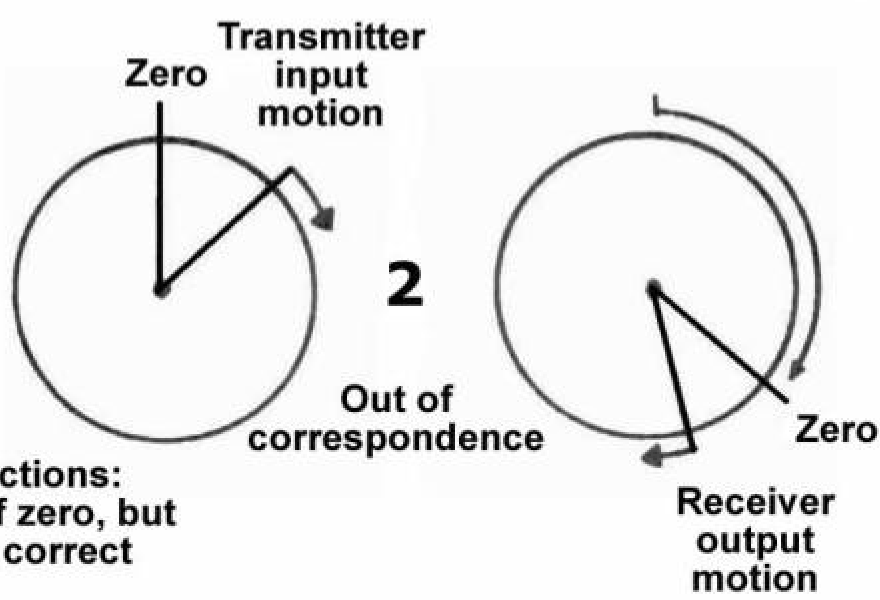
Stator leads shifted by 1 group



R1 and R2 leads reversed



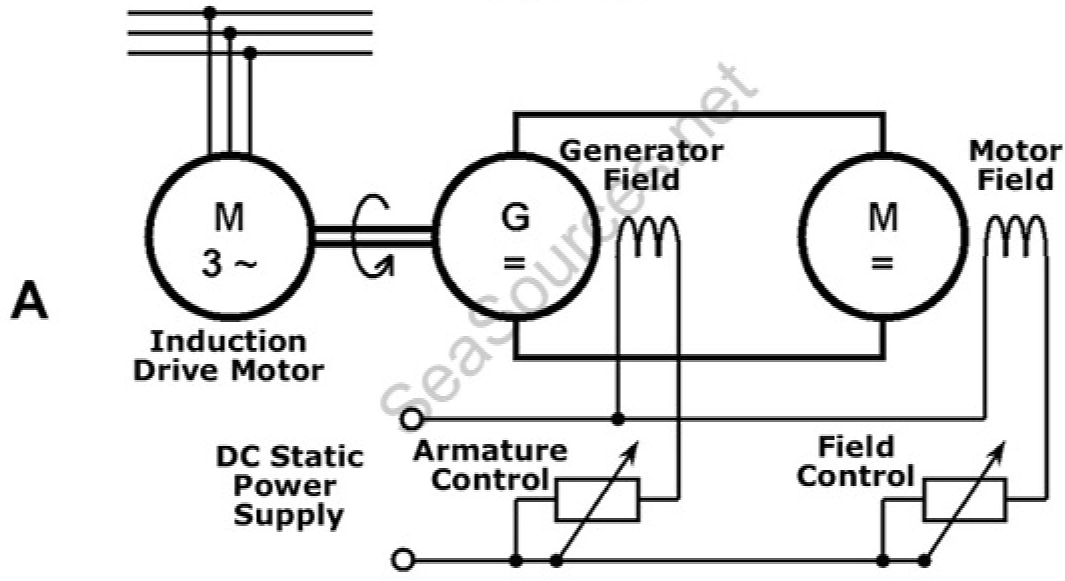
Stator leads shifted by 2 groups



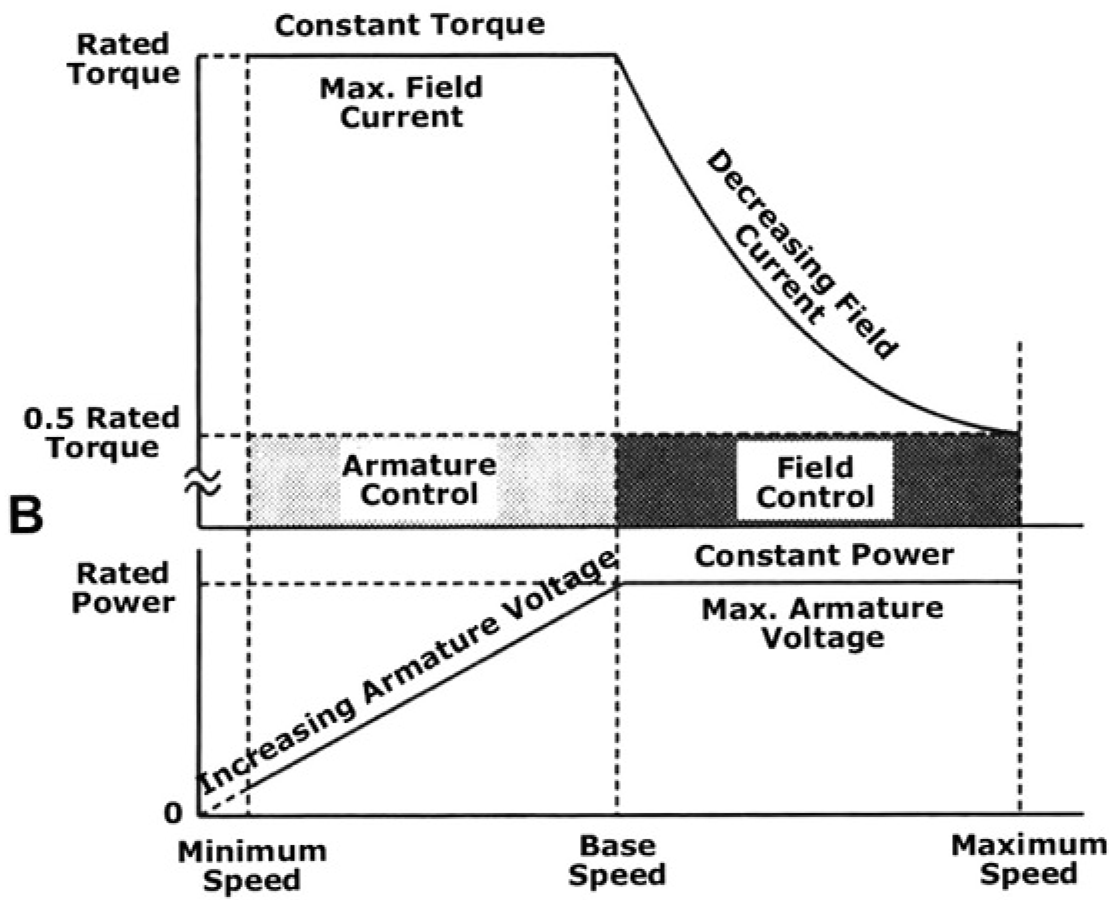
Incorrect connections:
120 degrees out of zero, but torque direction correct

EL-0153

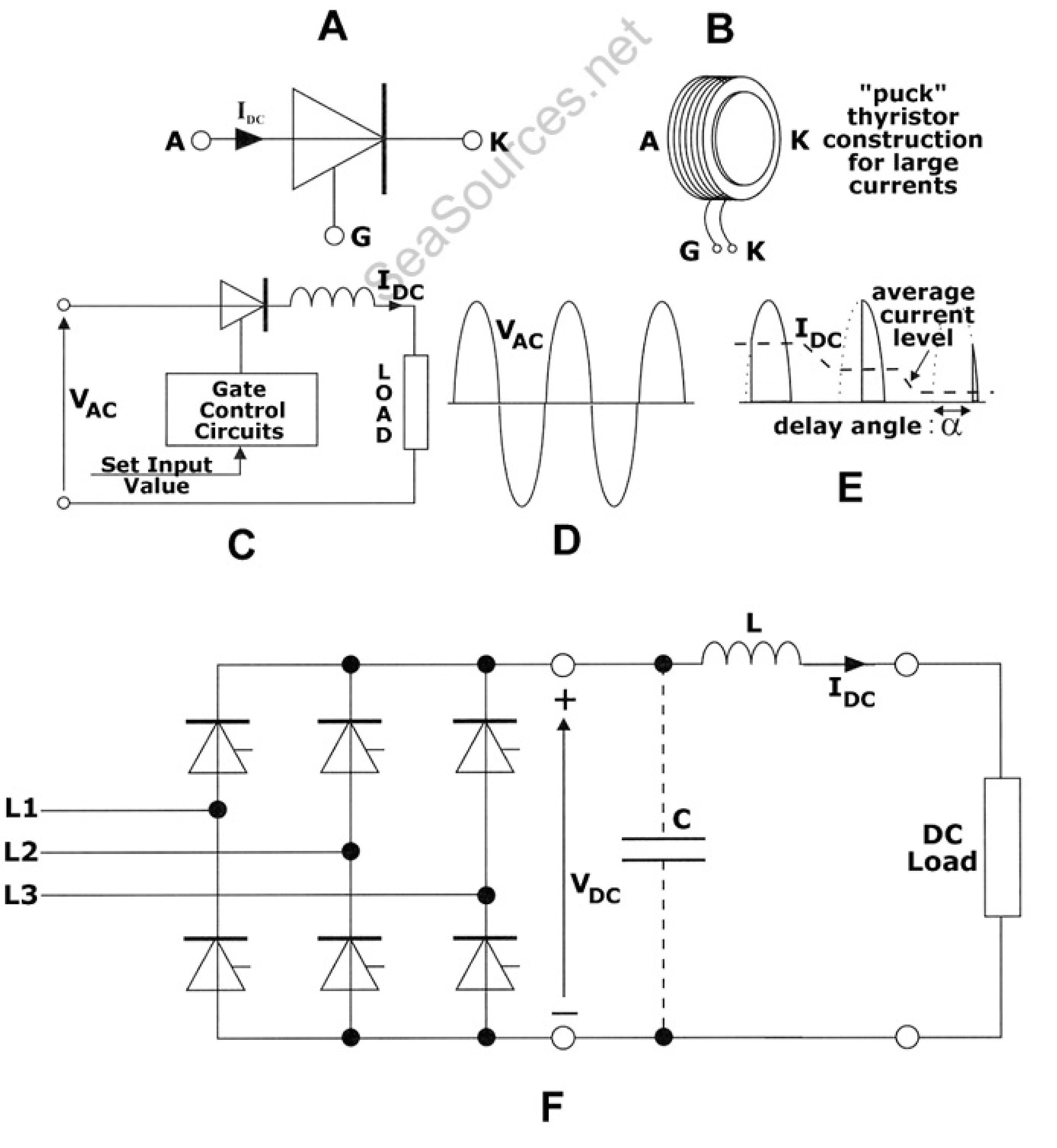
A


M
3 ~
Induction Drive Motor
G
=
Generator Field
M
=
Motor Field
DC Static Power Supply
Armature Control
Field Control

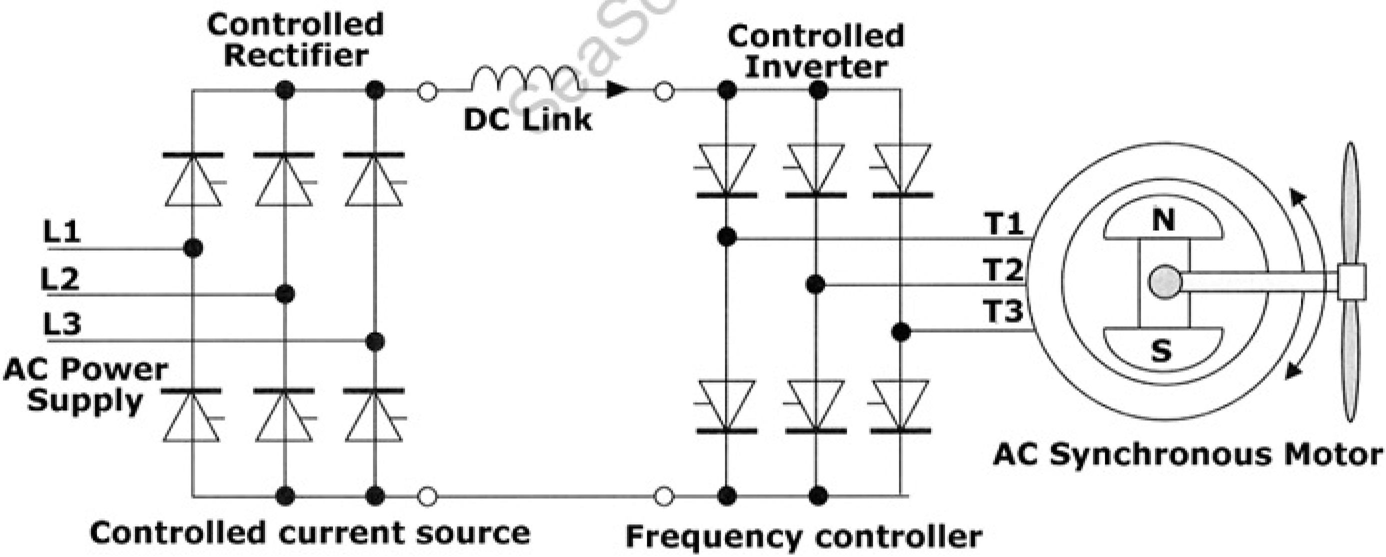
B


Constant Torque
Rated Torque
Max. Field Current
Decreasing Field Current
0.5 Rated Torque
Armature Control
Field Control
Constant Power
Rated Power
Increasing Armature Voltage
Max. Armature Voltage
0
Minimum Speed
Base Speed
Maximum Speed

EL-0154

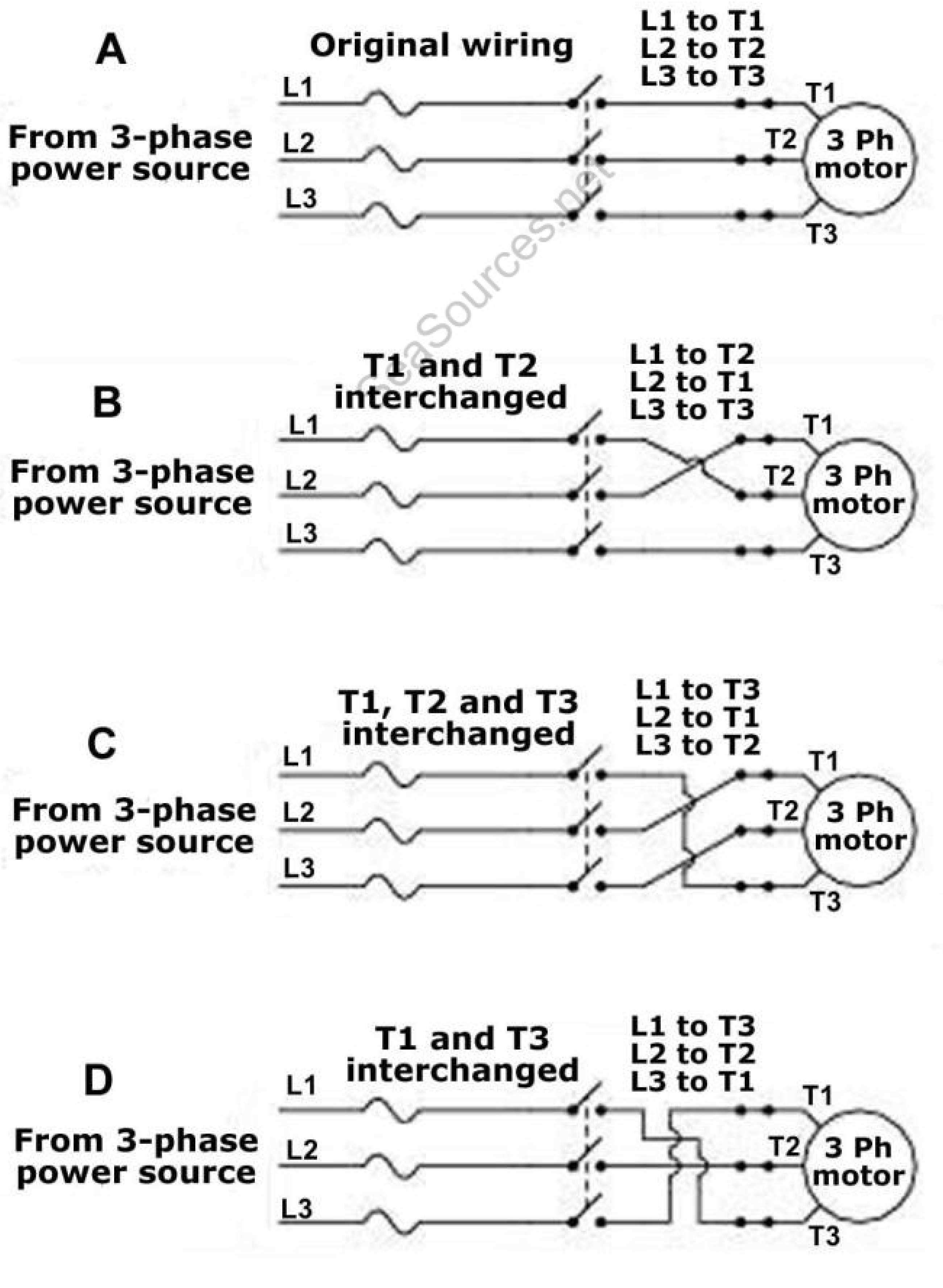

A
A
I_{DC}
K
G
B
"puck"
thyristor
construction
for large
currents
A
K
G
K
I_{DC}
V_{AC}
Gate
Control
Circuits
Set Input
Value
LOAD
C
V_{AC}
D
average
current
level
I_{DC}
delay angle : α
E
L1
L2
L3
+
−
V_{DC}
C
L
I_{DC}
DC
Load
F

EL-0155

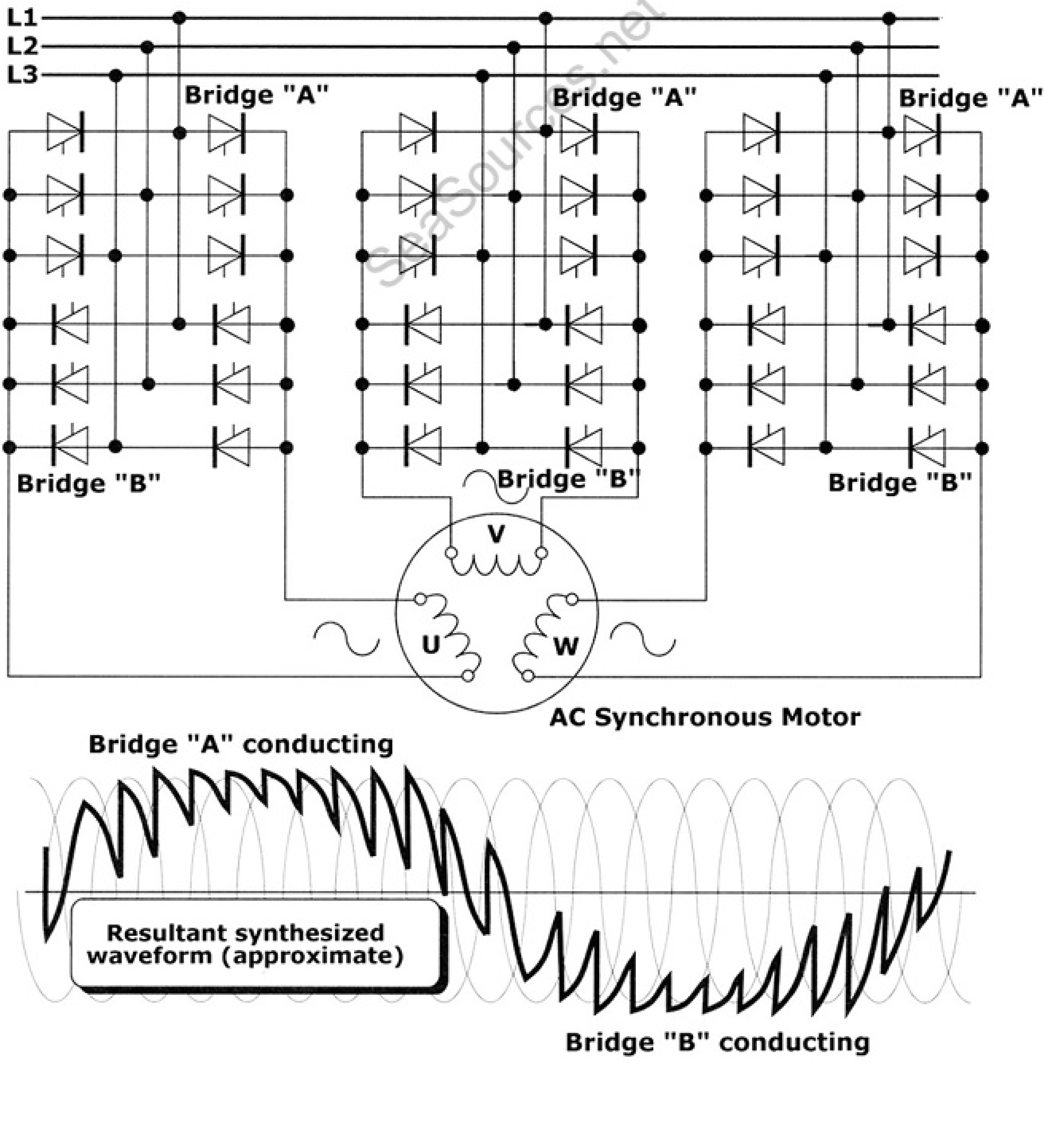


Controlled
Rectifier
DC Link
Controlled
Inverter
L1
L2
L3
AC Power
Supply
T1
T2
T3
N
S
AC Synchronous Motor
Controlled current source
Frequency controller

EL-0156

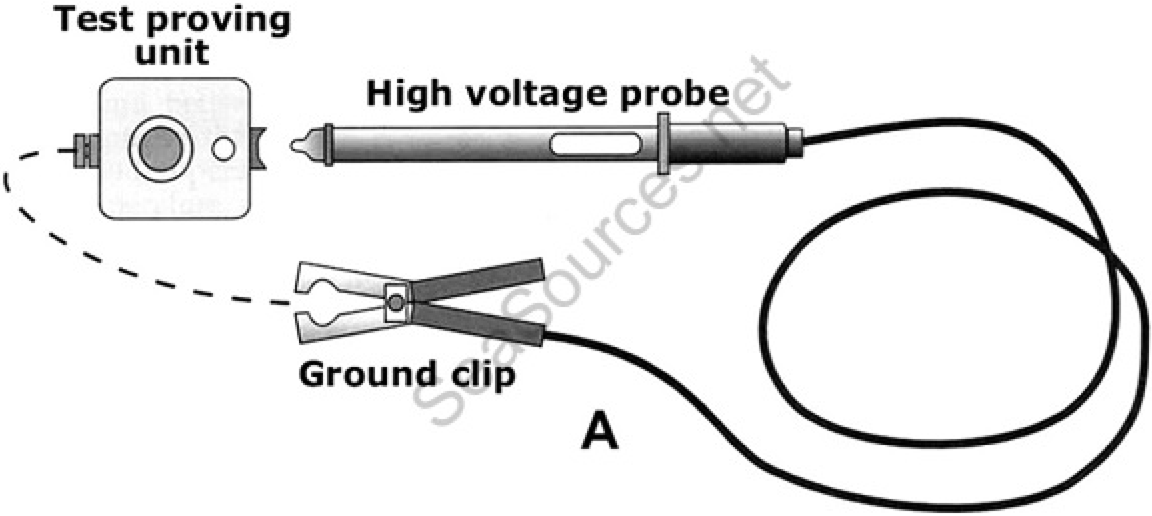

A
Original wiring
L1 to T1
L2 to T2
L3 to T3
From 3-phase power source
L1
L2
L3
T1
T2
T3
3 Ph motor
B
T1 and T2 interchanged
L1 to T2
L2 to T1
L3 to T3
From 3-phase power source
L1
L2
L3
T1
T2
T3
3 Ph motor
C
T1, T2 and T3 interchanged
L1 to T3
L2 to T1
L3 to T2
From 3-phase power source
L1
L2
L3
T1
T2
T3
3 Ph motor
D
T1 and T3 interchanged
L1 to T3
L2 to T2
L3 to T1
From 3-phase power source
L1
L2
L3
T1
T2
T3
3 Ph motor

EL-0157



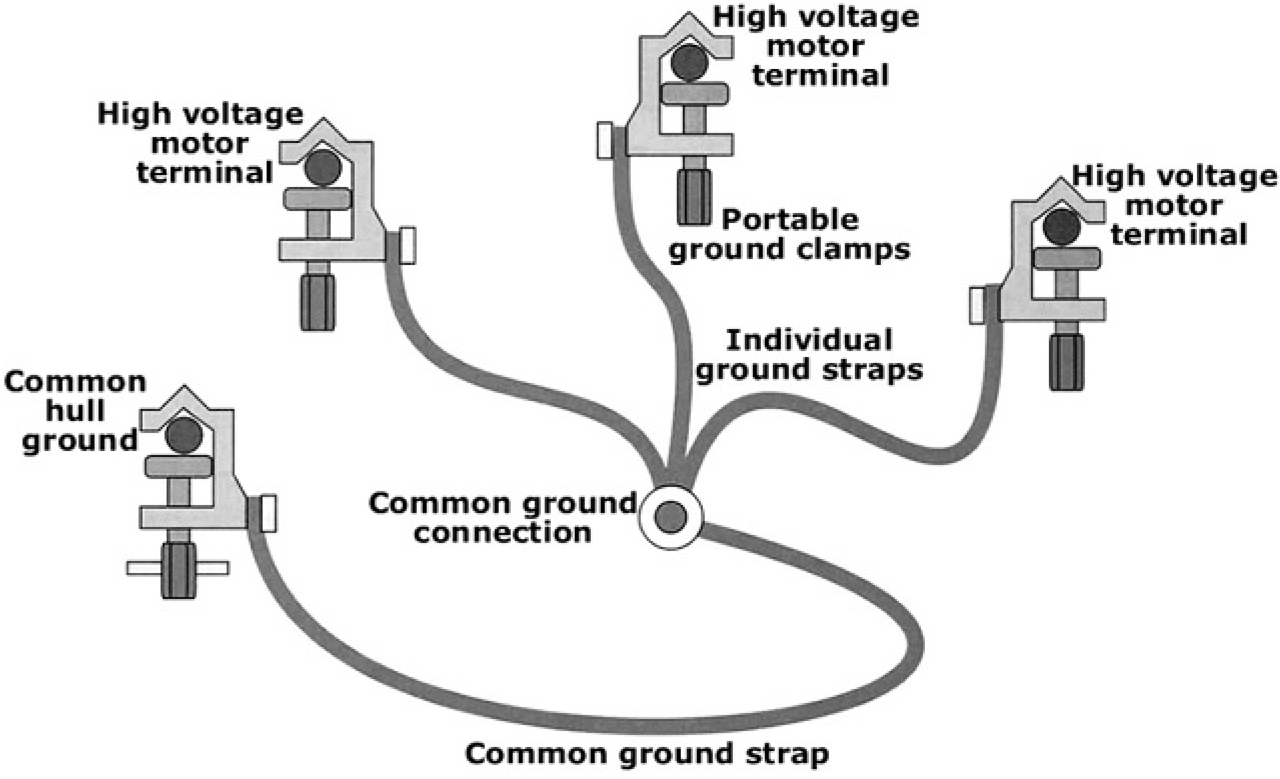
L1
L2
L3
Bridge "A"
Bridge "A"
Bridge "A"
Bridge "B"
Bridge "B"
Bridge "B"
V
U
W
AC Synchronous Motor
Bridge "A" conducting
Resultant synthesized waveform (approximate)
Bridge "B" conducting

EL-0158



Test proving unit
High voltage probe
Ground clip

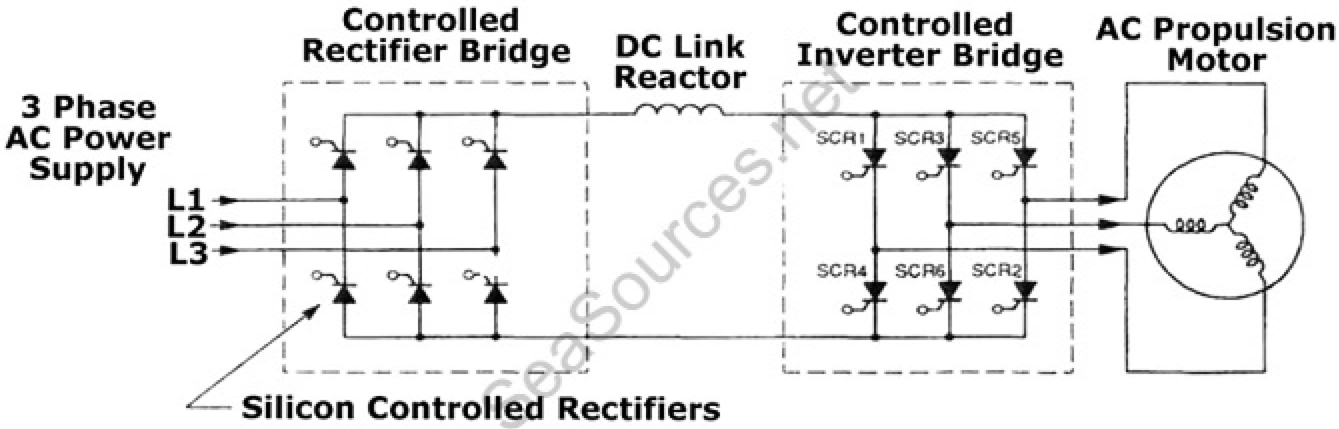
A



High voltage motor terminal
High voltage motor terminal
Portable ground clamps
High voltage motor terminal
Individual ground straps
Common hull ground
Common ground connection
Common ground strap

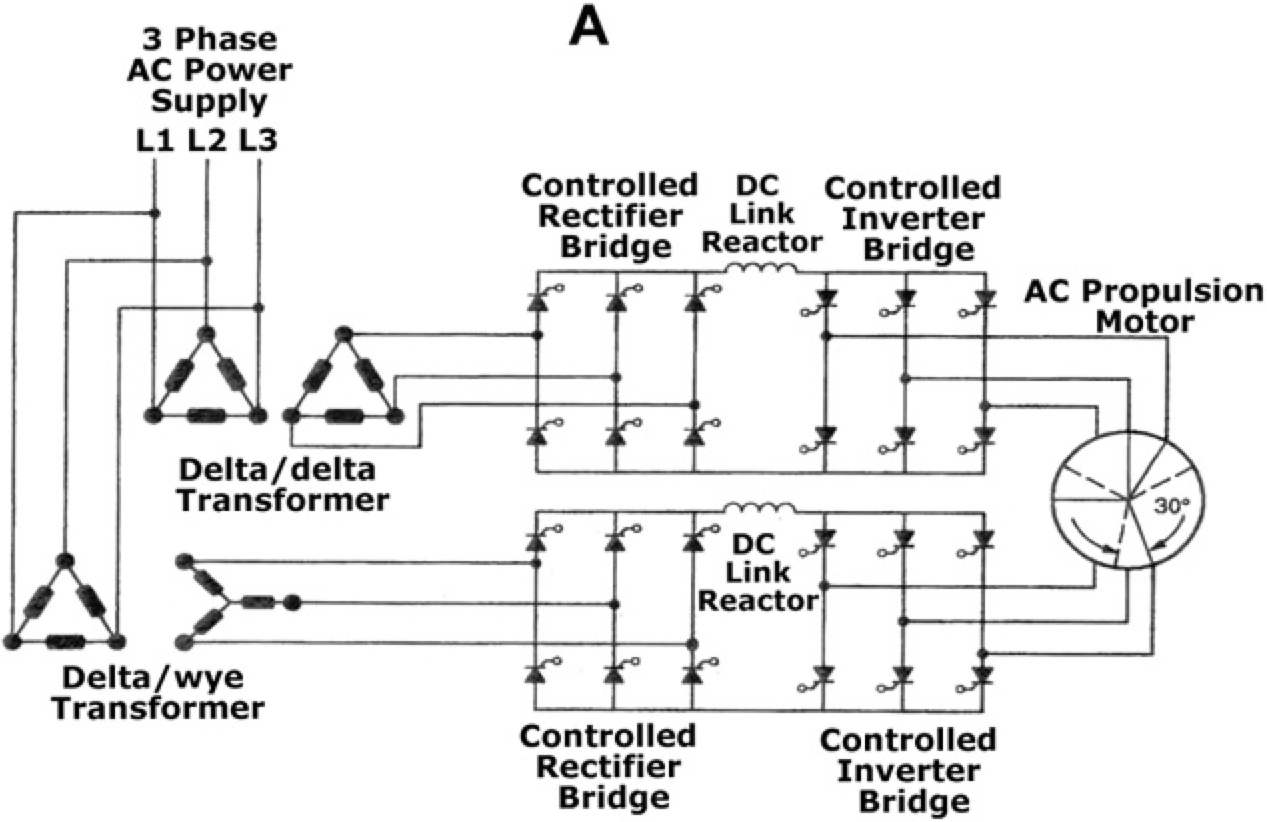
B

EL-0159



Controlled
Rectifier Bridge
DC Link
Reactor
Controlled
Inverter Bridge
AC Propulsion
Motor
3 Phase
AC Power
Supply
L1
L2
L3
SCR1
SCR3
SCR5
SCR4
SCR6
SCR2
Silicon Controlled Rectifiers

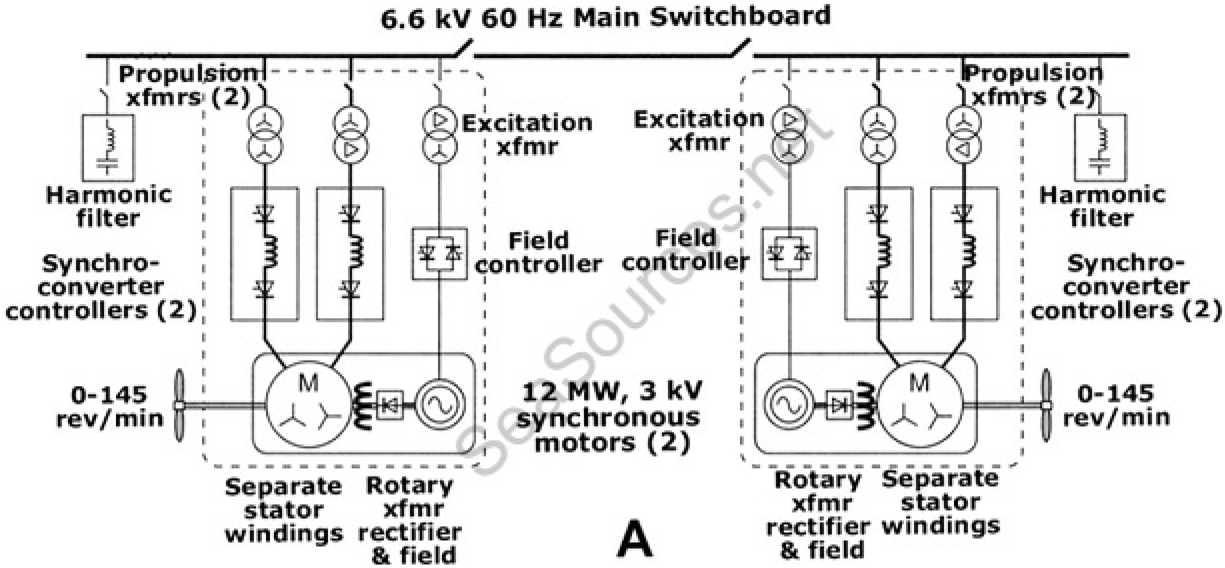
A



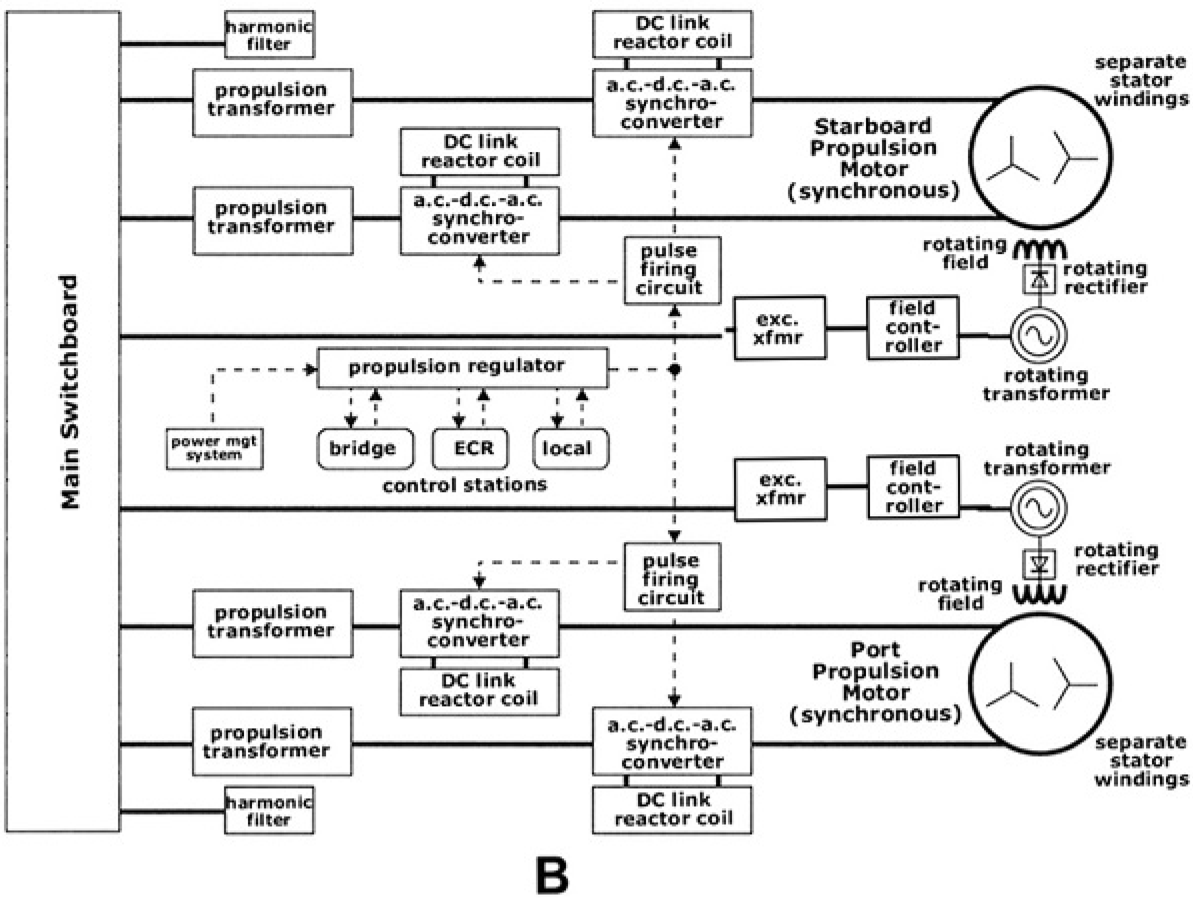
3 Phase
AC Power
Supply
L1 L2 L3
Controlled
Rectifier
Bridge
DC
Link
Reactor
Controlled
Inverter
Bridge
AC Propulsion
Motor
Delta/delta
Transformer
30°
DC
Link
Reactor
Delta/wye
Transformer
Controlled
Rectifier
Bridge
Controlled
Inverter
Bridge

B

EL-0160

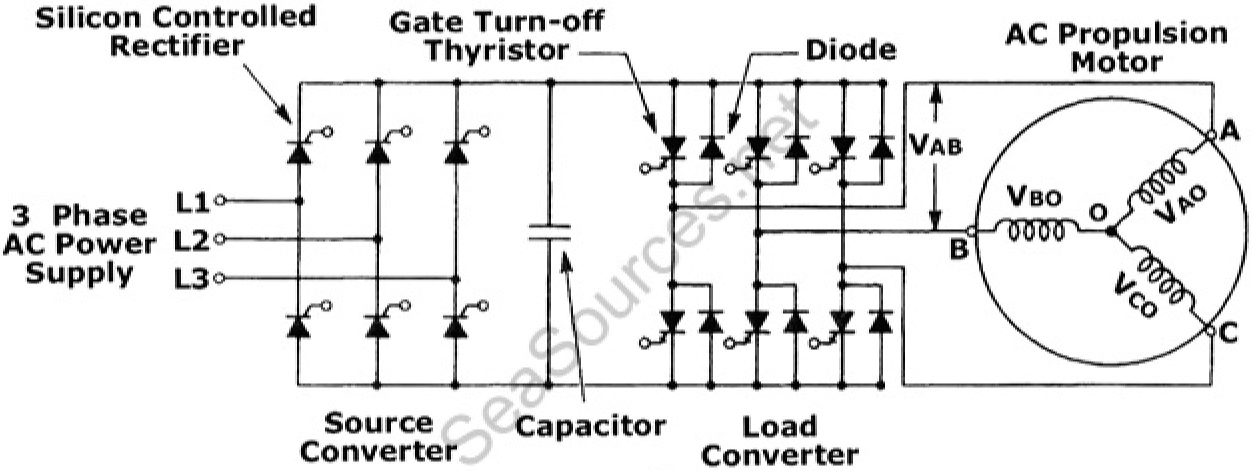


6.6 kV 60 Hz Main Switchboard
Propulsion xfmrs (2)
Propulsion xfmrs (2)
Excitation xfmr
Excitation xfmr
Harmonic filter
Harmonic filter
Field controller
Field controller
Synchro-converter controllers (2)
Synchro-converter controllers (2)
M
M
0-145 rev/min
0-145 rev/min
12 MW, 3 kV synchronous motors (2)
Separate stator windings
Rotary xfmr rectifier & field
Rotary xfmr rectifier & field
Separate stator windings
A



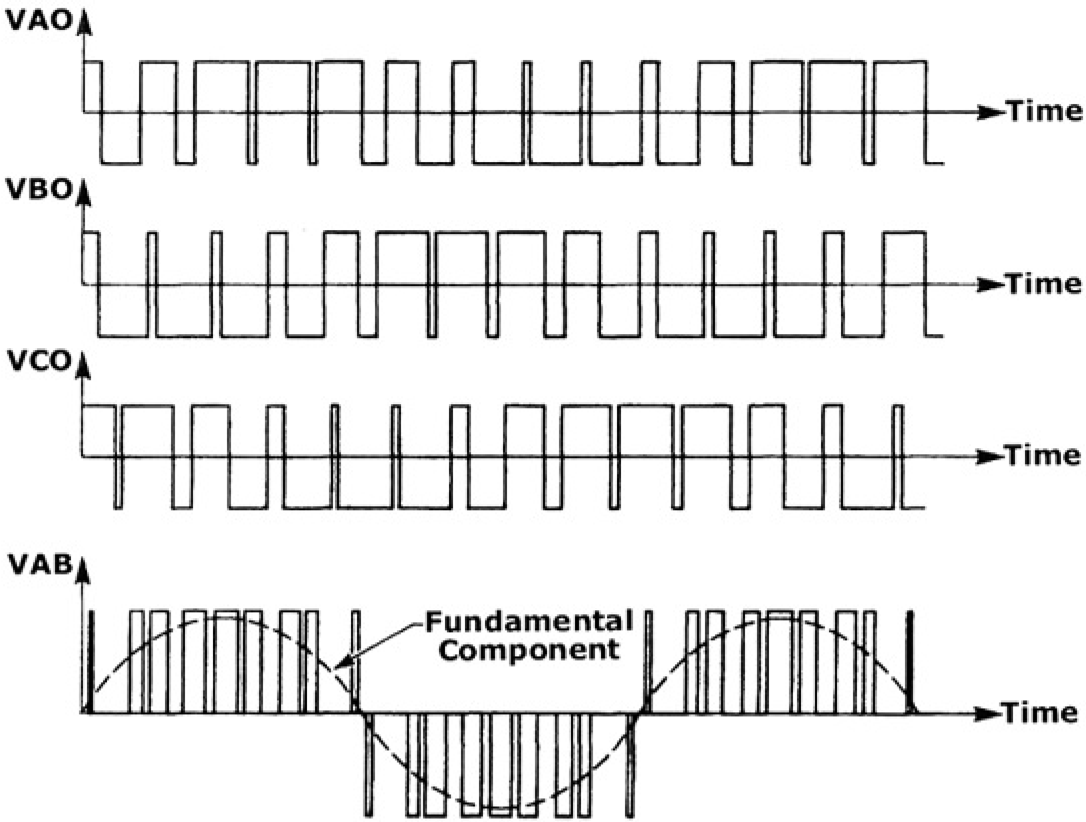
Main Switchboard
harmonic filter
propulsion transformer
DC link reactor coil
a.c.-d.c.-a.c. synchro-converter
separate stator windings
Starboard Propulsion Motor (synchronous)
propulsion transformer
DC link reactor coil
a.c.-d.c.-a.c. synchro-converter
pulse firing circuit
rotating field
rotating rectifier
exc. xfmr
field cont-roller
rotating transformer
propulsion regulator
power mgt system
bridge
ECR
local
control stations
exc. xfmr
field cont-roller
rotating transformer
pulse firing circuit
rotating rectifier
rotating field
propulsion transformer
a.c.-d.c.-a.c. synchro-converter
DC link reactor coil
Port Propulsion Motor (synchronous)
propulsion transformer
a.c.-d.c.-a.c. synchro-converter
separate stator windings
harmonic filter
DC link reactor coil
B

EL-0161



Silicon Controlled Rectifier
Gate Turn-off Thyristor
Diode
AC Propulsion Motor
3 Phase AC Power Supply
L1
L2
L3
VAB
VBO
VAO
VCO
O
A
B
C
Source Converter
Capacitor
Load Converter

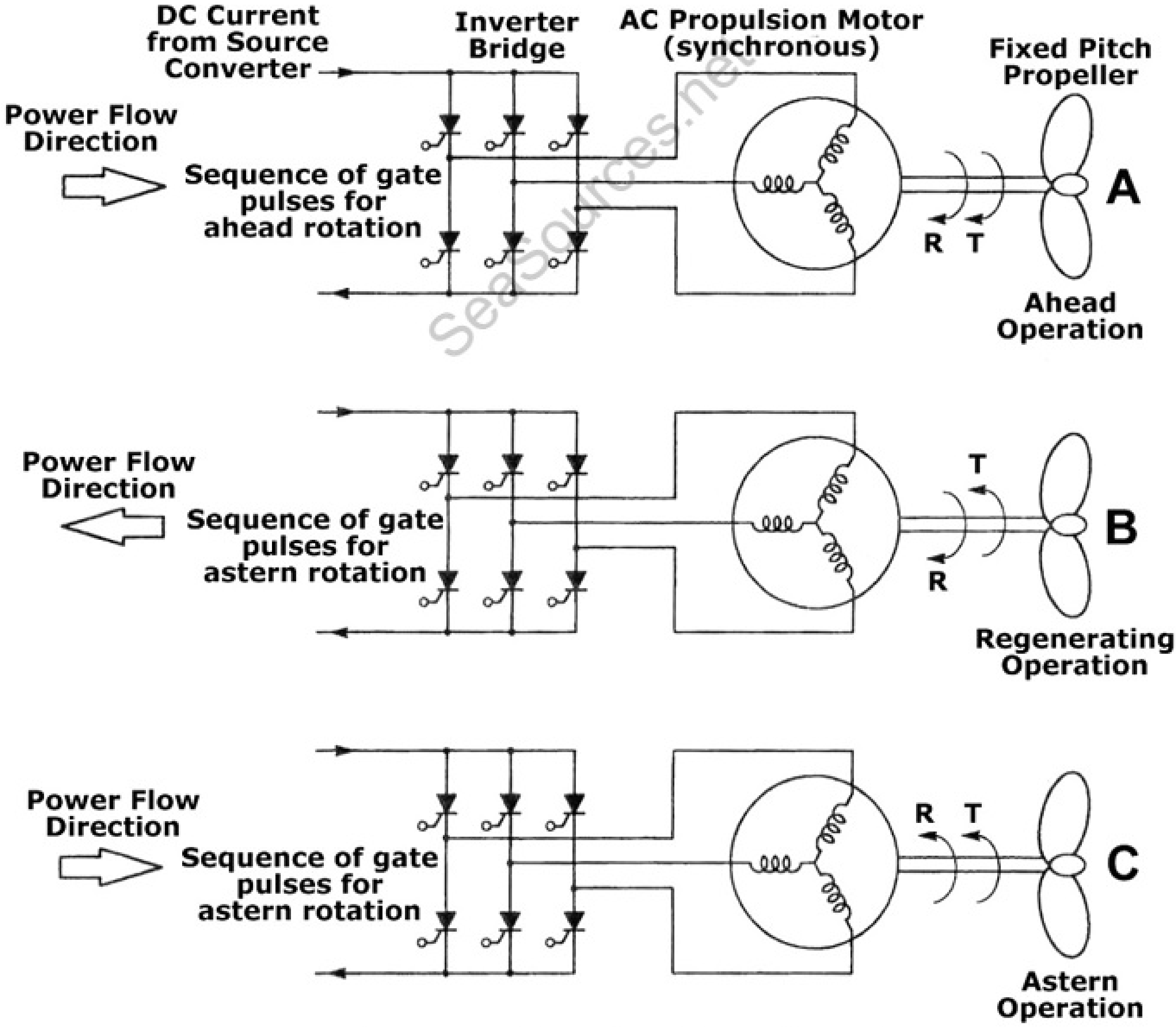
A



VAO
Time
VBO
Time
VCO
Time
VAB
Fundamental Component
Time

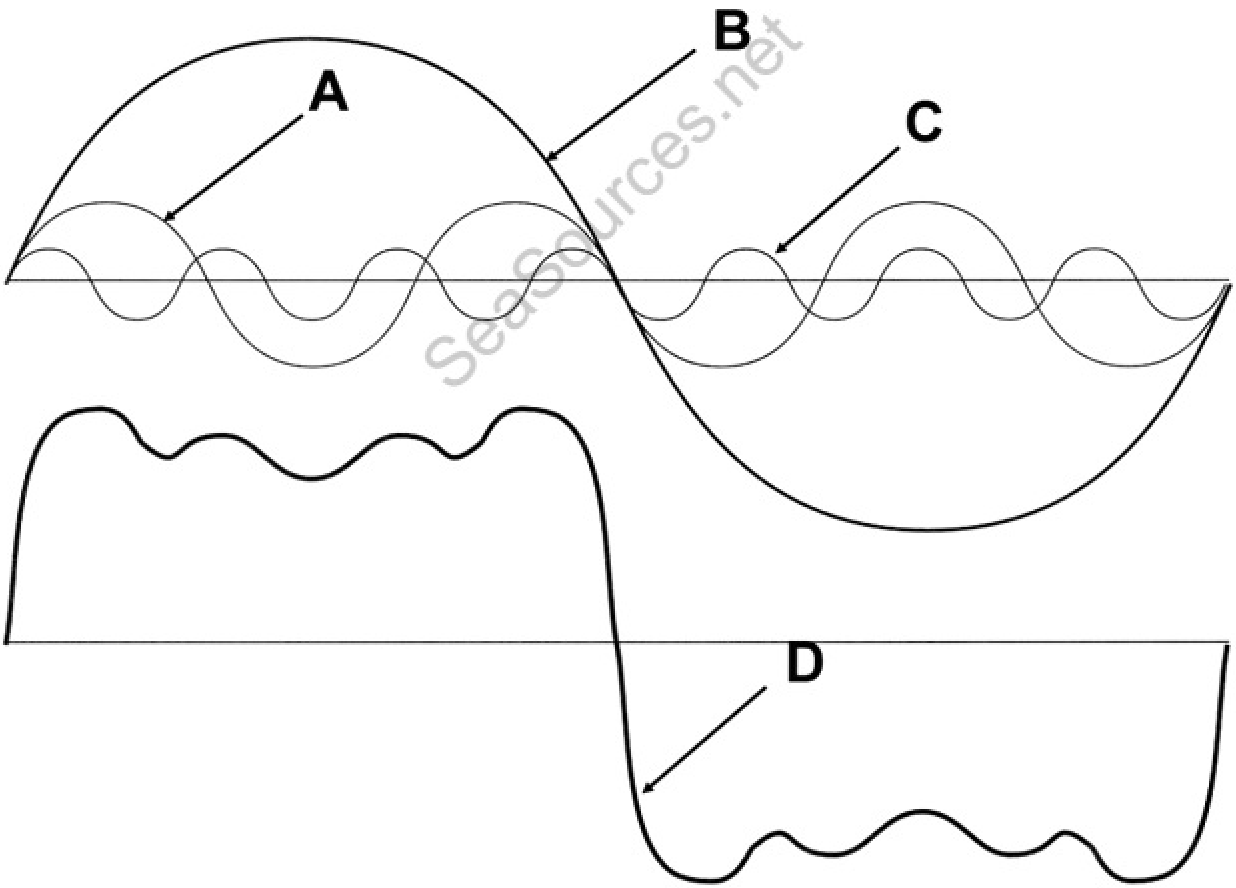
B

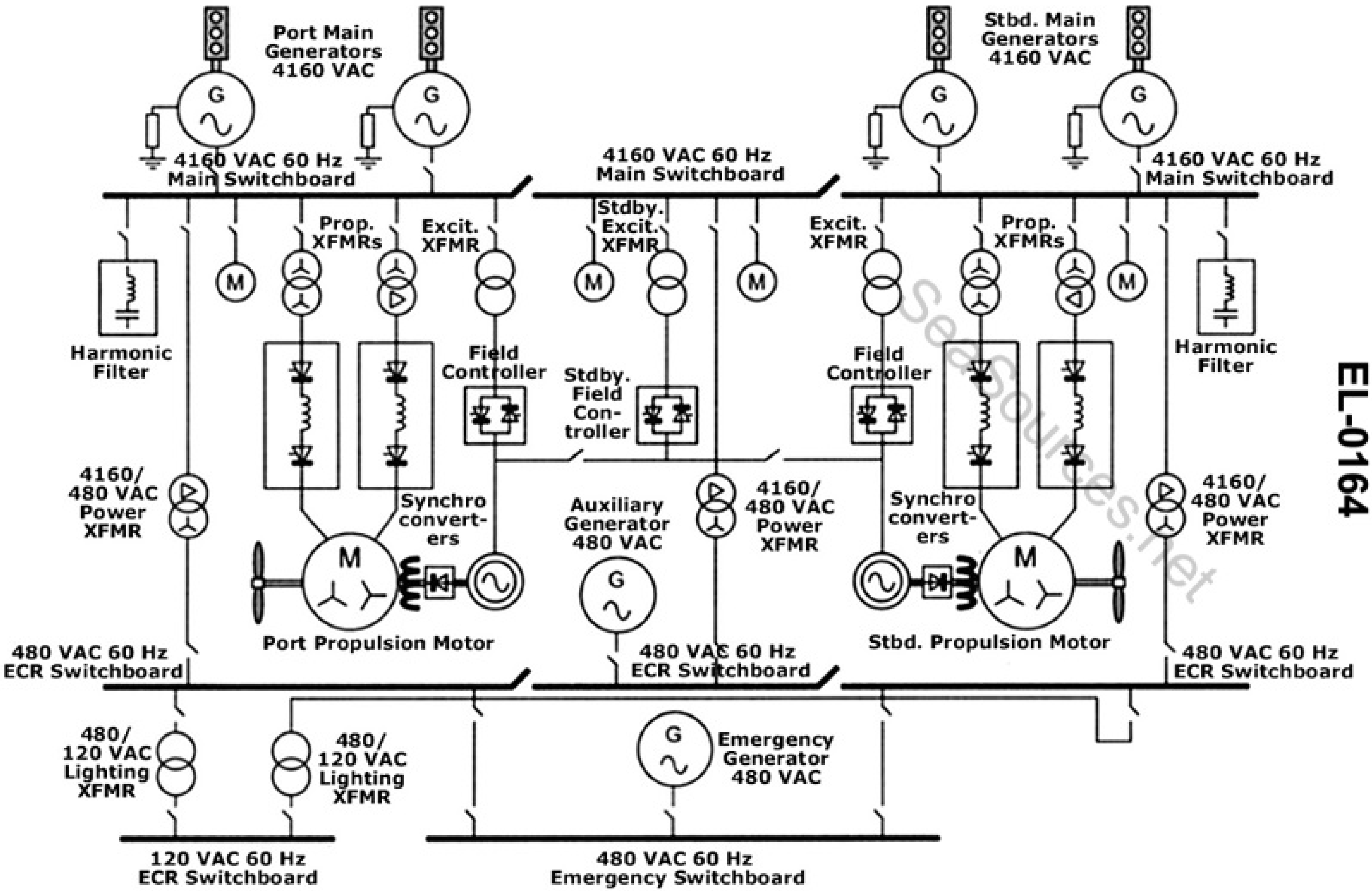
EL-0162

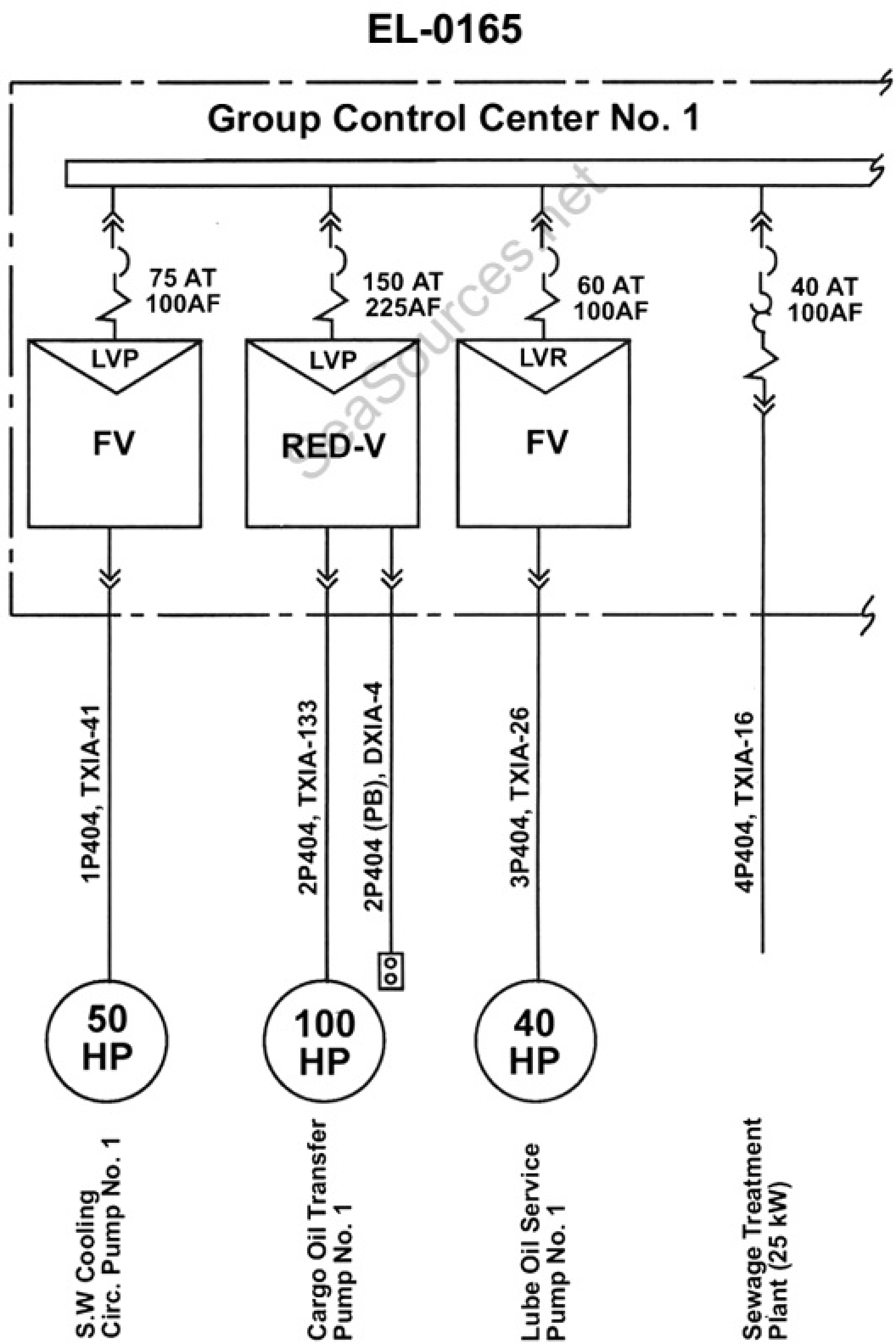


Where R = Direction of actual rotation
T = Direction of applied torque

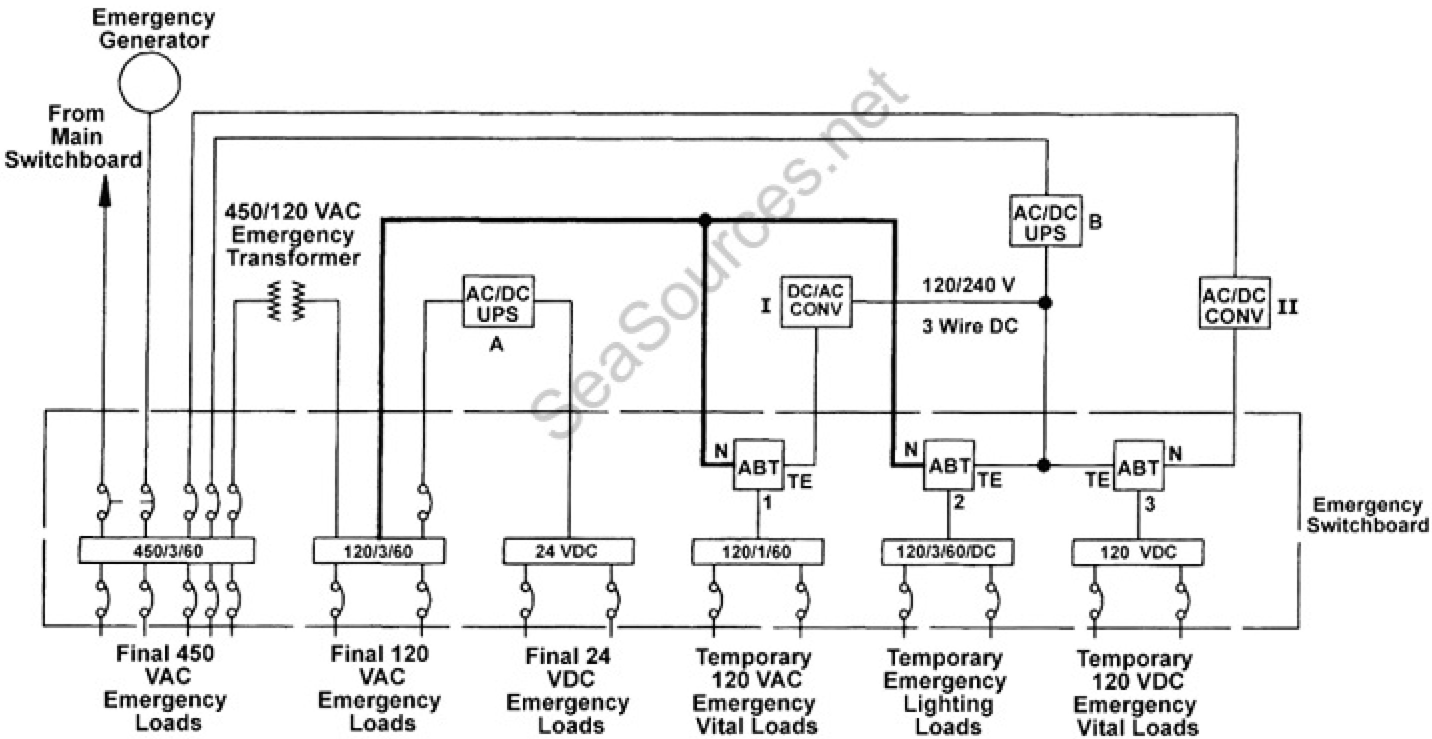
EL-0163




Port Main Generators 4160 VAC
Stbd. Main Generators 4160 VAC
G
4160 VAC 60 Hz Main Switchboard
4160 VAC 60 Hz Main Switchboard
4160 VAC 60 Hz Main Switchboard
Prop. XFMRs
Excit. XFMR
Stdby. Excit. XFMR
Excit. XFMR
Prop. XFMRs
M
Harmonic Filter
Field Controller
Stdby. Field Con- troller
Field Controller
Harmonic Filter
4160/ 480 VAC Power XFMR
Synchro convert- ers
Auxiliary Generator 480 VAC
4160/ 480 VAC Power XFMR
Synchro convert- ers
4160/ 480 VAC Power XFMR
Port Propulsion Motor
Stbd. Propulsion Motor
480 VAC 60 Hz ECR Switchboard
480 VAC 60 Hz ECR Switchboard
480 VAC 60 Hz ECR Switchboard
480/ 120 VAC Lighting XFMR
480/ 120 VAC Lighting XFMR
Emergency Generator 480 VAC
120 VAC 60 Hz ECR Switchboard
480 VAC 60 Hz Emergency Switchboard
EL-0164

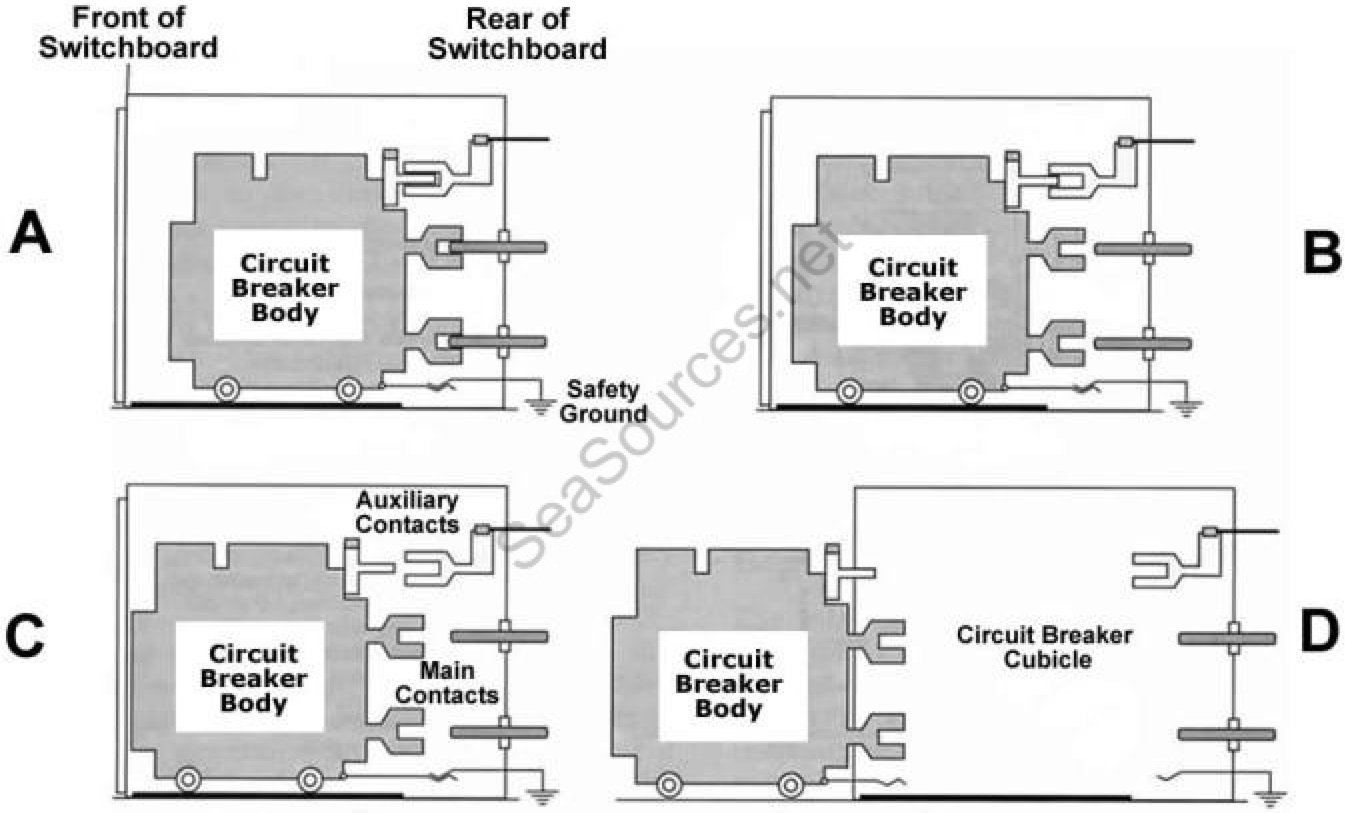

EL-0165
Group Control Center No. 1
75 AT
100AF
150 AT
225AF
60 AT
100AF
40 AT
100AF
LVP
FV
LVP
RED-V
LVR
FV
1P404, TXIA-41
2P404, TXIA-133
2P404 (PB), DXIA-4
3P404, TXIA-26
4P404, TXIA-16
50
HP
100
HP
40
HP
S.W Cooling
Circ. Pump No. 1
Cargo Oil Transfer
Pump No. 1
Lube Oil Service
Pump No. 1
Sewage Treatment
Plant (25 kW)
SeaSources.net

EL-0166



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 120VDC
N - Normal & Final Emergency Power Source
TE - Temporary Emergency Power Source

EL-0167

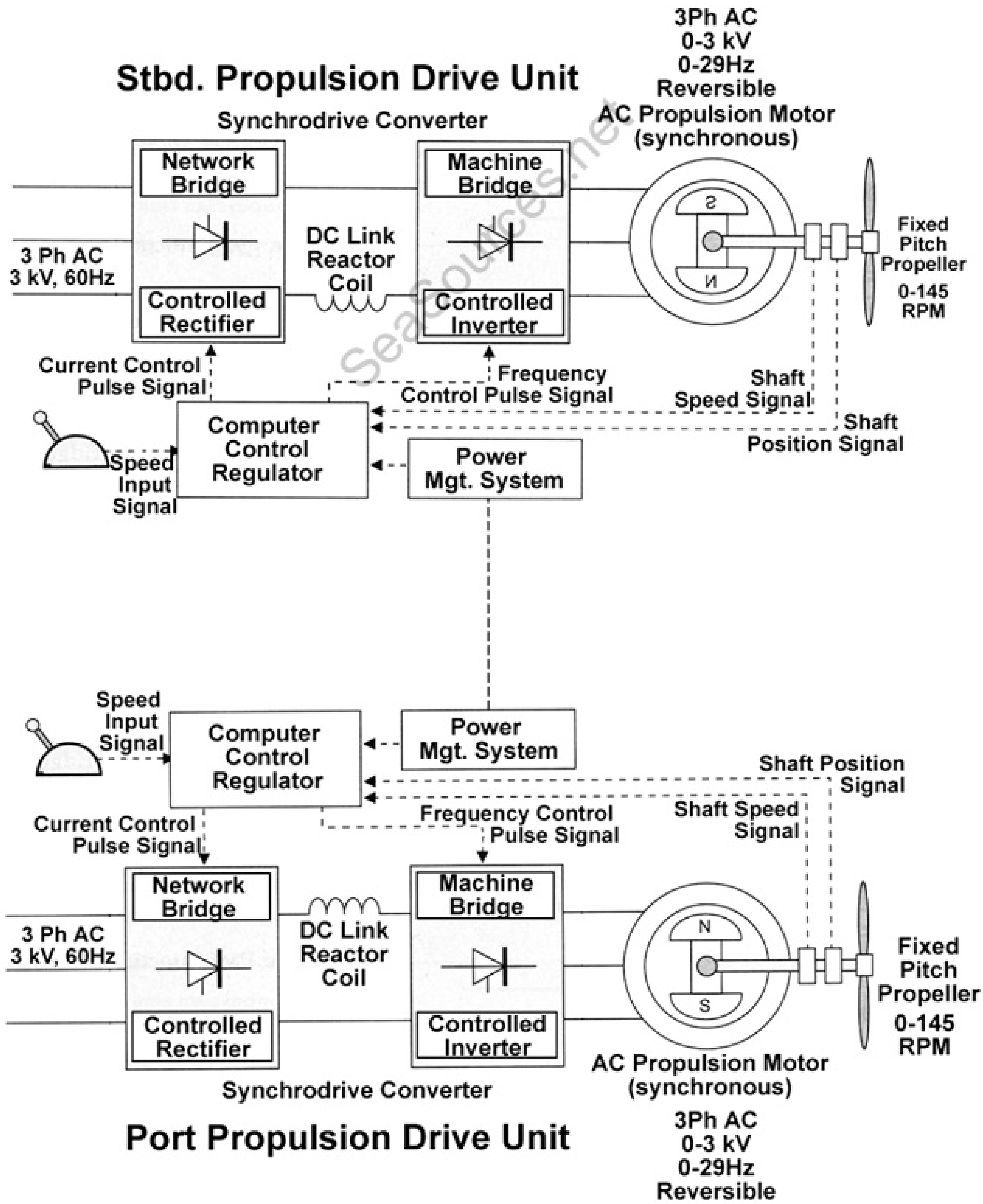


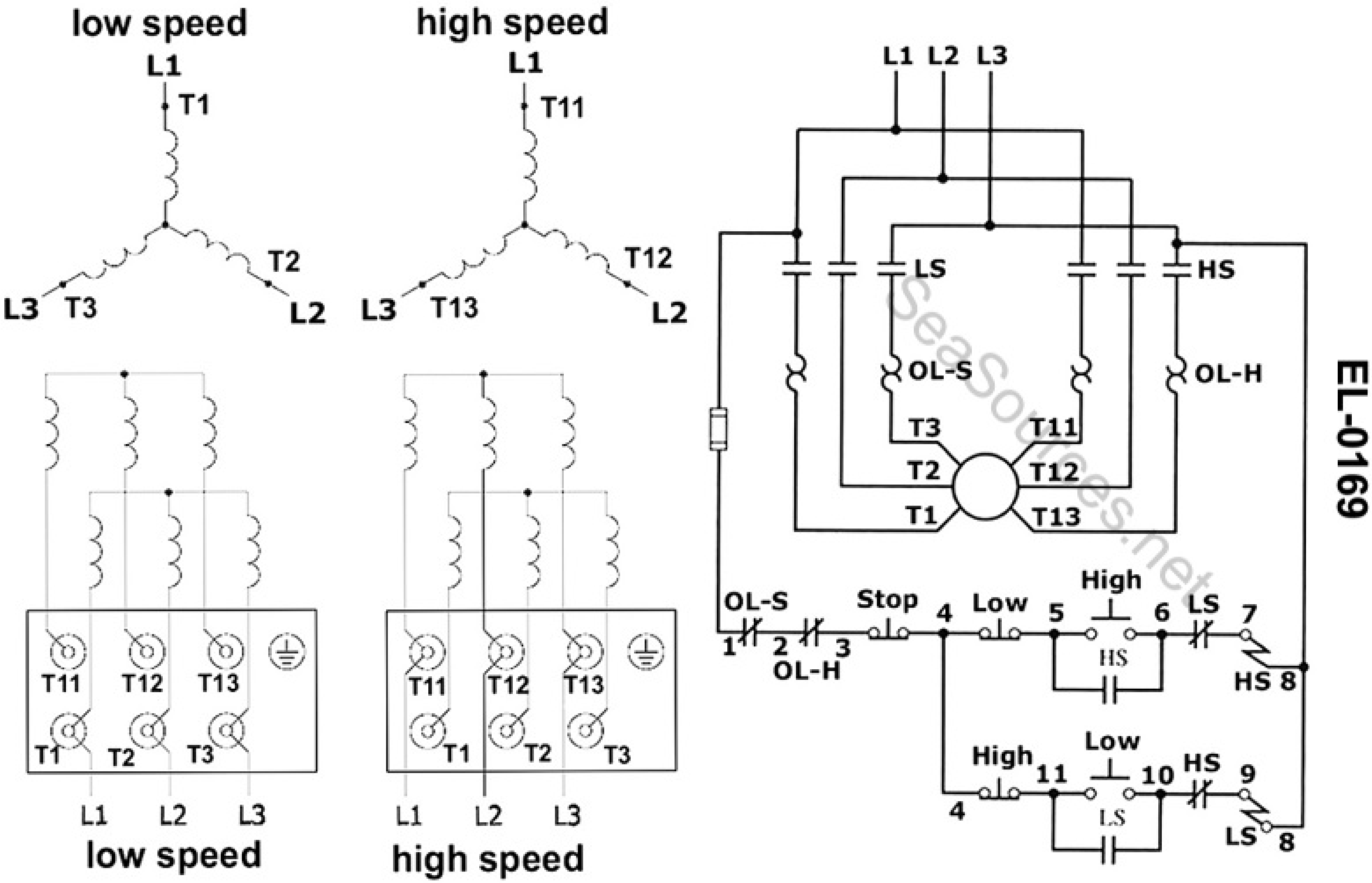
Front of Switchboard
Rear of Switchboard
A
Circuit Breaker Body
Safety Ground
B
Circuit Breaker Body
C
Auxiliary Contacts
Circuit Breaker Body
Main Contacts
Circuit Breaker Body
Circuit Breaker Cubicle
D

E

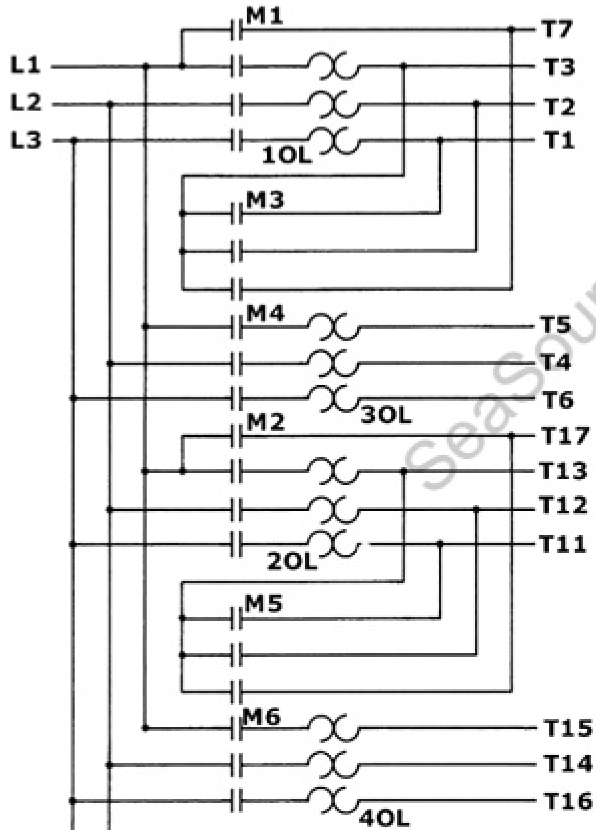
F

EL-0168

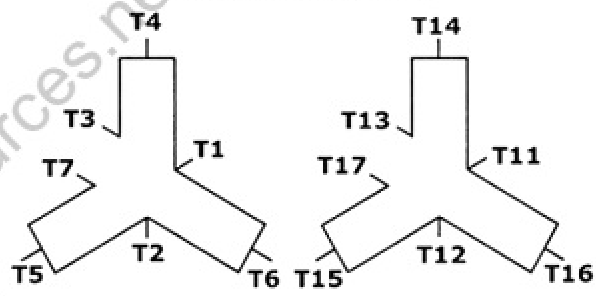

Stbd. Propulsion Drive Unit
Synchrodrive Converter
3Ph AC
0-3 kV
0-29Hz
Reversible
AC Propulsion Motor
(synchronous)
Network Bridge
Controlled Rectifier
DC Link Reactor Coil
Machine Bridge
Controlled Inverter
3 Ph AC
3 kV, 60Hz
Fixed Pitch Propeller
0-145 RPM
Current Control Pulse Signal
Frequency Control Pulse Signal
Shaft Speed Signal
Shaft Position Signal
Computer Control Regulator
Speed Input Signal
Power Mgt. System
Speed Input Signal
Computer Control Regulator
Power Mgt. System
Shaft Position Signal
Shaft Speed Signal
Frequency Control Pulse Signal
Current Control Pulse Signal
Network Bridge
Controlled Rectifier
DC Link Reactor Coil
Machine Bridge
Controlled Inverter
3 Ph AC
3 kV, 60Hz
N
S
Fixed Pitch Propeller
0-145 RPM
AC Propulsion Motor
(synchronous)
Synchrodrive Converter
Port Propulsion Drive Unit
3Ph AC
0-3 kV
0-29Hz
Reversible


low speed
L1
T1
T2
L3
T3
L2
high speed
L1
T11
T12
L3
T13
L2
T11
T12
T13
T1
T2
T3
L1
L2
L3
low speed
T11
T12
T13
T1
T2
T3
L1
L2
L3
high speed
L1 L2 L3
LS
HS
OL-S
OL-H
T3
T2
T1
T11
T12
T13
EL-0169
OL-S
1
2
OL-H
3
Stop
4
Low
5
High
HS
6
LS
7
HS 8
High
4
11
Low
LS
10
HS
9
LS
8

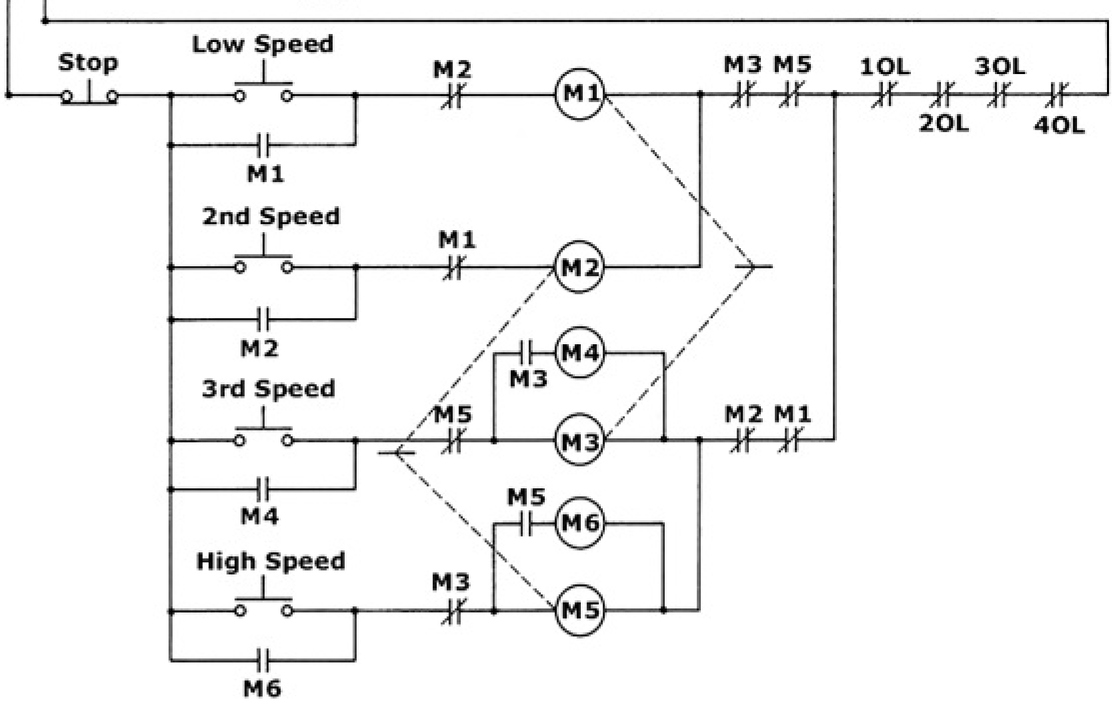
EL-0170



Constant Torque



Speed	L1	L2	L3	Open	Tie Together
Low	T1	T2	T3,T7	All others	
2nd	T11	T12	T13,T17	All others	
3rd	T6	T4	T5	All others	T1,T2,T3,T7
High	T16	T14	T15	All others	T11,T12,T13,T17



EL-0171

Standard Overload Relays

General Instructions for Selection of Overload Relay Heater Elements:

1. Obtain full load current and service factor from motor nameplate or from motor manufacturer. Do not estimate full-load motor current from horsepower tables.
2. Determine if 1, 2, or 3 overload relays are needed.
3. Select proper heater from appropriate table according to class, size, type of enclosure and number of overload relays being used. Full load motor currents should be within the Min.-Max. ratings shown for the number of overload relays being used.
4. The tables apply only to standard, open type or totally enclosed fan-cooled, continuous duty motors (with a service factor of 1.15 and rated for 40 degrees C rise) in applications where motor and stater are located in the same ambient temperature. For applications of other motors with a service factor of 1, 50-55 degrees C rise, totally enclosed non-ventilated, explosion proof, or for installations where ambient temperatures of motor and starter are different, refer to Chart "A" for selection of overload heater units.

Chart A: Variations by Operating Conditions

Motor continuous rating °C rise	Ambient temperature same at starter and motor	Ambient temperature higher at starter than at motor	Ambient temperature lower at starter than at motor
1.15 service factor 40°C rise	As specified from tables	One size larger than specified for each 15°C difference	One size smaller than specified for each 15°C difference
1.0 service factor 50-55°C rise	One size smaller than for 1.15 service factor as above	One size smaller than for 1.15 service factor as above	One size smaller than for 1.15 service factor as above

Motor Nameplate

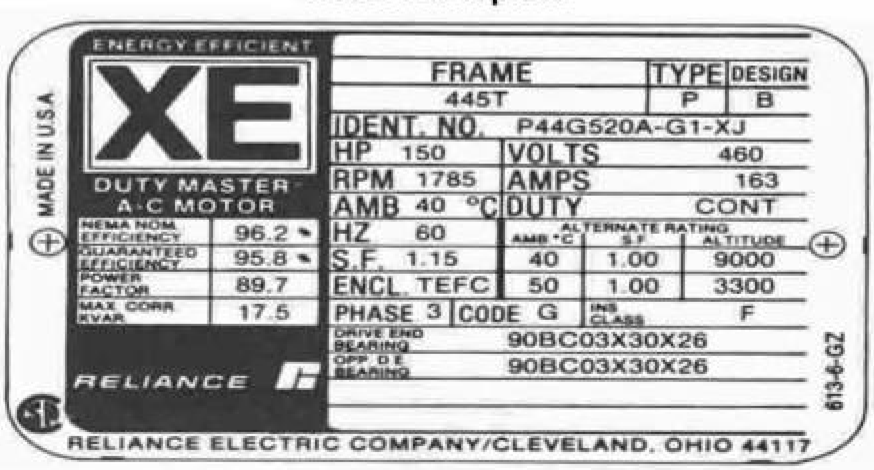
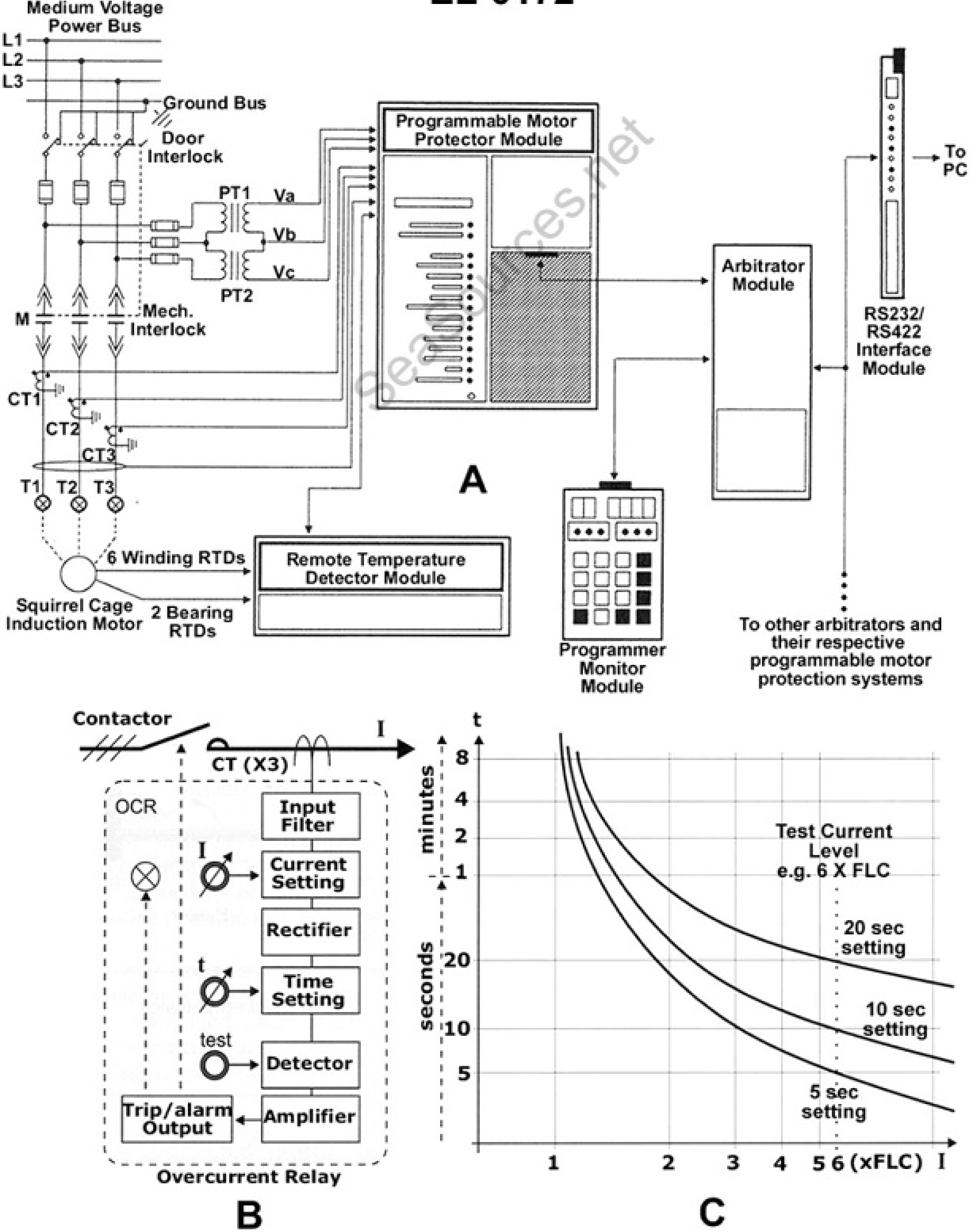


Table 24: NEMA Size 6
For all Standard Enclosures
Three Overload Relays per Starter

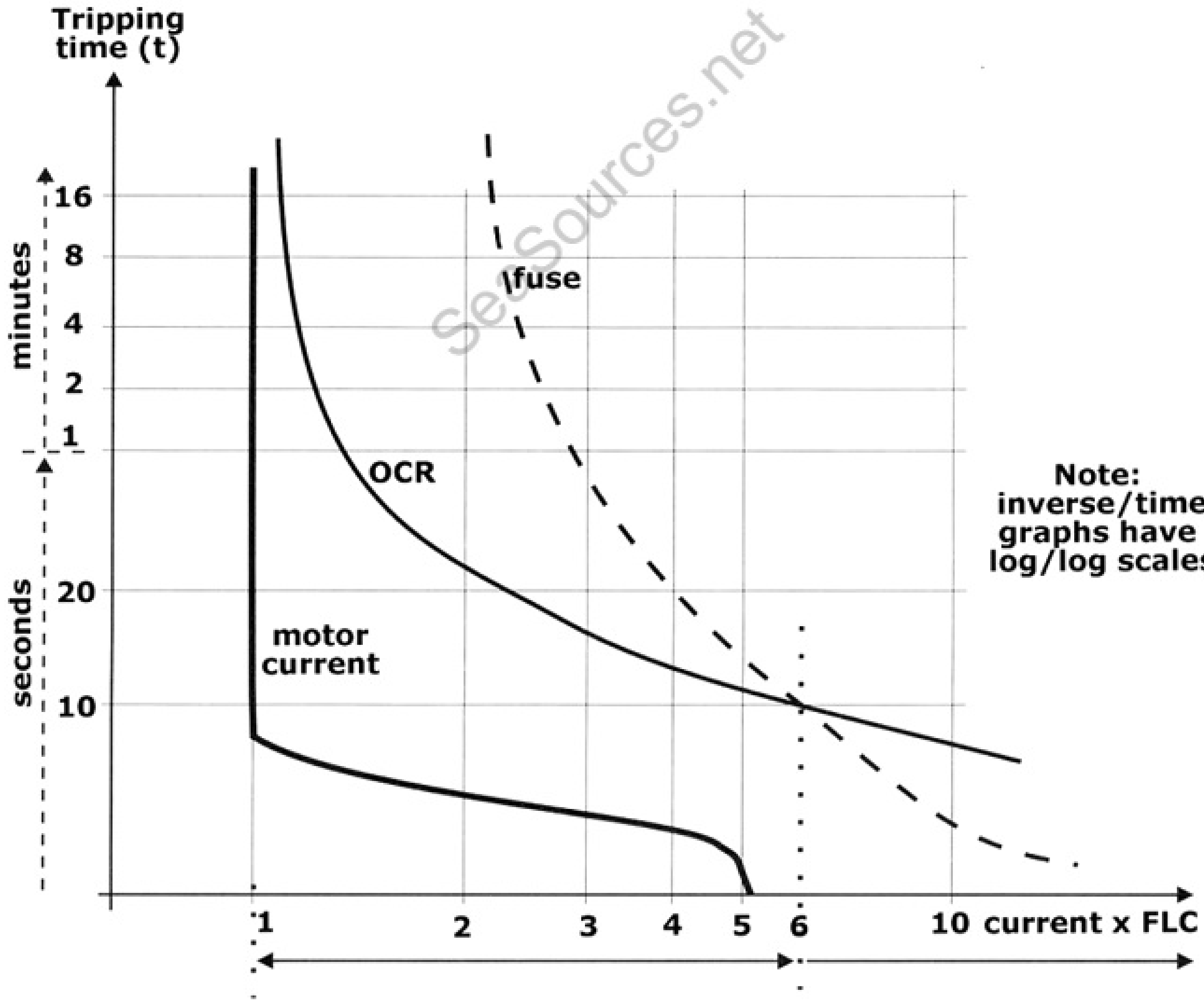
Heater Cat. No.	Motor Current	
	Min	Max
G30T19	142	157
G30T20	158	171
G30T21	172	188
G30T22	189	207
G30T23	208	229
G30T24	230	252
G30T25	253	277
G30T26	278	306
G30T27	307	336
G30T28	337	368
G30T29	369	405
G30T30	406	459
G30T31	460	480

EL-0172



Medium Voltage Power Bus
L1
L2
L3
Ground Bus
Door Interlock
PT1
PT2
Va
Vb
Vc
M
Mech. Interlock
CT1
CT2
CT3
T1
T2
T3
6 Winding RTDs
2 Bearing RTDs
Squirrel Cage Induction Motor
Programmable Motor Protector Module
Remote Temperature Detector Module
Arbitrator Module
Programmer Monitor Module
RS232/ RS422 Interface Module
To PC
To other arbitrators and their respective programmable motor protection systems
A
Contactor
CT (X3)
I
OCR
Input Filter
Current Setting
Rectifier
Time Setting
Detector
Amplifier
Trip/alarm Output
t
test
Overcurrent Relay
B
t
minutes
seconds
8
4
2
1
20
10
5
Test Current Level e.g. 6 X FLC
20 sec setting
10 sec setting
5 sec setting
1
2
3
4
5
6
(xFLC)
I
C

EL-0173



Tripping time (t)
minutes
seconds
16
8
4
2
1
20
10
fuse
OCR
motor current
Note: inverse/time graphs have log/log scales
1
2
3
4
5
6
10 current x FLC

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EL-0176

A

B

C

D

EL-0177

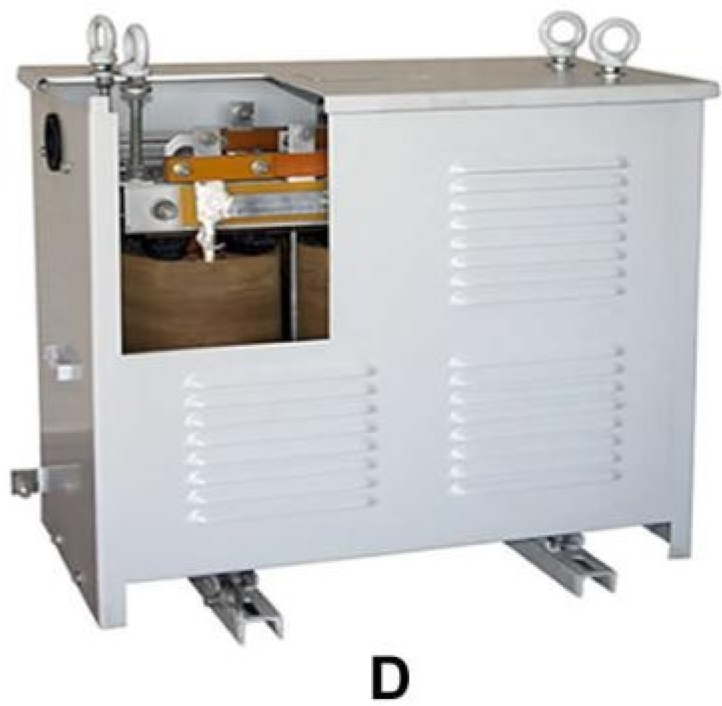

ADVANCE
e-Vision®
IntelliVolt®: 120V to 277V 50/60Hz
Lamp End-of-life (EOL) Detection
CAUTION:

A


H4 H2 H3 H1

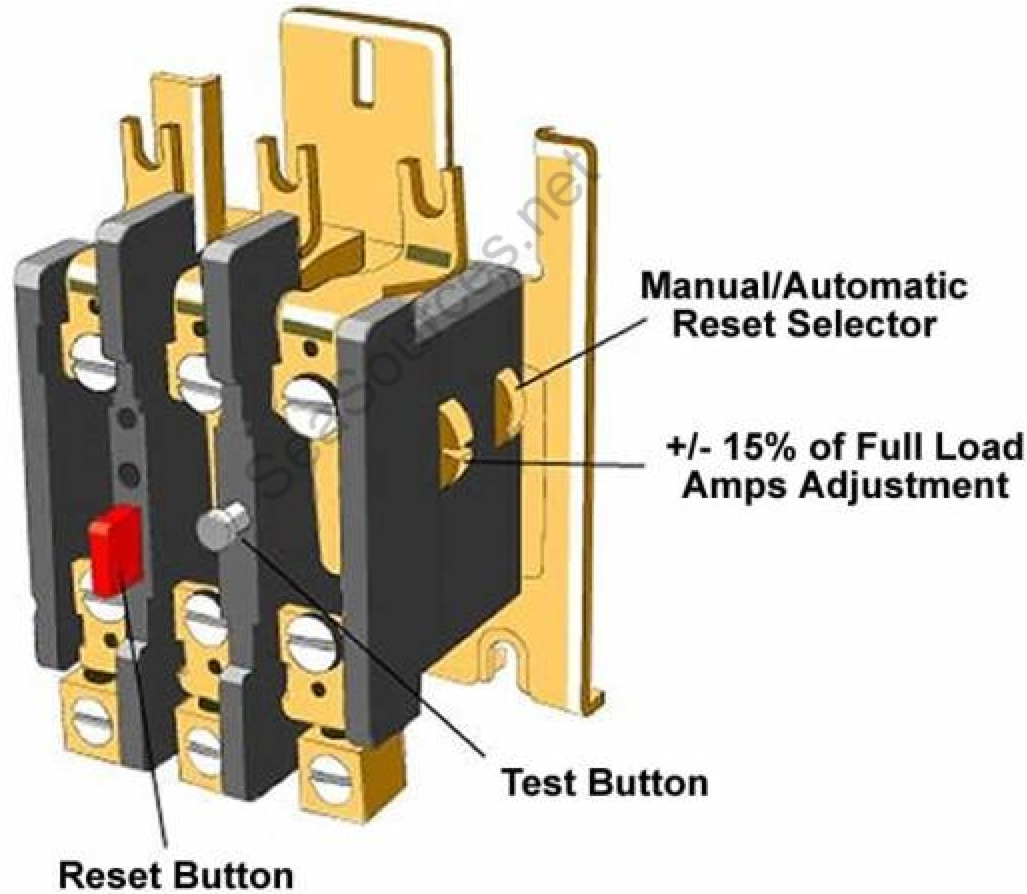
B

C



D

EL-0178



Manual/Automatic
Reset Selector
+/- 15% of Full Load
Amps Adjustment
Test Button
Reset Button

A

F.L.C.
I
U32
Fuse amp.
flink, normal 80A
tr. gL, slow 63A
80A
100A
O/R
94
96
97
28 48
26 45
24
22 40
20 35
22 24 26
20 28A
F.L.C.
2 T1
4 T2
6 T3
98

B

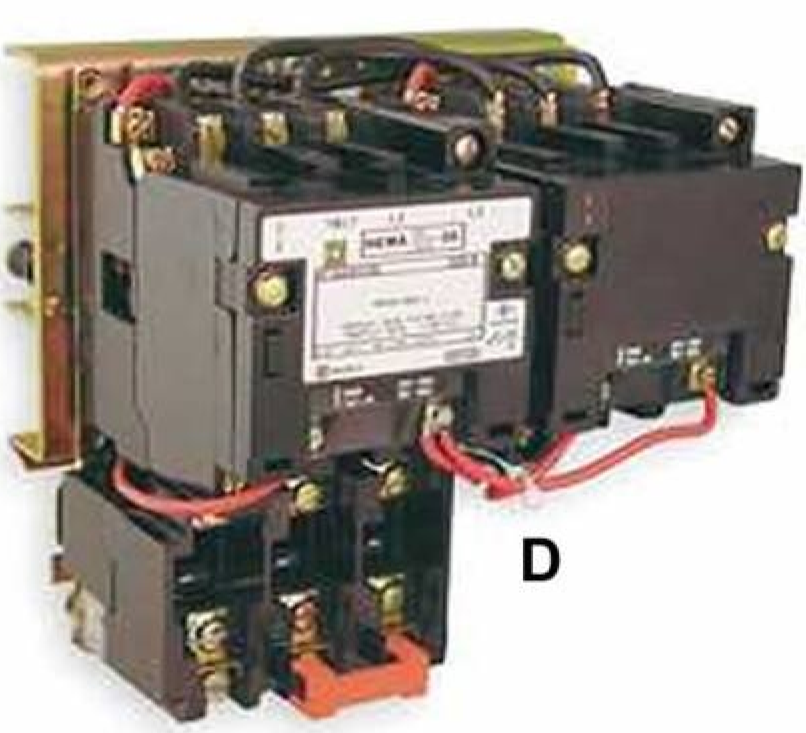
C

EL-0179

A

B

C



D

Catalog Number Selection Chart

Example Catalog Number

A N 1 9 A N 0 A 5E 005

Device Type

- **A** = Starter
- **C** = Contactor

Standard

- **E** = IEC
- **N** = NEMA

Device Assembly Configurations

- **70** = Multi-speed
- **1** = Non-reversing
- **5** = Reversing

OLR Type

- **5** = Contactor only-no overload relay
- **6** = Starter w/C306 bi-metallic OLR
- **9** = Starter w/C440 electronic overload

Contactor Frame Size *

Suffix	NEMA Size	Continuous Amperes
A =	00	9
B =	0	18
D =	1	27
G =	2	45
K =	3	90
N =	4	135
S =	5	270
T =	6	540
U =	7	810
V =	8	1215

NEMA Enclosure

- **N** = Open

For Starters

Starter Mounting Option

- **0** = Horizontal
- **V** = Vertical

For Contactors only

- **2** = Two-pole
- **3** = Three-pole
- **4** = Four-pole
- **5** = Five-pole

AC Coil Suffix

Suffix	Coil Volts and Hertz
A	= 120/60 or 110/50
B	= 240/60 or 220/50
C	= 480/60 or 440/50
D	= 600/60 or 550/50
E	= 208/60
H	= 277/60
J	= 208-240/60 **
K	= 240/50
L	= 380-415/50
N	= 550/50
T	= 24/60, 24/50 ***
U	= 24/50
V	= 32/50
W	= 48/60
Y	= 48/50

C440 OLR Designation (FVNR and FVR only)

- **5E** = Standard feature set
  SEL Reset, SEL Class (10A, 10, 20, 30)
- **5G** = Ground fault feature set
  SEL Reset, SEL Class (10, 20)

C440 FLA Range (FVNR and FVR only)

NEMA Size 00

- **1P6** = 0.33-1.65A
- **005** = 1-5A
- **020** = 4-20A

NEMA Size 0

- **1P6** = 0.33-1.65A
- **005** = 1-5A
- **020** = 4-20A

NEMA Size 1

- **1P6** = 0.33-1.65A
- **005** = 1-5A
- **020** = 4-20A
- **045** = 9-45A

NEMA Size 2

- **005** = 1-5A
- **020** = 4-20A
- **045** = 9-45A

NEMA Size 3

- **100** = 20-100A ****

NEMA Size 4 **

- **300** = 60-300A ****

NEMA Size 5 **

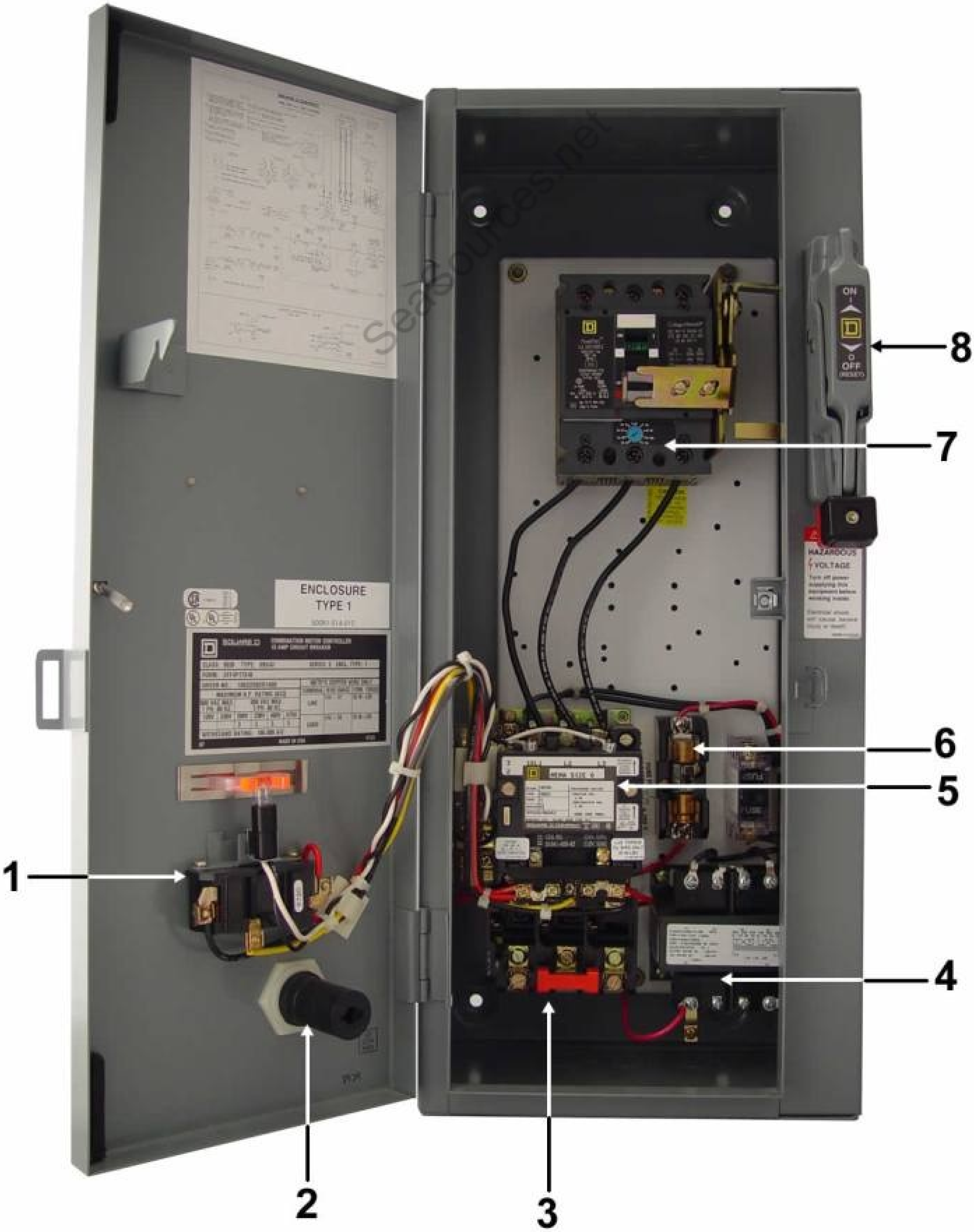
- **300** = 60-300A ****

Notes:

* For contactor only orders, add B to end of catalog number if NEMA size 00-2, 6.
** NEMA sizes 00 and 0 only.
*** NEMA sizes 00 and 0 only. Sizes 1-8 are 24/60 only.
**** NEMA sizes 4 and 5 require the use of CTs with 1-5A OL relay. Size 4 starters are not shipped as assembled units. Order CN15NN01 contactor 1-5A OL (C440A1A005SAX or C440A2A005SAX) with 60-300A CTs (ZEB-XCT300).

EL-0180

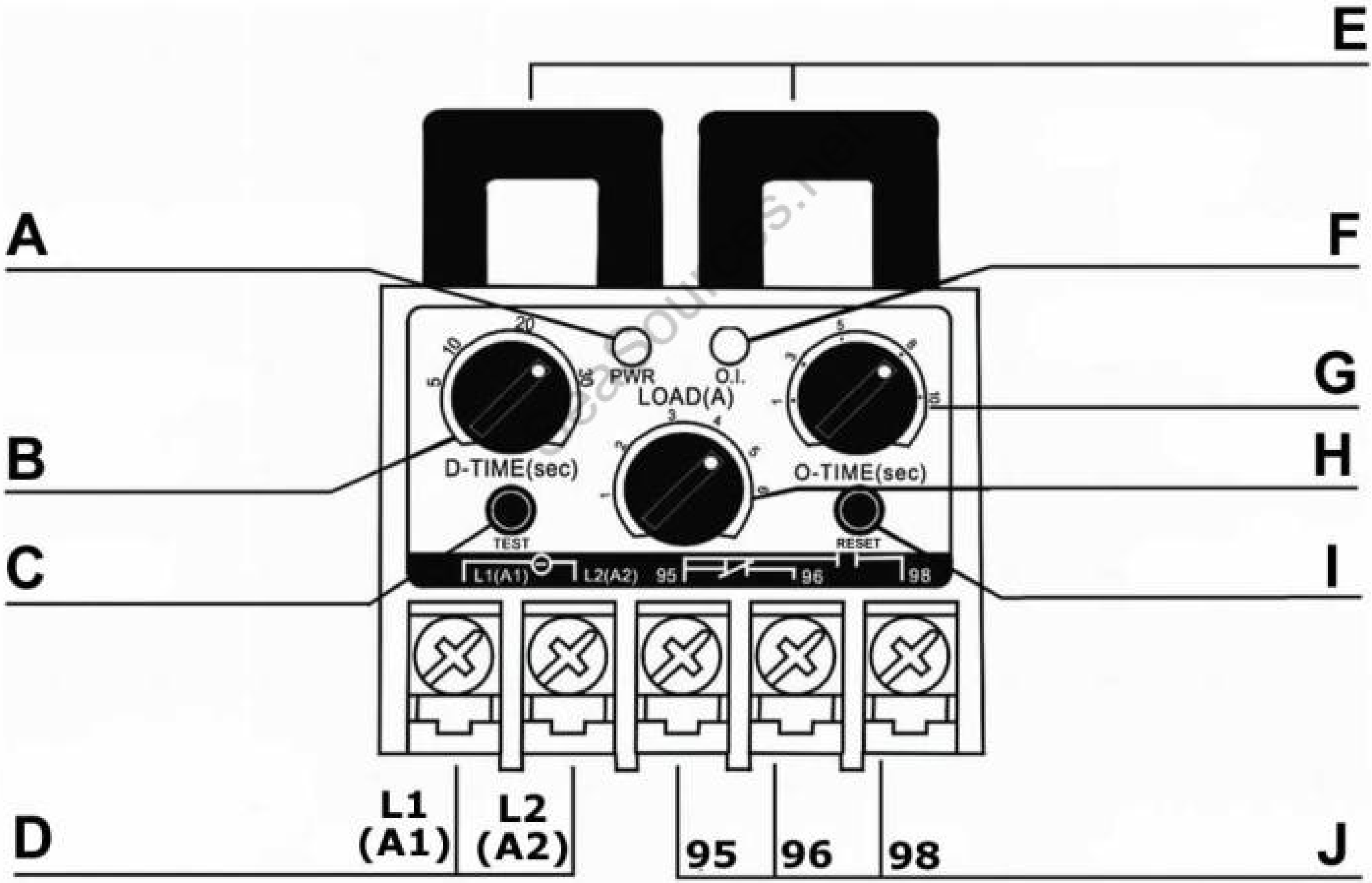
EL-0181



EL-0182


SIEMENS
ESP200
TRIP CLASS
5
20
10
30
PHASE UNBAL ON
OFF
PHASE LOSS ON
OFF
RESET MODE MAN
AUTO
GROUND FAULT ON
OFF
FULL LOAD AMPS
CAT.NO.
48ATC3S00
TEST
RESET
3UB8123-4CW2
95
96
A3+
A4-
97
98

EL-0183



Electronic Overload Relay

EL-0184

A

B

C

D

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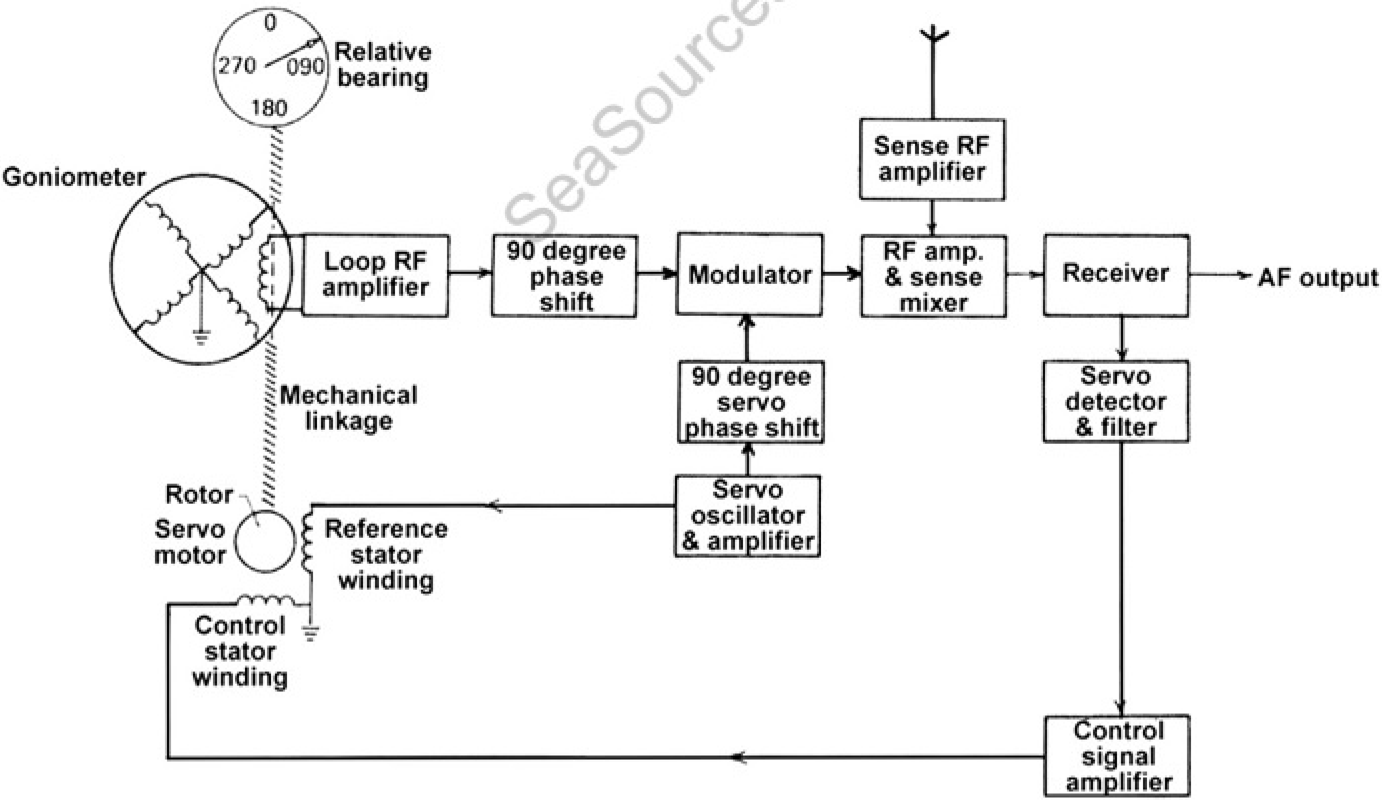
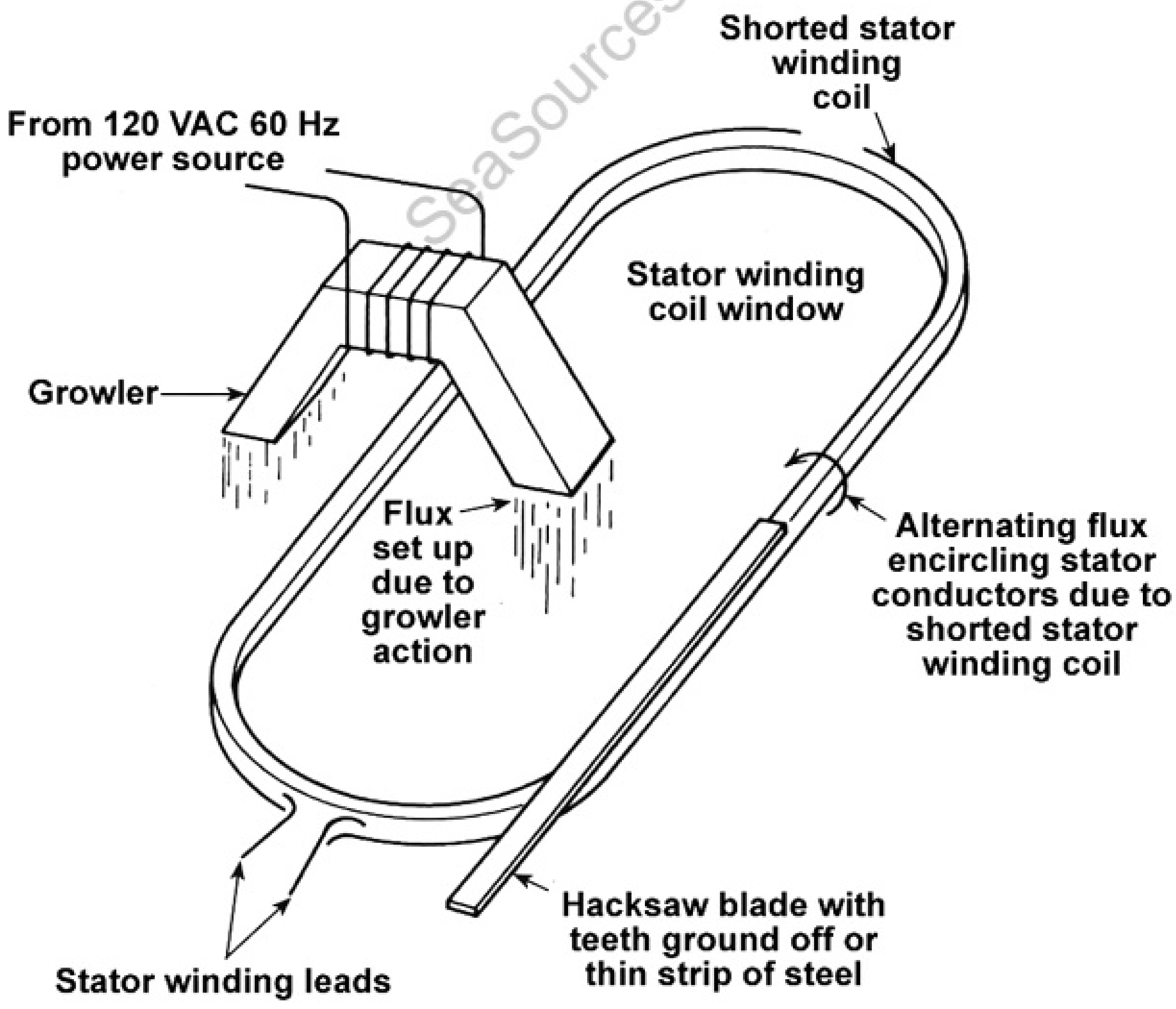
EL-0199



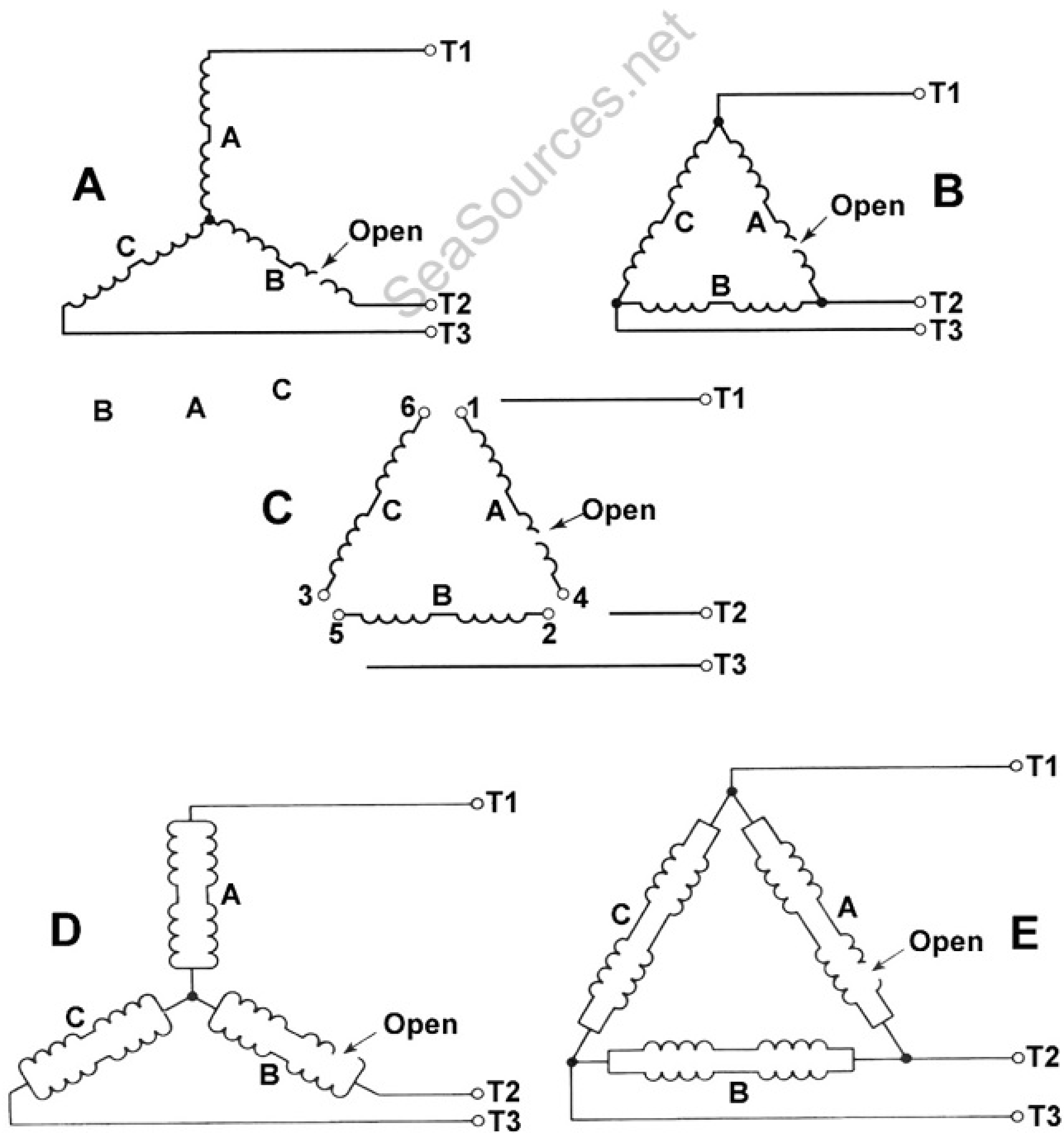
0
270
090
180
Relative bearing
Goniometer
Loop RF amplifier
90 degree phase shift
Modulator
Sense RF amplifier
RF amp. & sense mixer
Receiver
AF output
90 degree servo phase shift
Servo detector & filter
Mechanical linkage
Rotor
Servo motor
Reference stator winding
Servo oscillator & amplifier
Control stator winding
Control signal amplifier

EL-0200

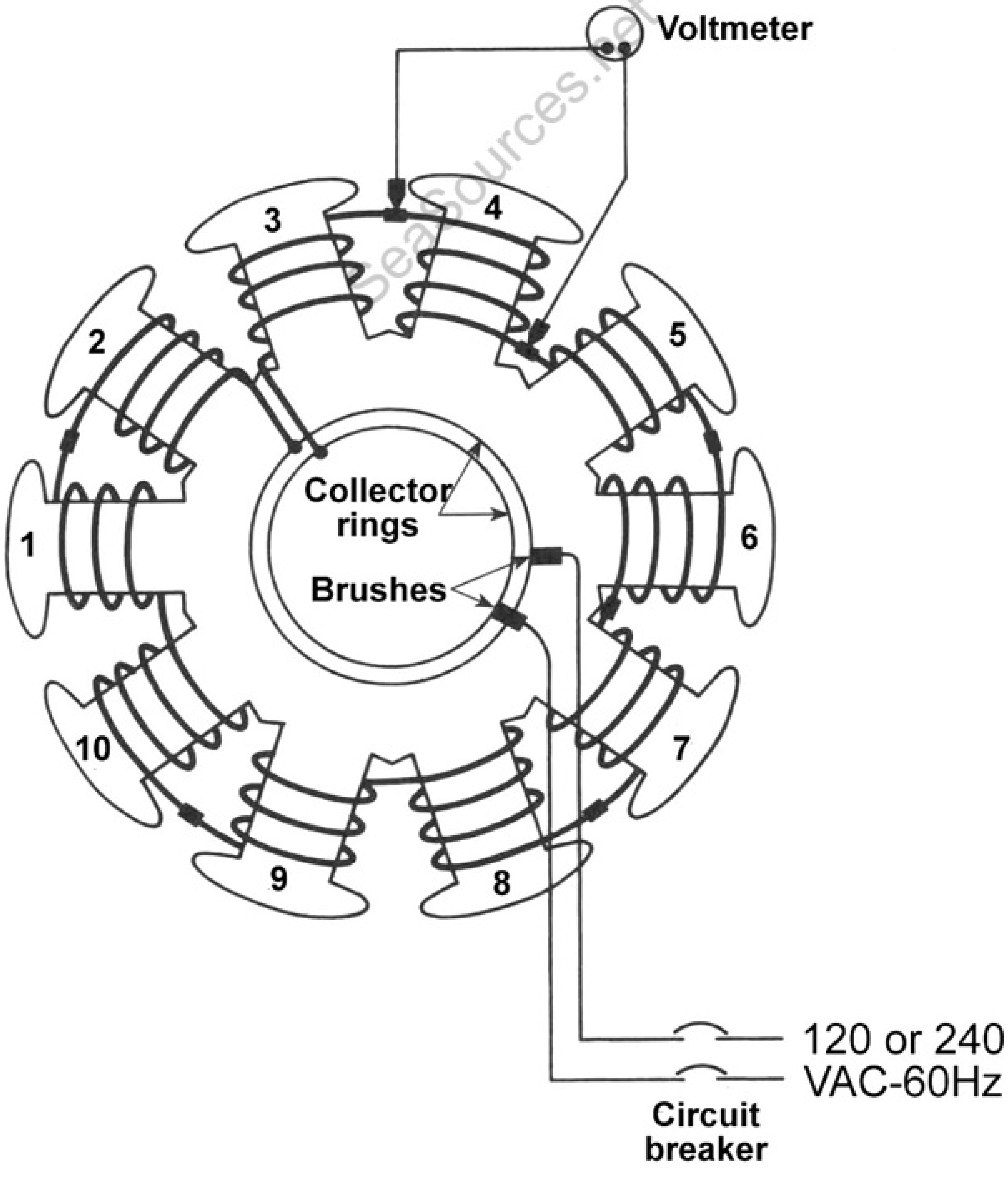


Shorted stator winding coil
From 120 VAC 60 Hz power source
Stator winding coil window
Growler
Flux set up due to growler action
Alternating flux encircling stator conductors due to shorted stator winding coil
Hacksaw blade with teeth ground off or thin strip of steel
Stator winding leads

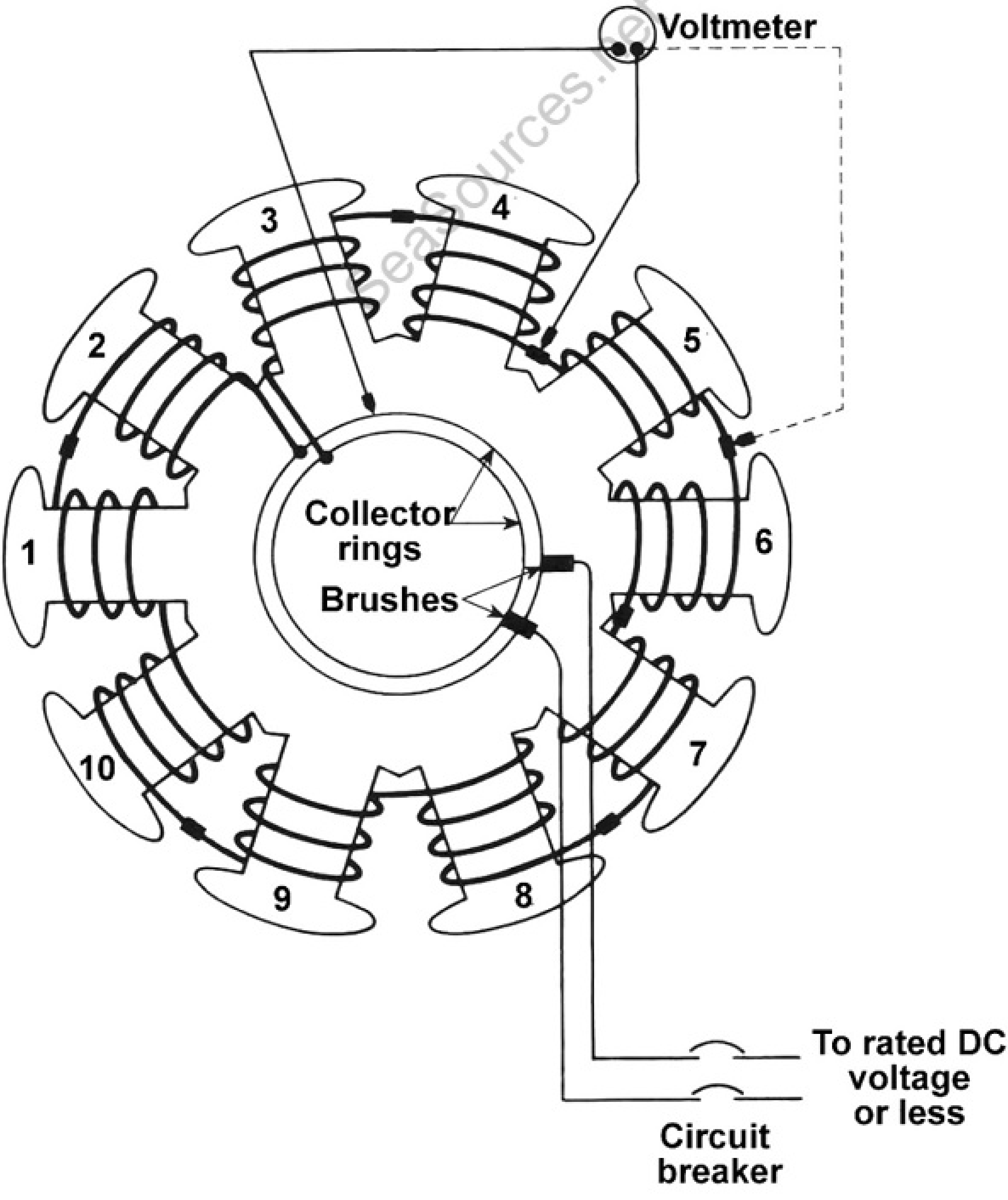
EL-0201


A
T1
A
C
B
Open
T2
T3
B
T1
A
C
B
Open
T2
T3
B
A
C
C
6
1
T1
C
A
Open
3
4
B
5
2
T2
T3
D
T1
A
C
B
Open
T2
T3
E
T1
C
A
Open
B
T2
T3

EL-0202


Voltmeter
3
4
2
5
1
6
10
7
9
8
Collector rings
Brushes
120 or 240 VAC-60Hz
Circuit breaker

EL-0203



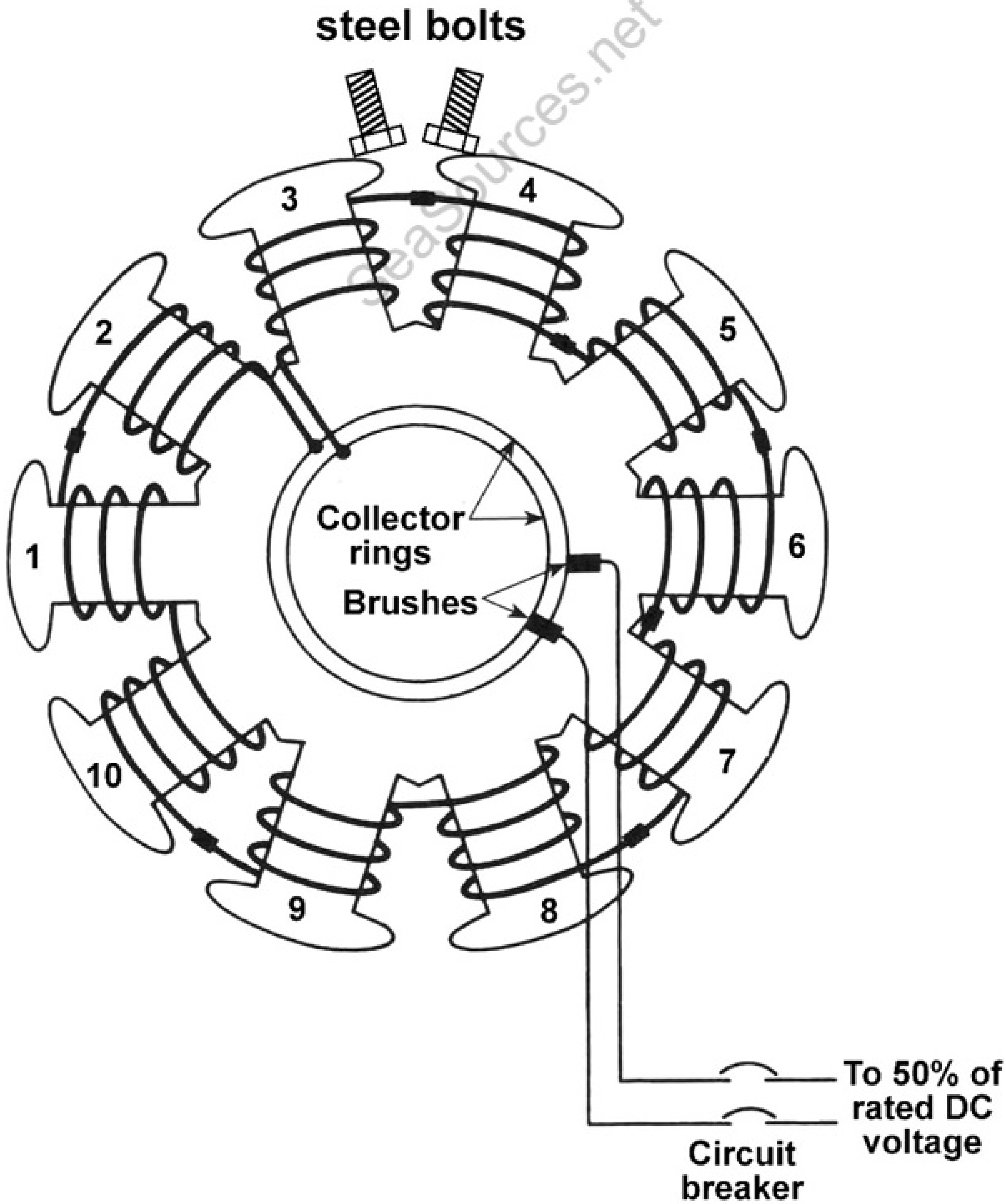
Voltmeter
1
2
3
4
5
6
7
8
9
10
Collector rings
Brushes
To rated DC voltage or less
Circuit breaker

Table 3 Sample sheet of a typical "List of Motors and Controls"

Application		Motor												Control							
														Starter					Cont SW		
IT No.	Auxiliary	Qty	Hp	Volt	Ph	F L Amp	NEMA Dsgn.	Rpm	Amb. Temp	Encl	Duty	Mtg	Remarks	Function	UV	LCT	ENCL	Opn	Type	LCT	Remarks
51	Main eng piston cooling water pump	2	25	460	3	28.9	B	3535	50	DP	Cont	Vert		X-Line ST-SP	LVR	See note (1)	DP	Man	–	–	Remote PB ST-SP, ST-SP IND LTS, SEL SW-Stby & Alm at MCC. PB ST-SP at pump. Remote press SW.
52	Main eng sea water cooling pump	2	150	460	3	173	B	1188	50	DP	Cont	Vert		X-Line ST-SP	LVR	See note (1)	DP	Man	–	–	Remote PB ST-SP, ST-SP IND LTS, SEL SW Stby & Alm at MCC. PB ST-SP at pump. Remote press SW.
53	Mn fuel oil transfer pump	1	30	460	3	38.7	B	885	50	DP	Cont	Vert		X-Line ST-SP	LVP	See note (1)	DP	Man	PB ST-SP	Cont Door	Remote PB ST-SP at pump emer stop at fuel sta. P & S. emer stop at fire fighting sta.
54	Mooring winch (amidship)	4	75	460	3	79.6	B	3575	40	TE, WT, EXP PRF	Cont	Vert		X-Line ST-SP	LVP	Remote	DP	Man	–	–	Triplex controller remote PB ST-SP at pump thermostats in motor. MTR SP HTR.
55	Mooring winch brake (amidship)	4	2	460	3	3.1	B	1750	40	TE, WT, EXP PRF	Cont	Hor		X-Line	LVP	Remote	DP	Man	–	–	Triplex controller. See mooring winch (amidship). Thermostats in motor. MTR SP HTR.
56	Mooring winch fan (amidship)	4	1	460	3	1.5	–	1725	40	EXP PRF NV	Cont	F-1		X-Line	LVP	Remote	DP	Man	–	–	Triplex controller. See mooring winch (amidship). Thermostats in motor. MTR SP. HTR.

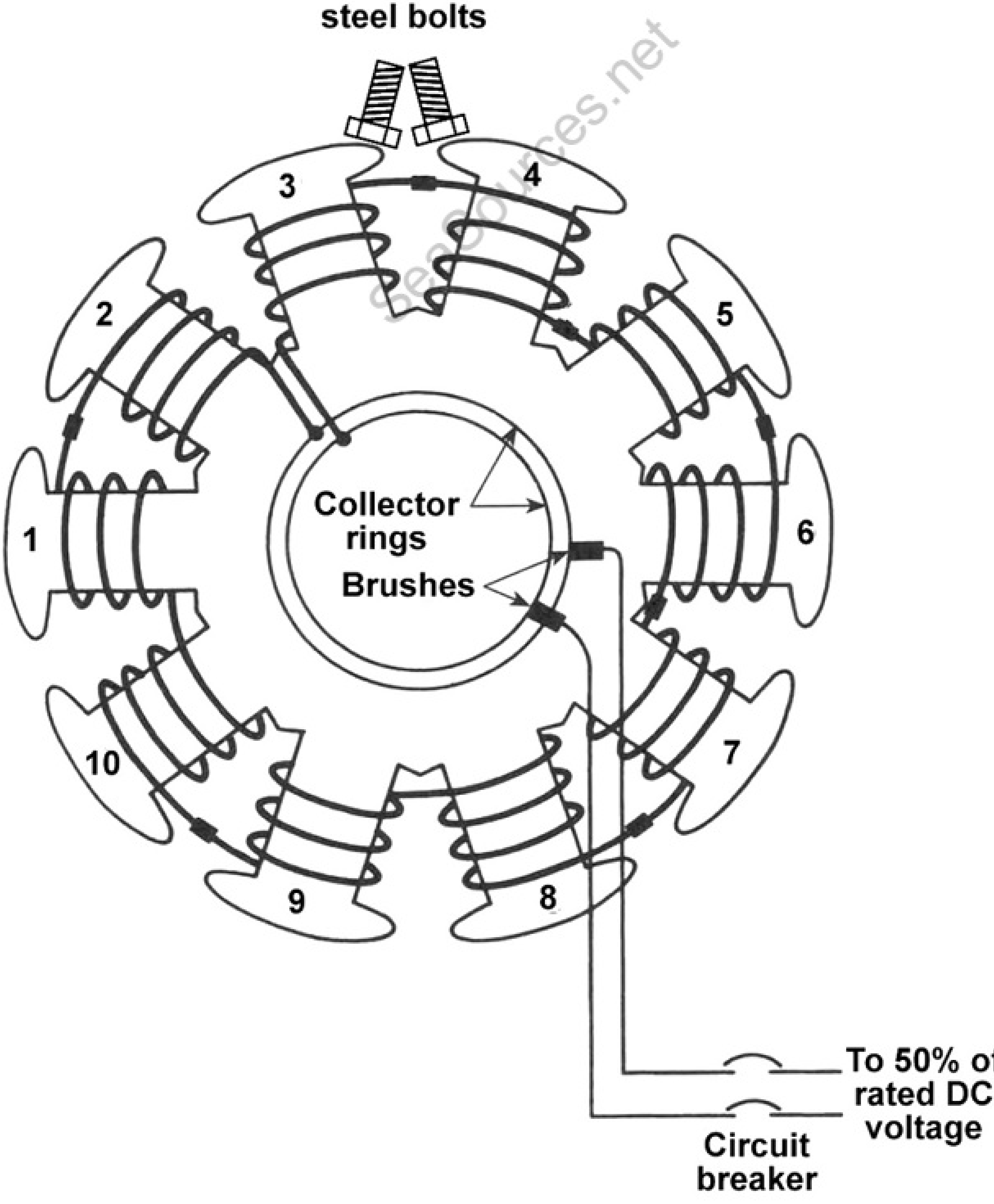
EL-0204

EL-0205



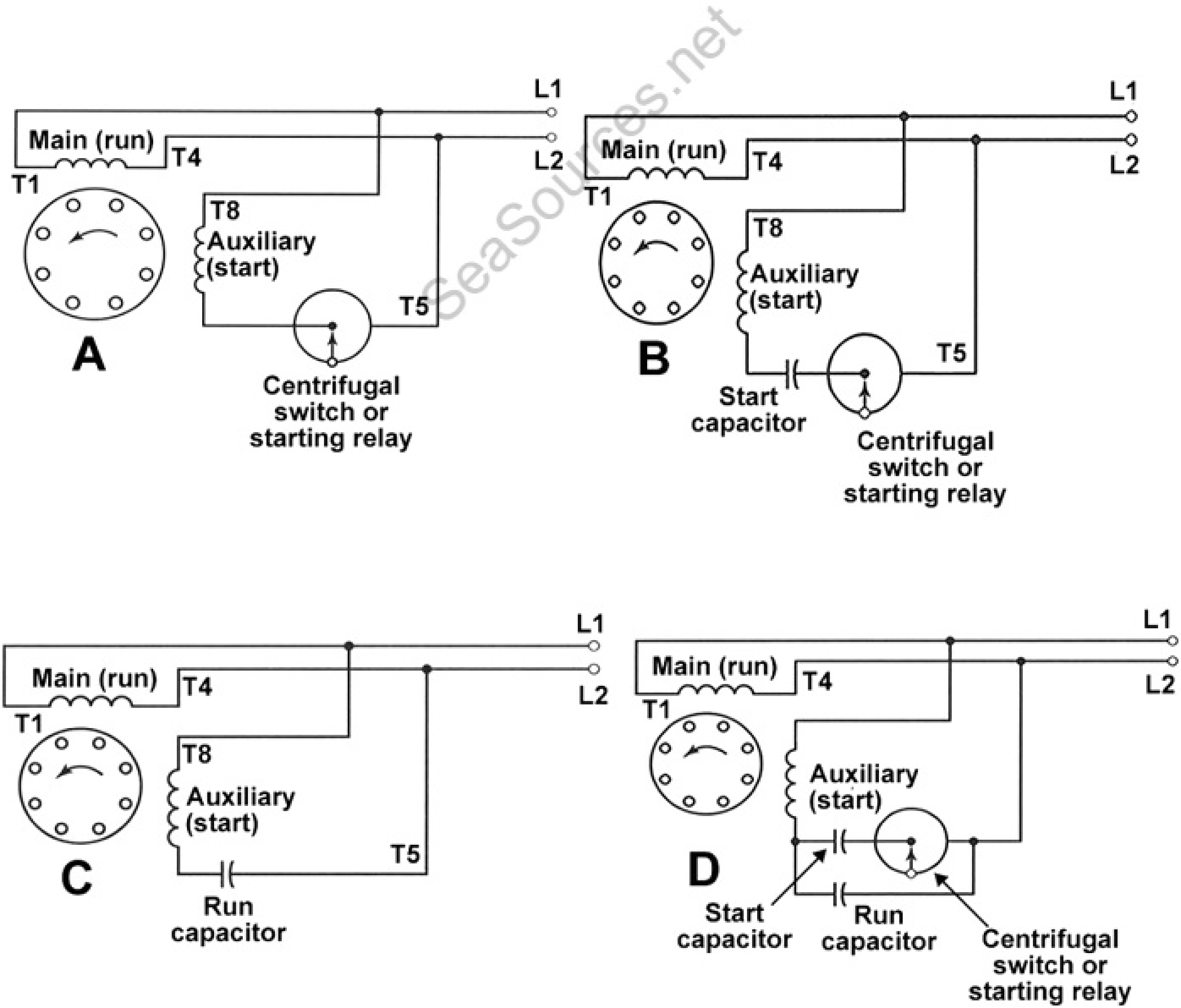
steel bolts
3
4
2
5
1
6
10
7
9
8
Collector
rings
Brushes
To 50% of
rated DC
voltage
Circuit
breaker

EL-0206



steel bolts
3
4
2
5
1
6
Collector rings
Brushes
10
7
9
8
To 50% of rated DC voltage
Circuit breaker

EL-0207



L1
L2
Main (run)
T1
T4
T8
Auxiliary (start)
T5
Centrifugal switch or starting relay
A
L1
L2
Main (run)
T1
T4
T8
Auxiliary (start)
T5
Start capacitor
Centrifugal switch or starting relay
B
L1
L2
Main (run)
T1
T4
T8
Auxiliary (start)
T5
Run capacitor
C
L1
L2
Main (run)
T1
T4
Auxiliary (start)
Start capacitor
Run capacitor
Centrifugal switch or starting relay
D

EL-0208

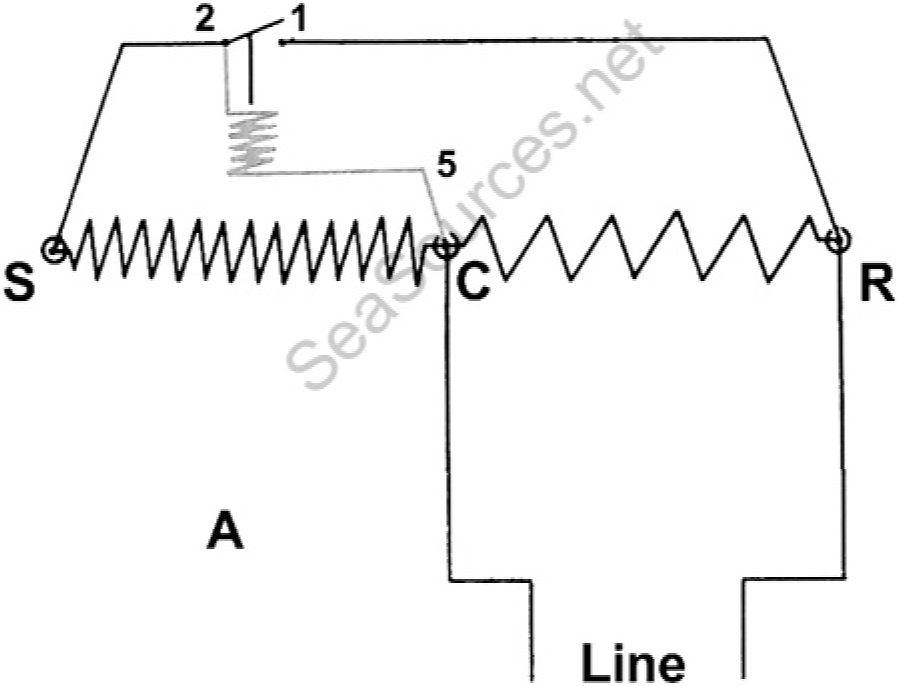
A

B

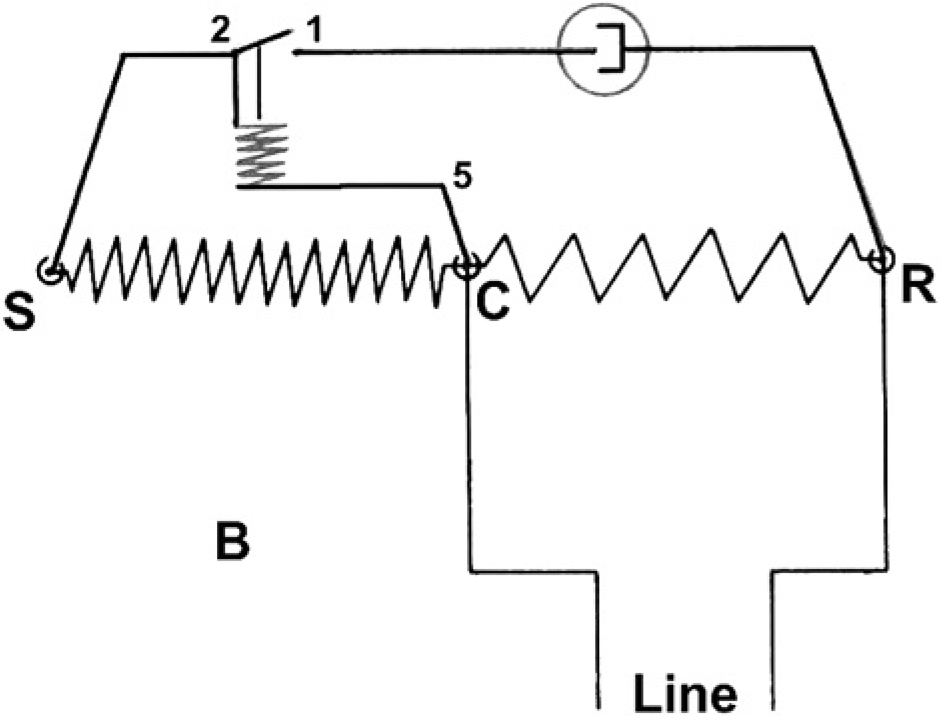
C

D

EL-0209

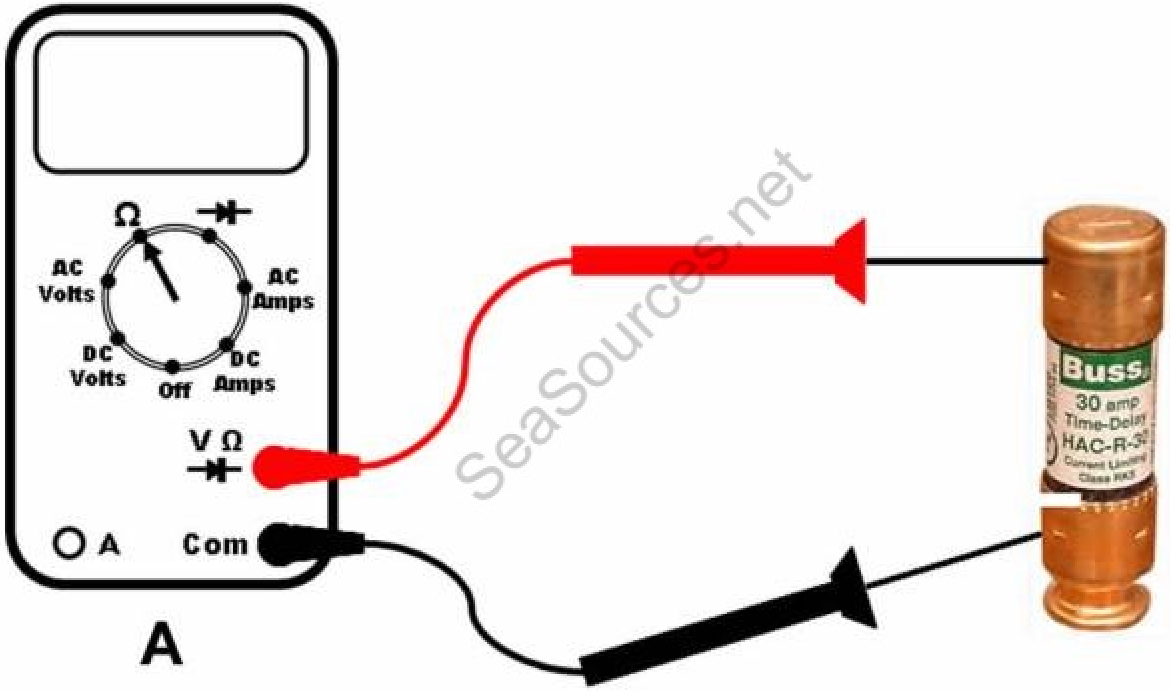


A

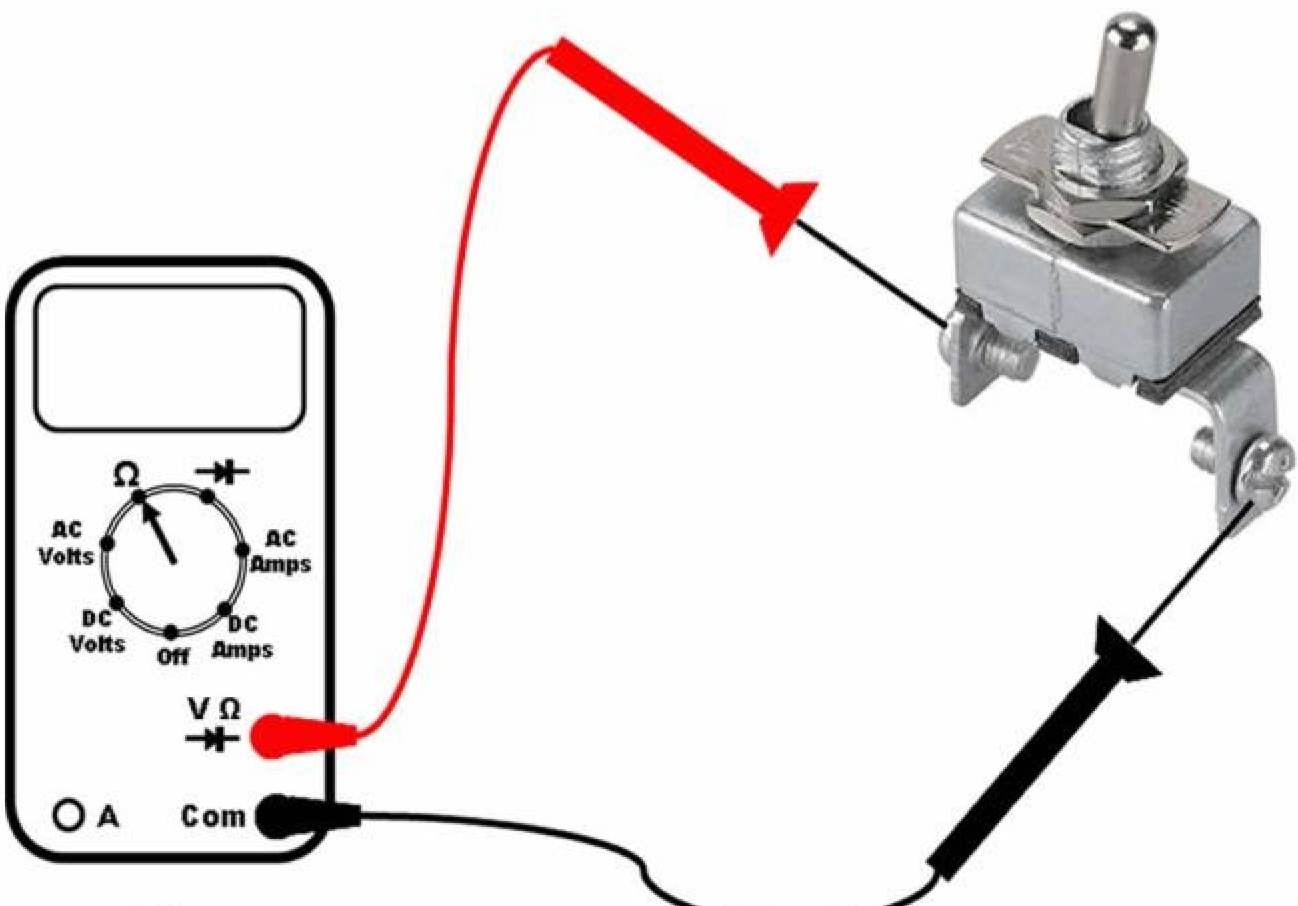


B

EL-0210

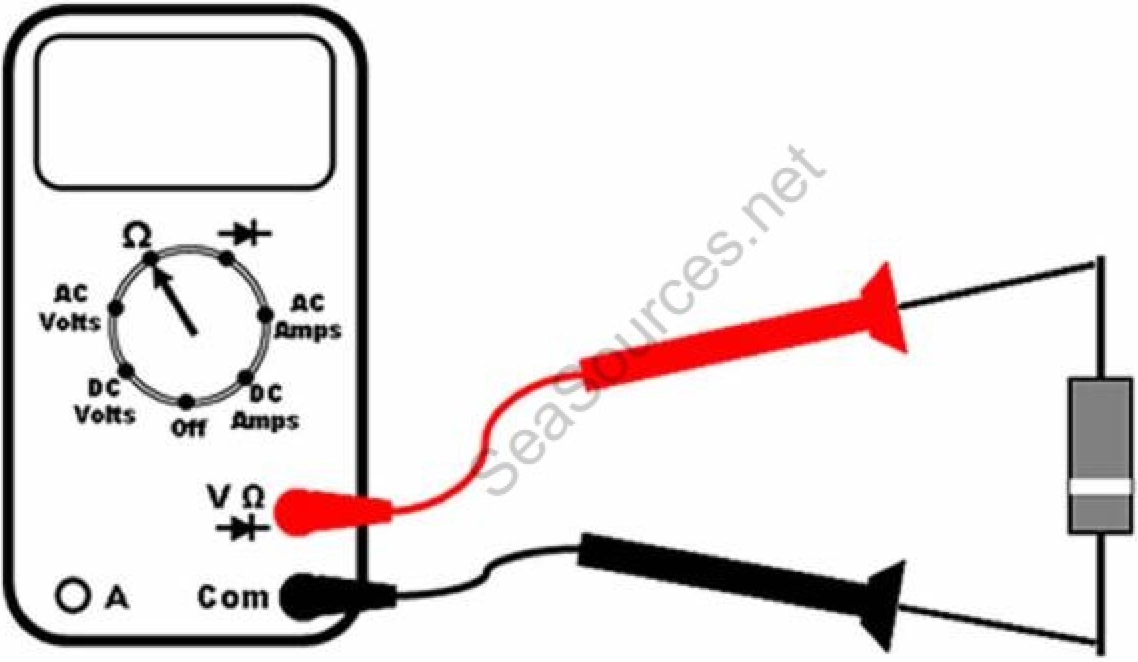

Ω
AC
Volts
AC
Amps
DC
Volts
Off
DC
Amps
V Ω
A
Com
Buss
30 amp
Time-Delay

A

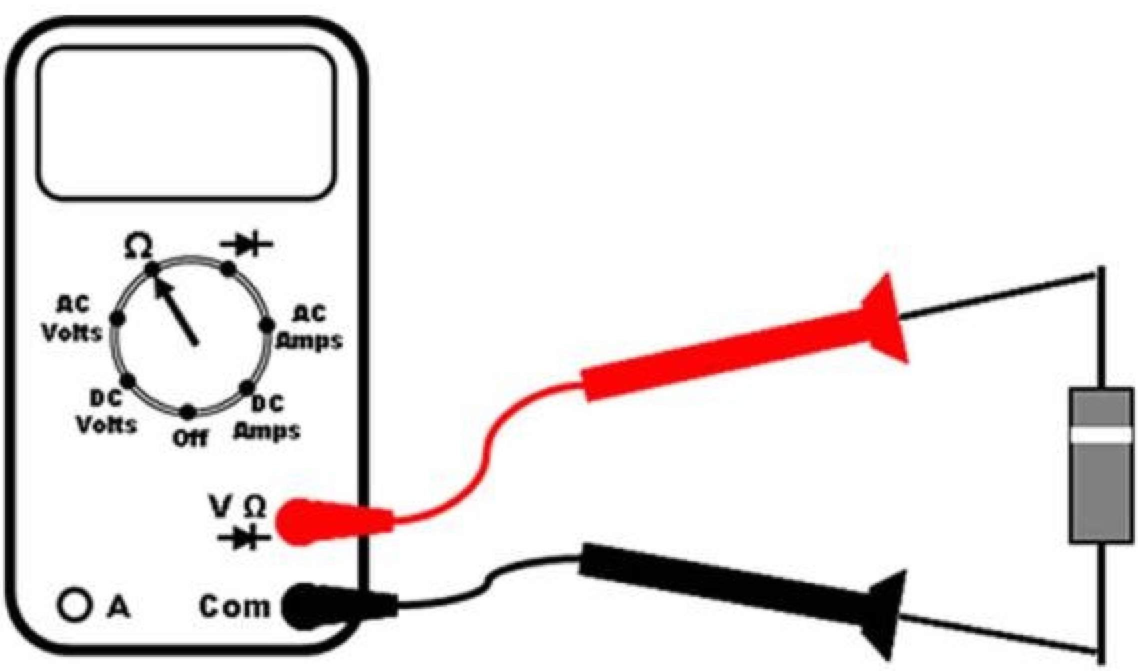

Ω
AC
Volts
AC
Amps
DC
Volts
Off
DC
Amps
V Ω
A
Com

B

EL-0211

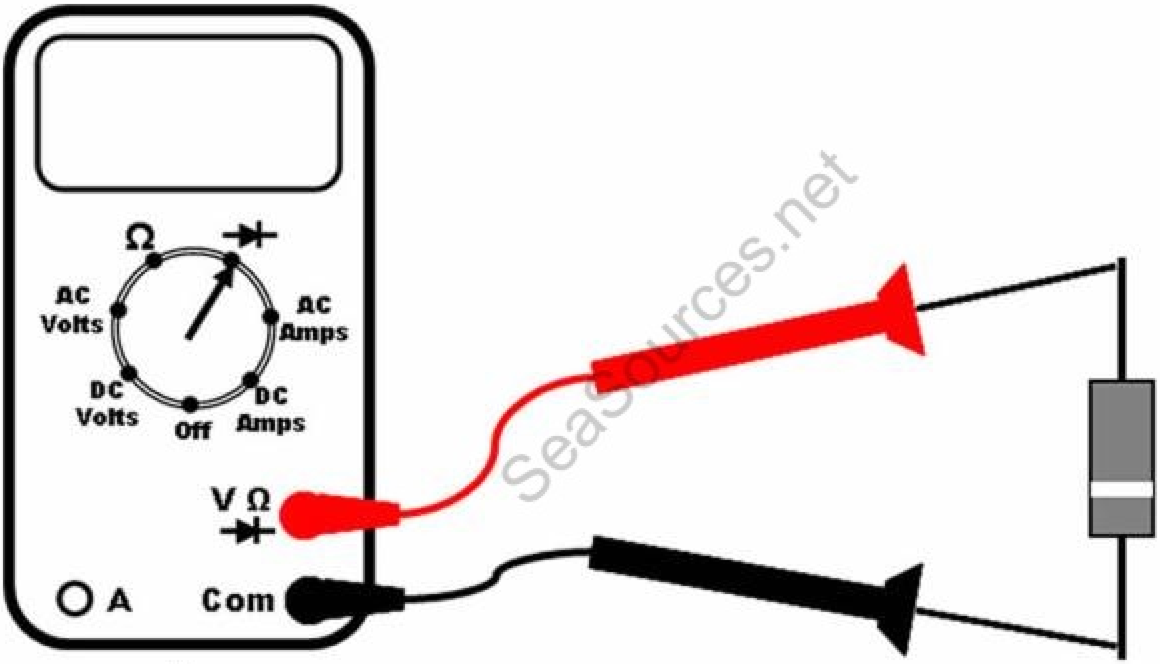

Ω
AC
Volts
AC
Amps
DC
Volts
Off
DC
Amps
V Ω
A
Com

A

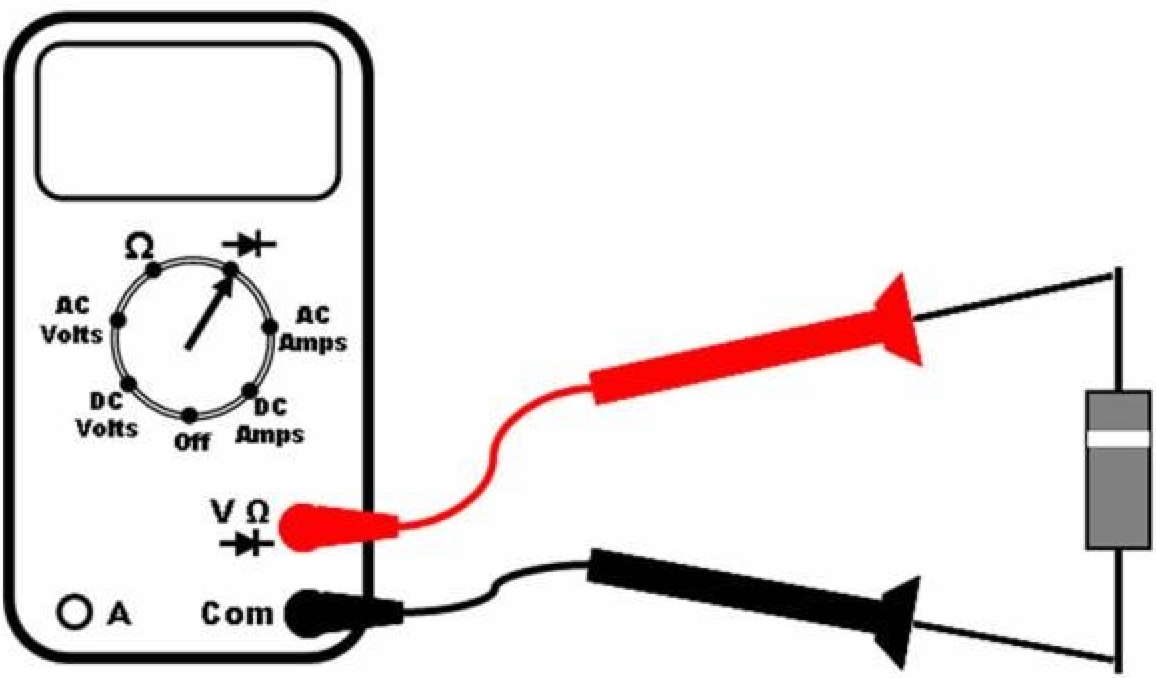

Ω
AC
Volts
AC
Amps
DC
Volts
Off
DC
Amps
V Ω
A
Com

B

EL-0212

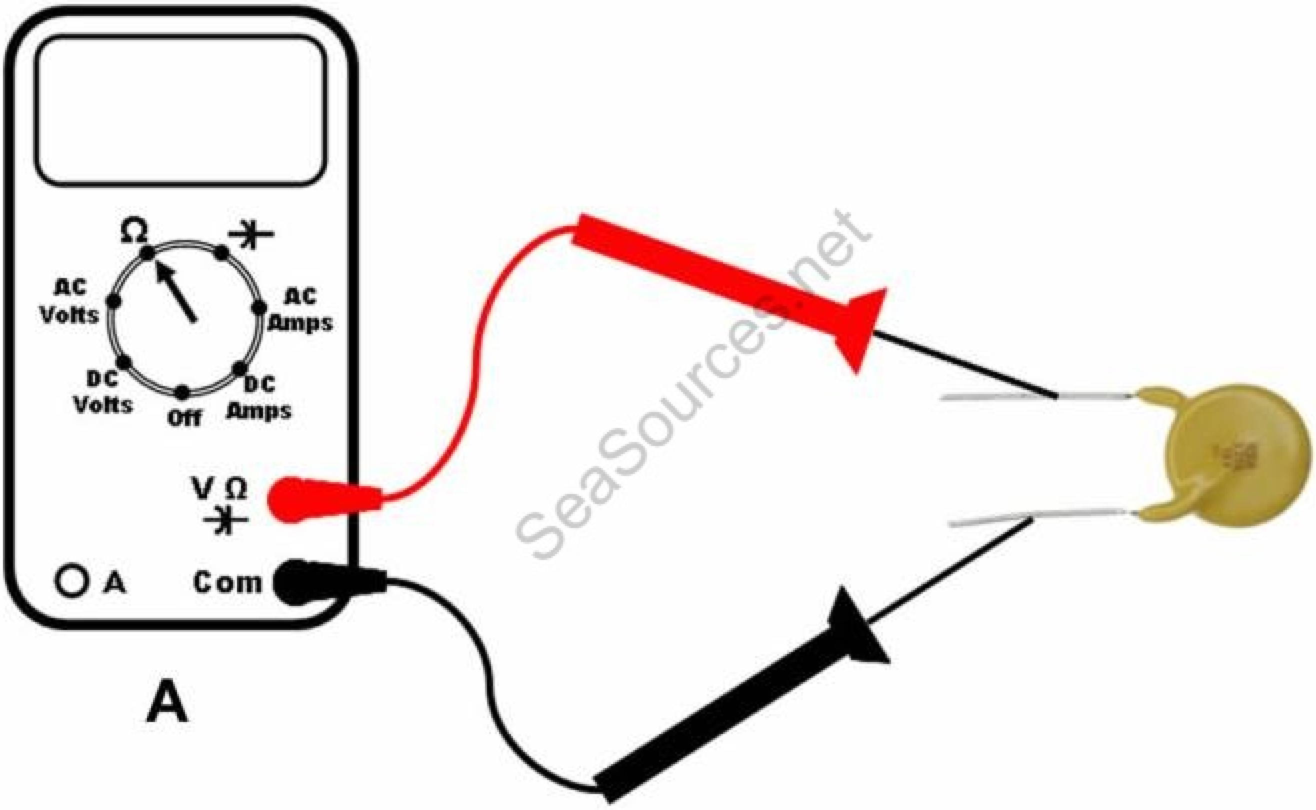

Ω
AC
Volts
AC
Amps
DC
Volts
Off
DC
Amps
V Ω
A
Com

A

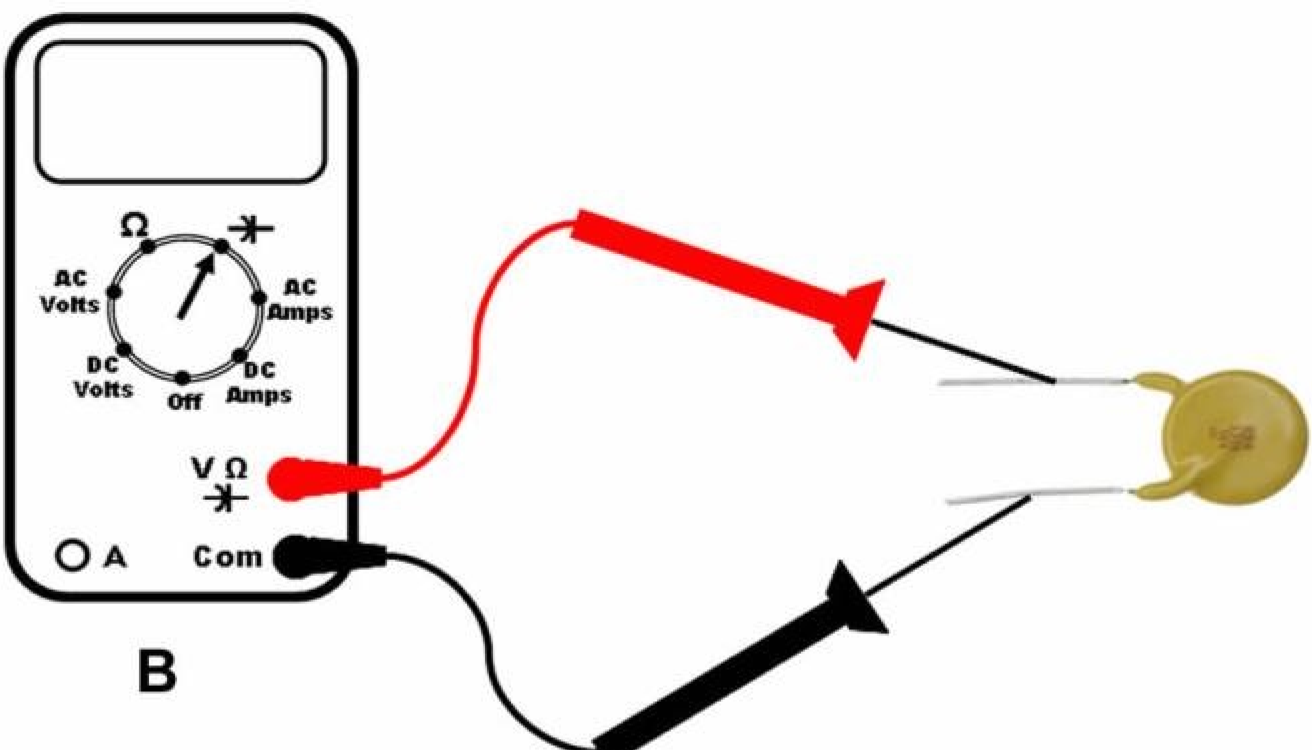

Ω
AC
Volts
AC
Amps
DC
Volts
Off
DC
Amps
V Ω
A
Com

B

EL-0213

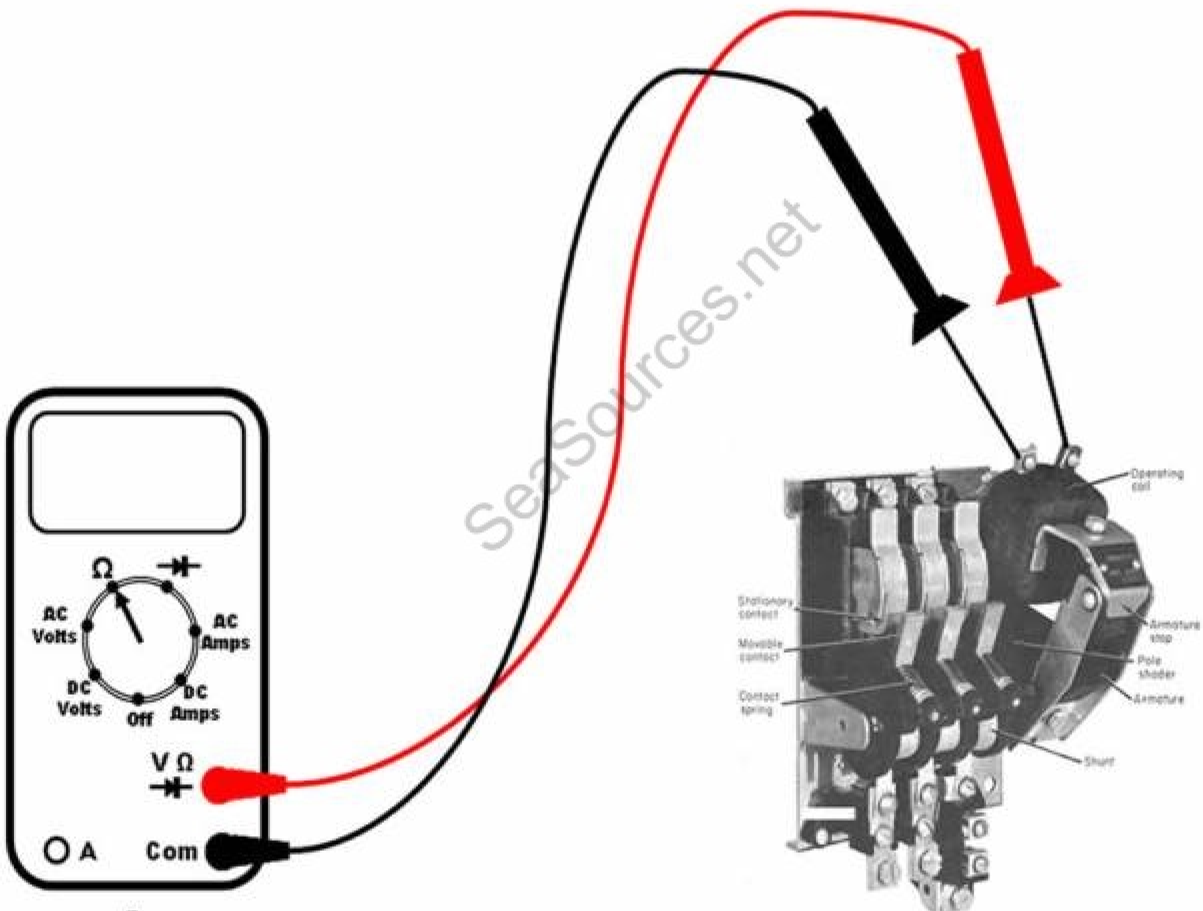

Ω
AC Volts
AC Amps
DC Volts
Off
DC Amps
V Ω
A
Com

A

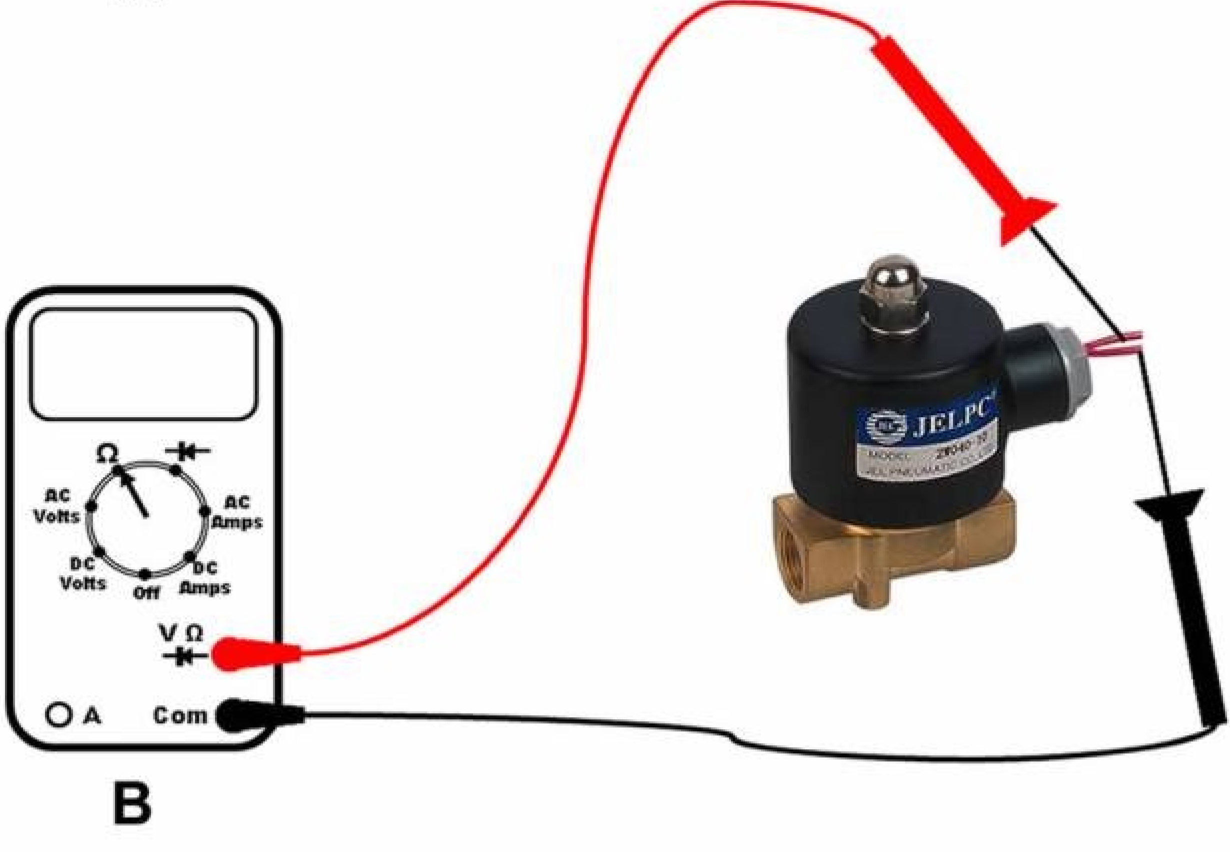

Ω
AC Volts
AC Amps
DC Volts
Off
DC Amps
V Ω
A
Com

B

EL-0214

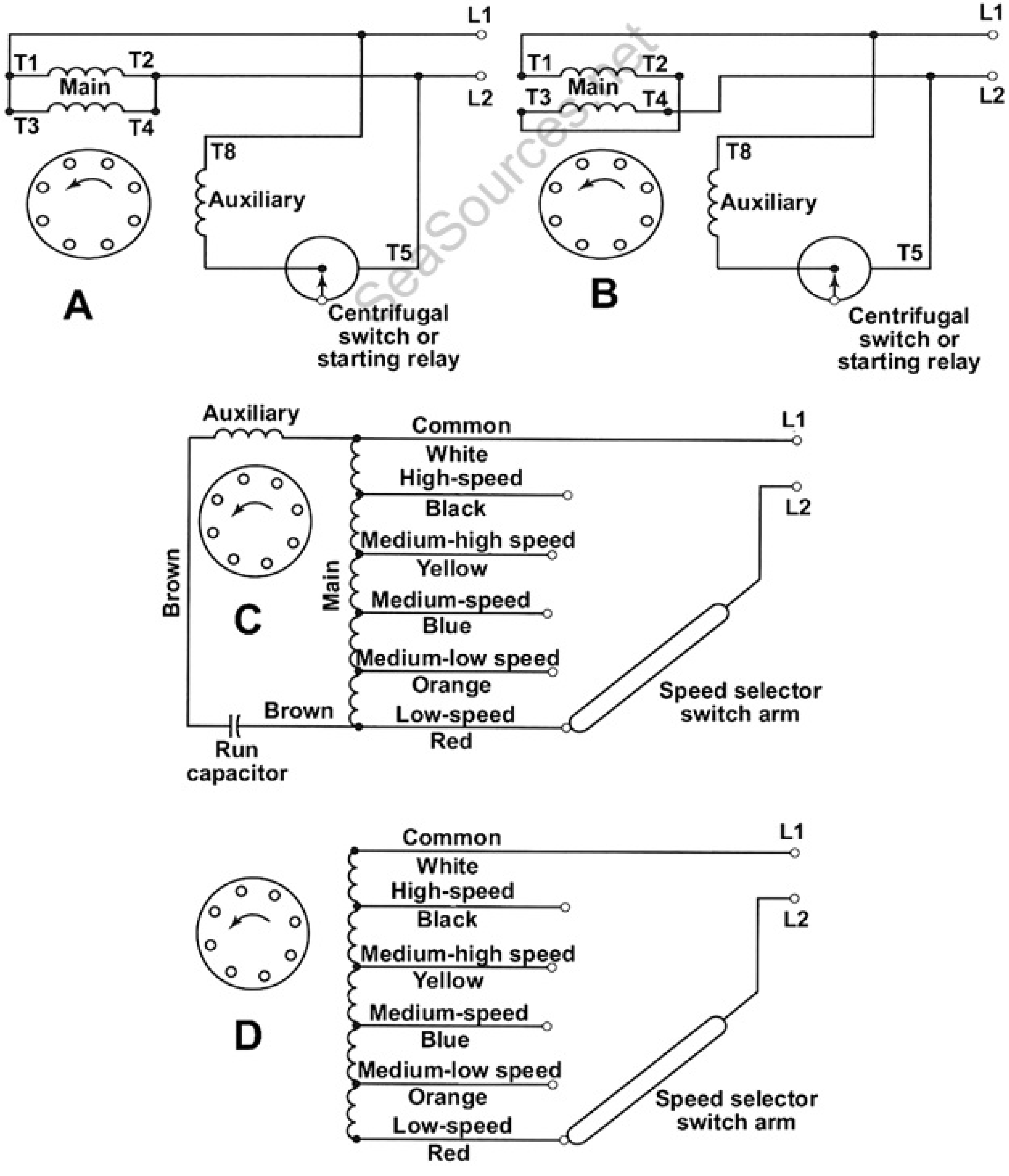

Ω
AC Volts
AC Amps
DC Volts
Off
DC Amps
V Ω
A
Com
Operating coil
Stationary contact
Movable contact
Contact spring
Armature stop
Pole shader
Armature
Shunt

A


Ω
AC Volts
AC Amps
DC Volts
Off
DC Amps
V Ω
A
Com
JELPC

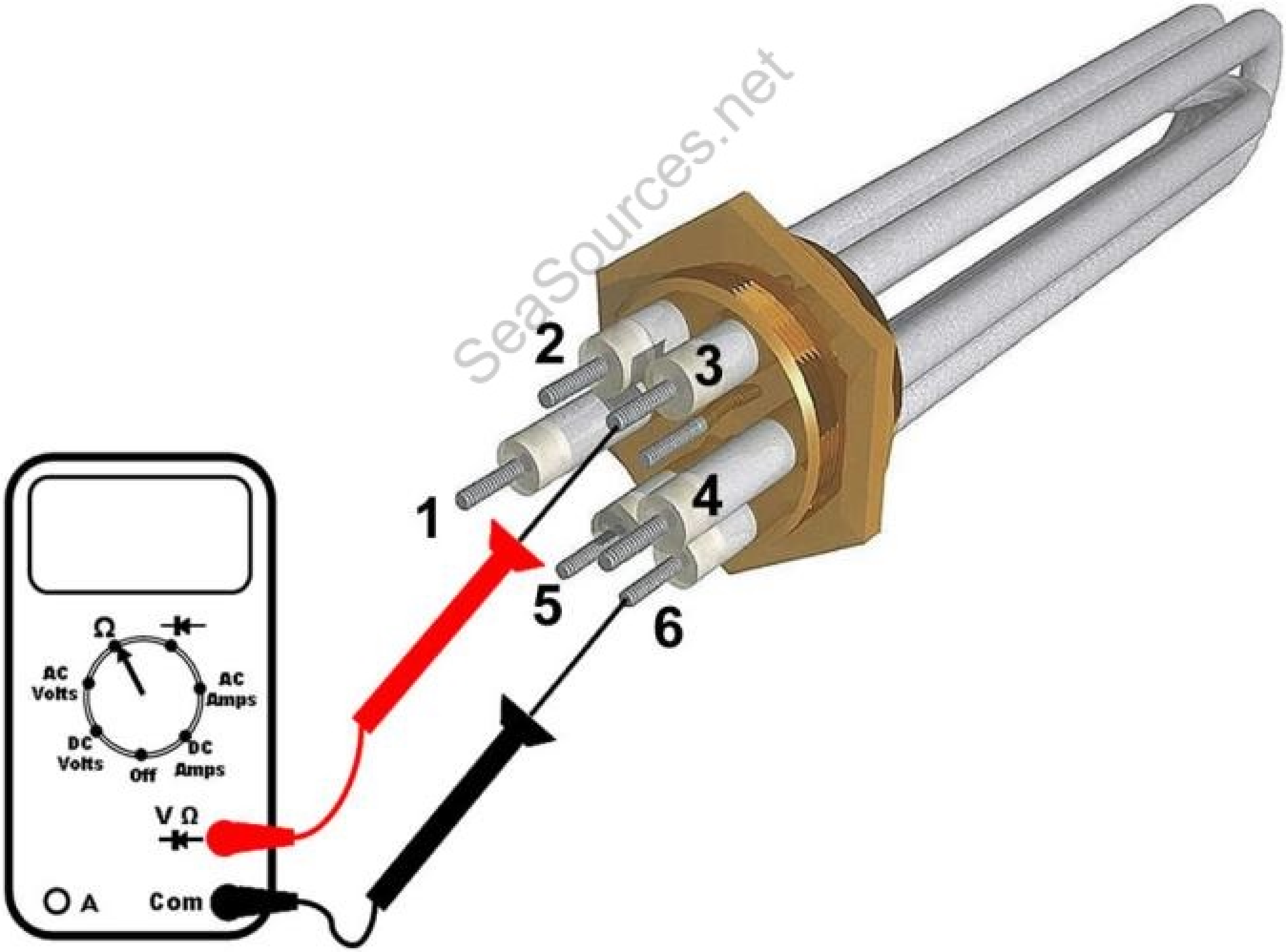
B

EL-0215

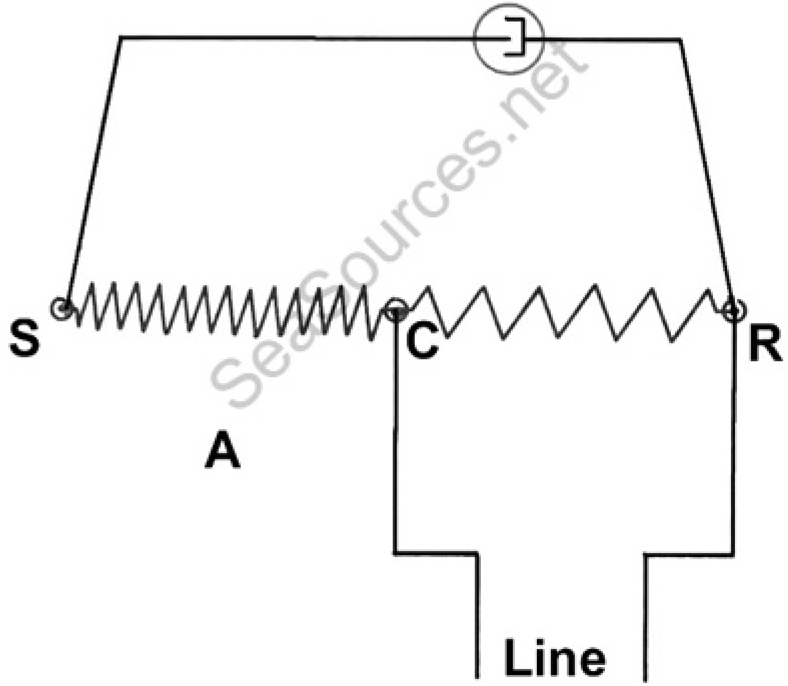


L1
T1
Main
T2
L2
T3
T4
T8
Auxiliary
T5
A
Centrifugal switch or starting relay
L1
T1
Main
T2
L2
T3
T4
T8
Auxiliary
T5
B
Centrifugal switch or starting relay
Auxiliary
Common
L1
White
High-speed
Black
L2
Medium-high speed
Yellow
Brown
Main
Medium-speed
C
Blue
Medium-low speed
Orange
Speed selector switch arm
Brown
Low-speed
Red
Run capacitor
Common
L1
White
High-speed
Black
L2
Medium-high speed
Yellow
Medium-speed
D
Blue
Medium-low speed
Orange
Speed selector switch arm
Low-speed
Red

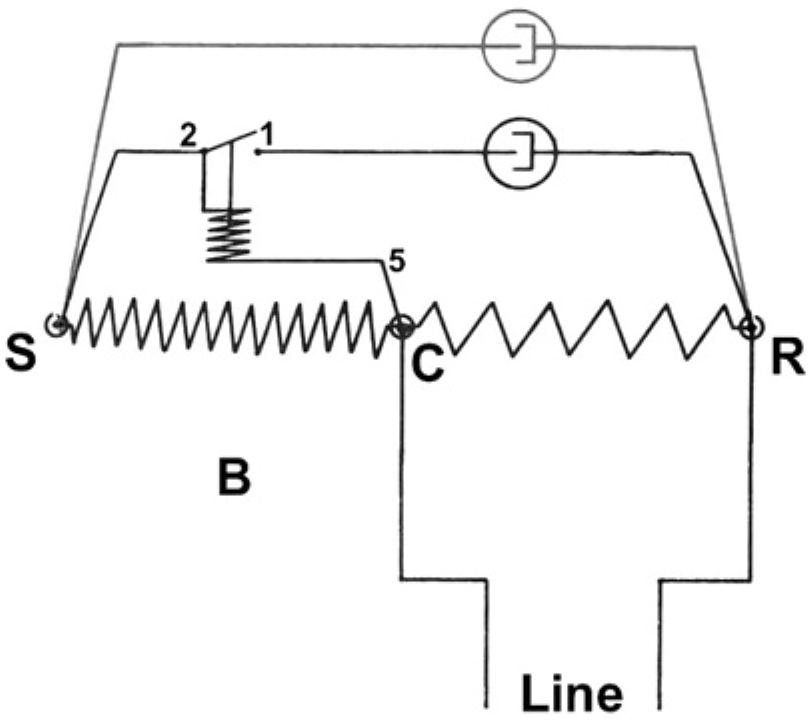
EL-0216


SeaSources.net
1
2
3
4
5
6
Ω
AC Volts
AC Amps
DC Volts
Off
DC Amps
V Ω
A
Com

EL-0217

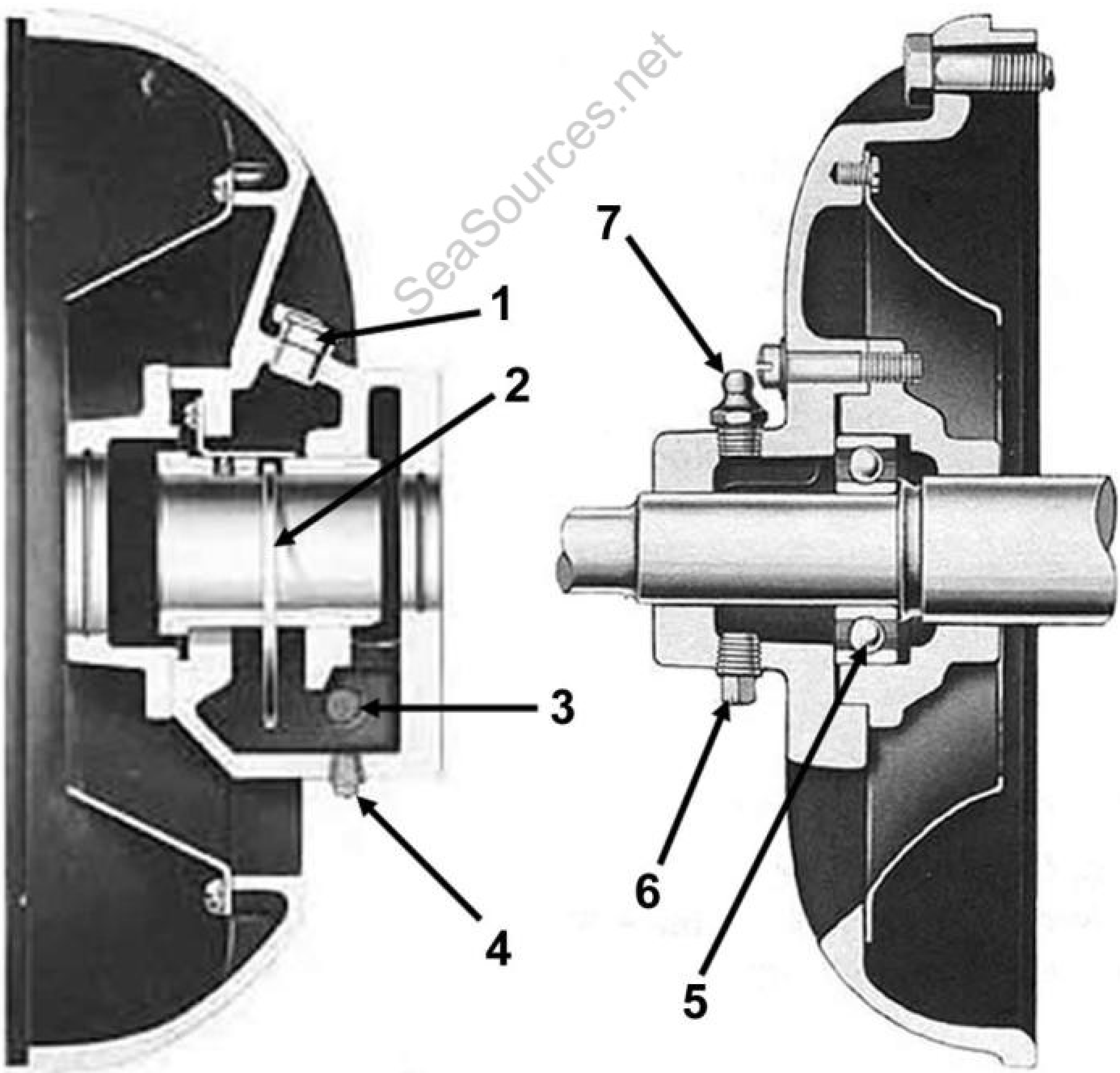


A



B

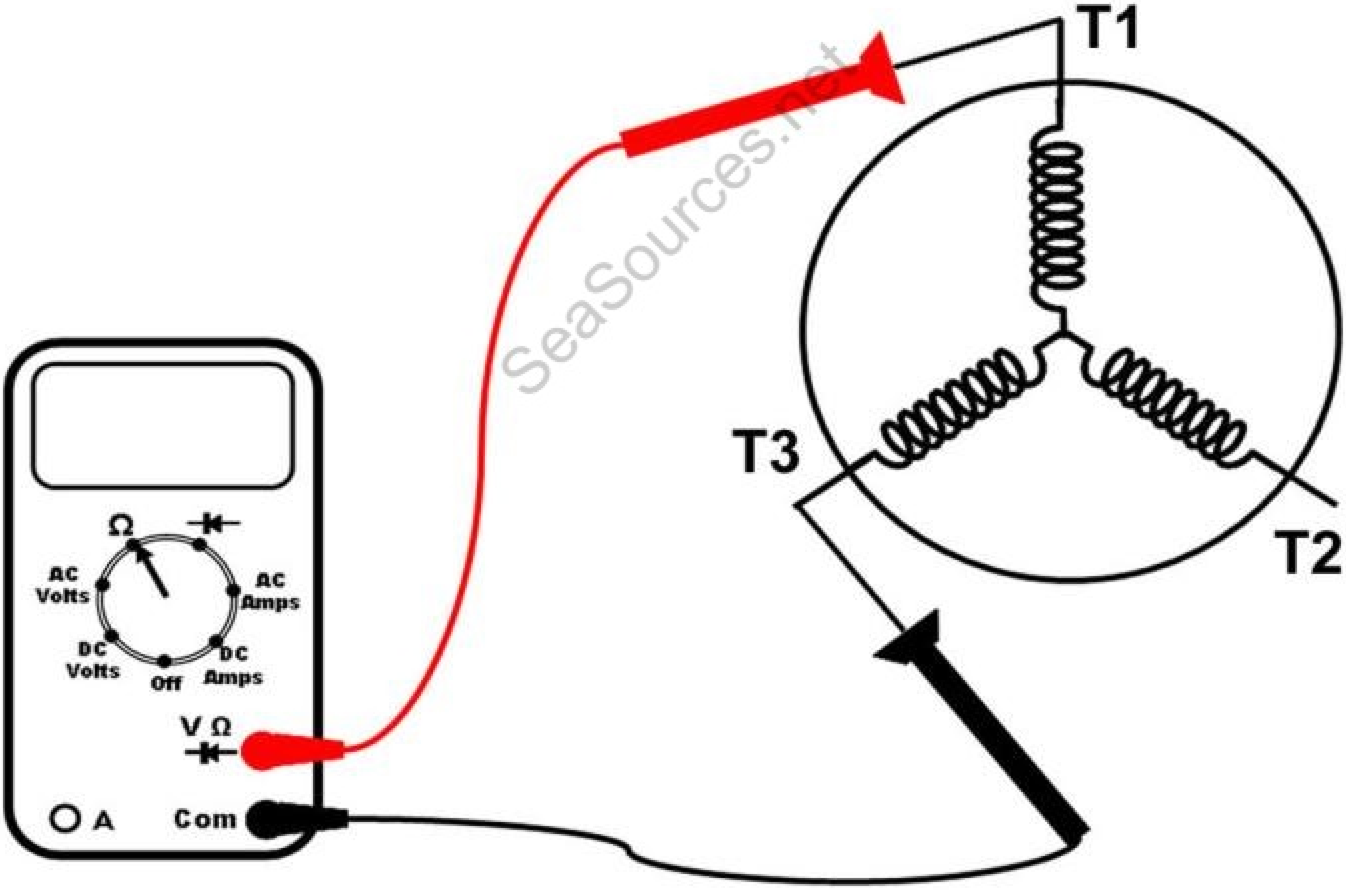
EL-0218



A

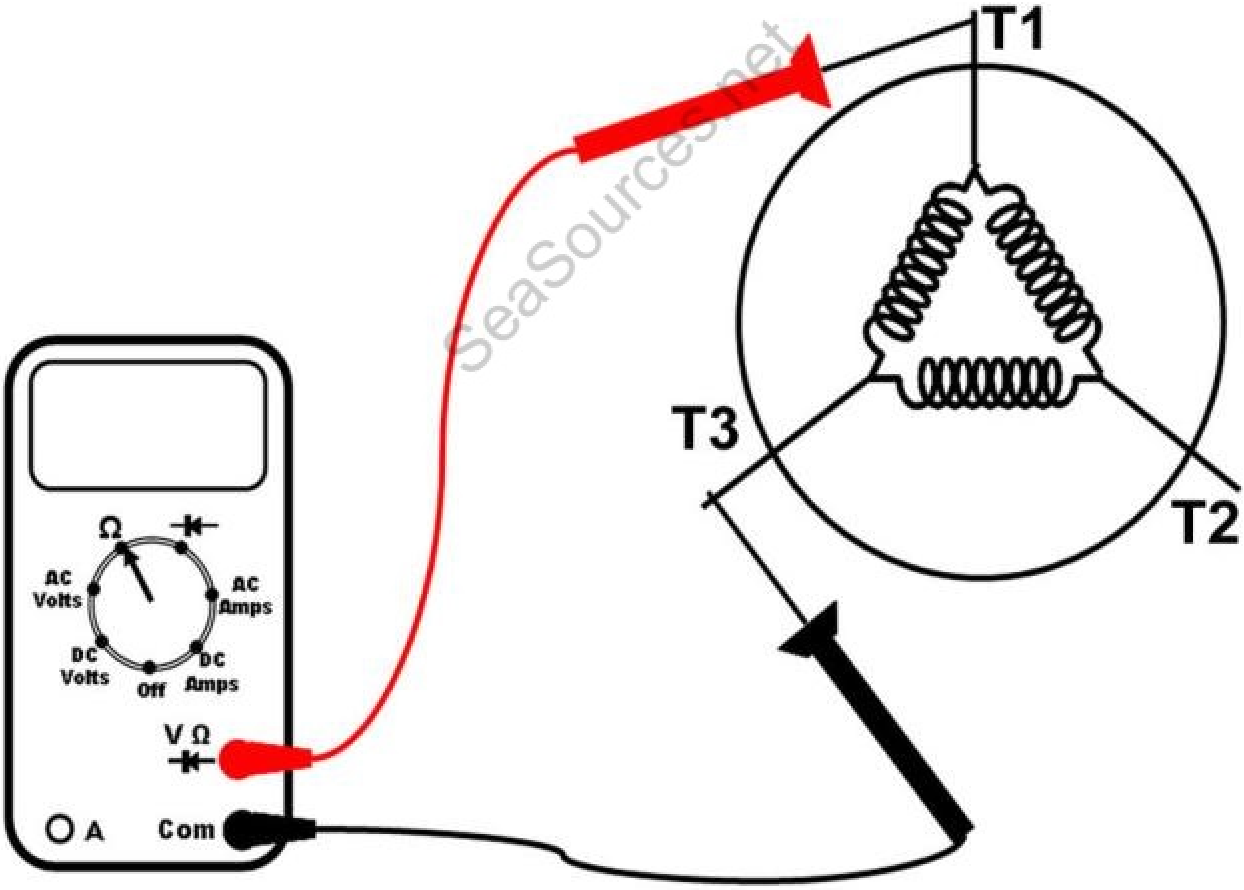
B

EL-0219

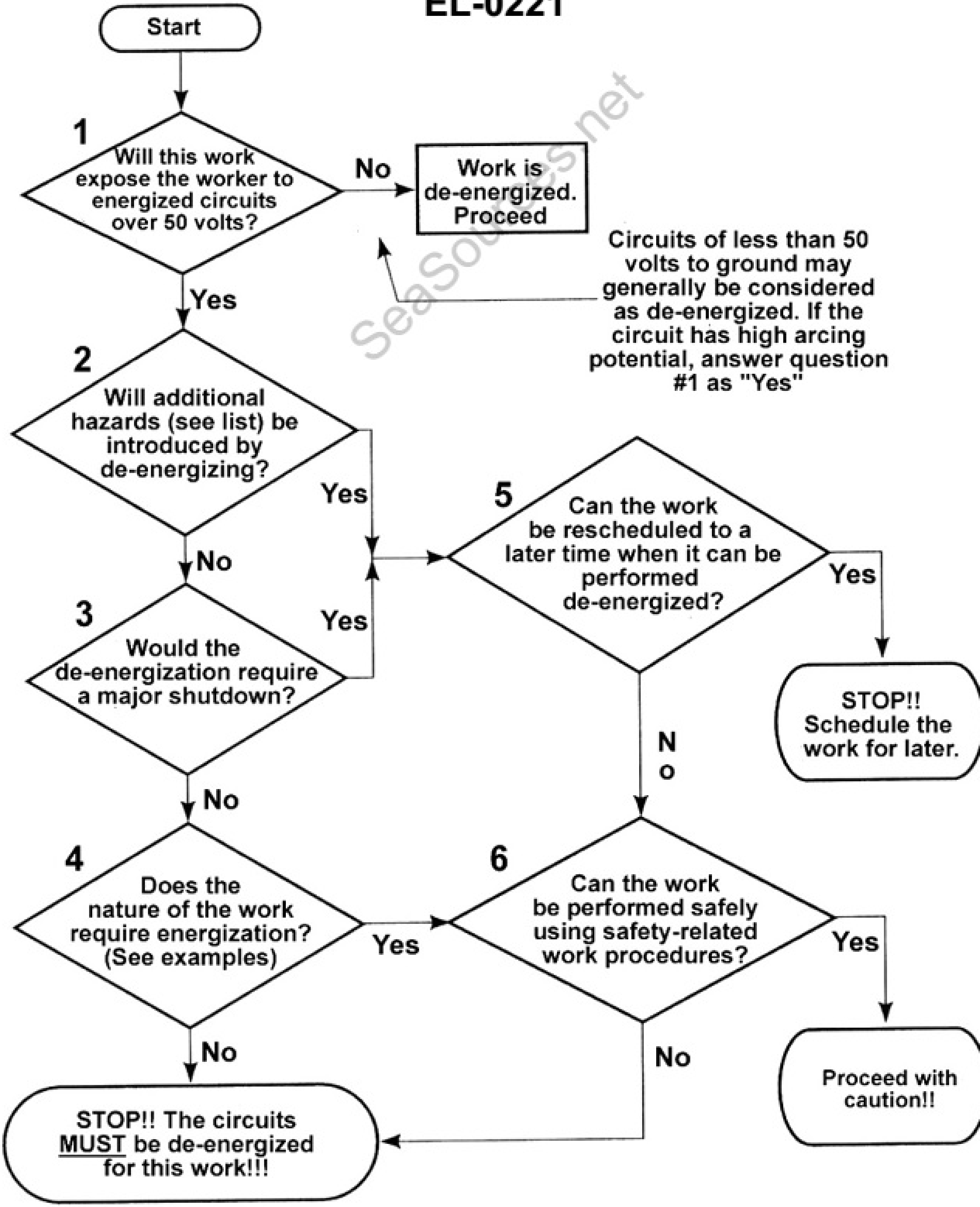


T1
T3
T2
Ω
AC
Volts
AC
Amps
DC
Volts
Off
DC
Amps
V Ω
A
Com
SeaSources.net

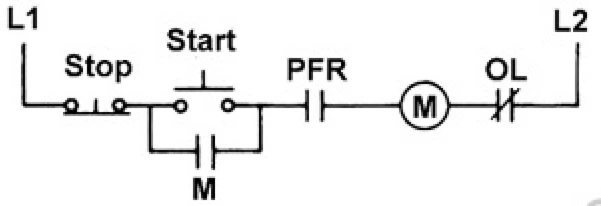
EL-0220



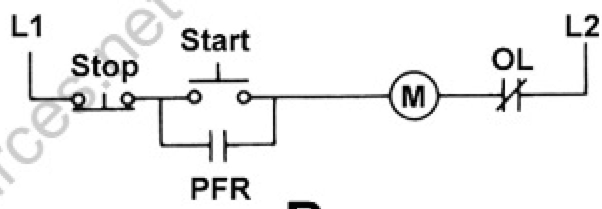
EL-0221


Start
1
Will this work expose the worker to energized circuits over 50 volts?
No
Work is de-energized. Proceed
Circuits of less than 50 volts to ground may generally be considered as de-energized. If the circuit has high arcing potential, answer question #1 as "Yes"
Yes
2
Will additional hazards (see list) be introduced by de-energizing?
Yes
No
3
Would the de-energization require a major shutdown?
Yes
No
4
Does the nature of the work require energization? (See examples)
Yes
No
5
Can the work be rescheduled to a later time when it can be performed de-energized?
Yes
STOP!! Schedule the work for later.
No
6
Can the work be performed safely using safety-related work procedures?
Yes
Proceed with caution!!
No
STOP!! The circuits MUST be de-energized for this work!!!

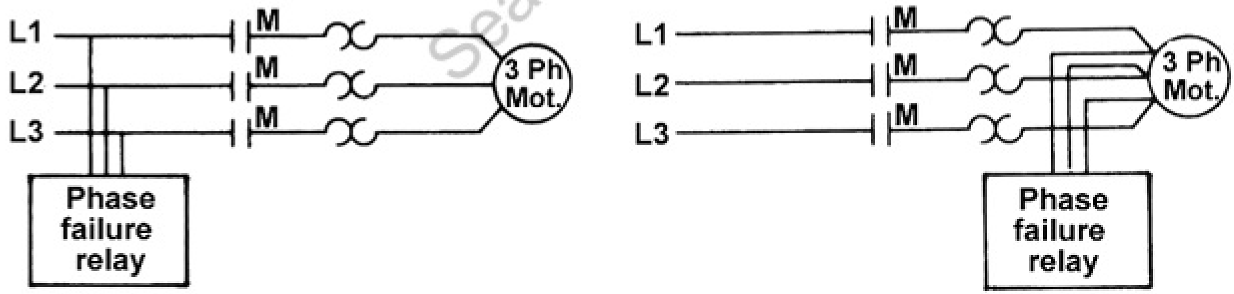
EL-0222

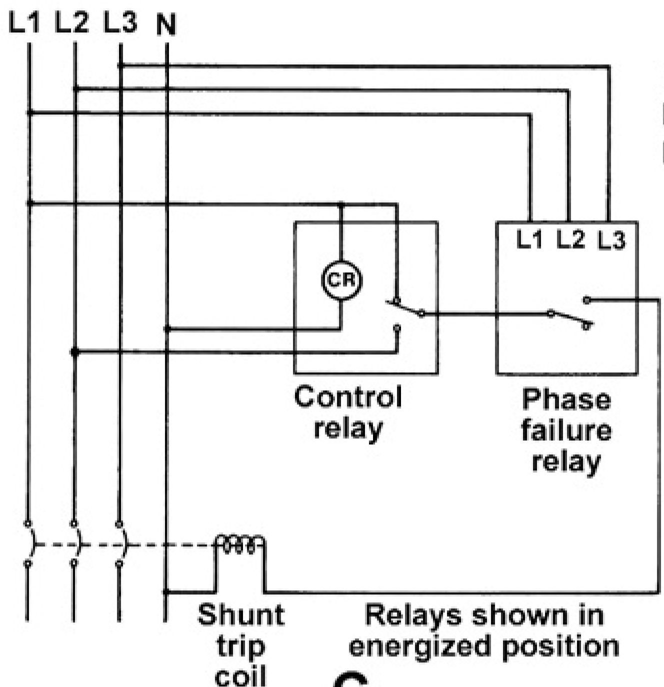

L1
Stop
Start
PFR
M
OL
L2
M

A

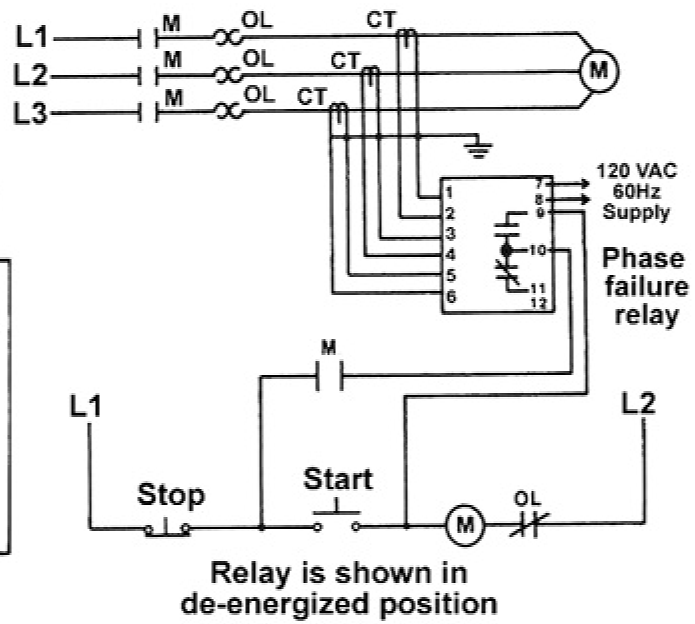

L1
Stop
Start
M
OL
L2
PFR

B


L1
L2
L3
M
M
M
3 Ph
Mot.
Phase
failure
relay
L1
L2
L3
M
M
M
3 Ph
Mot.
Phase
failure
relay

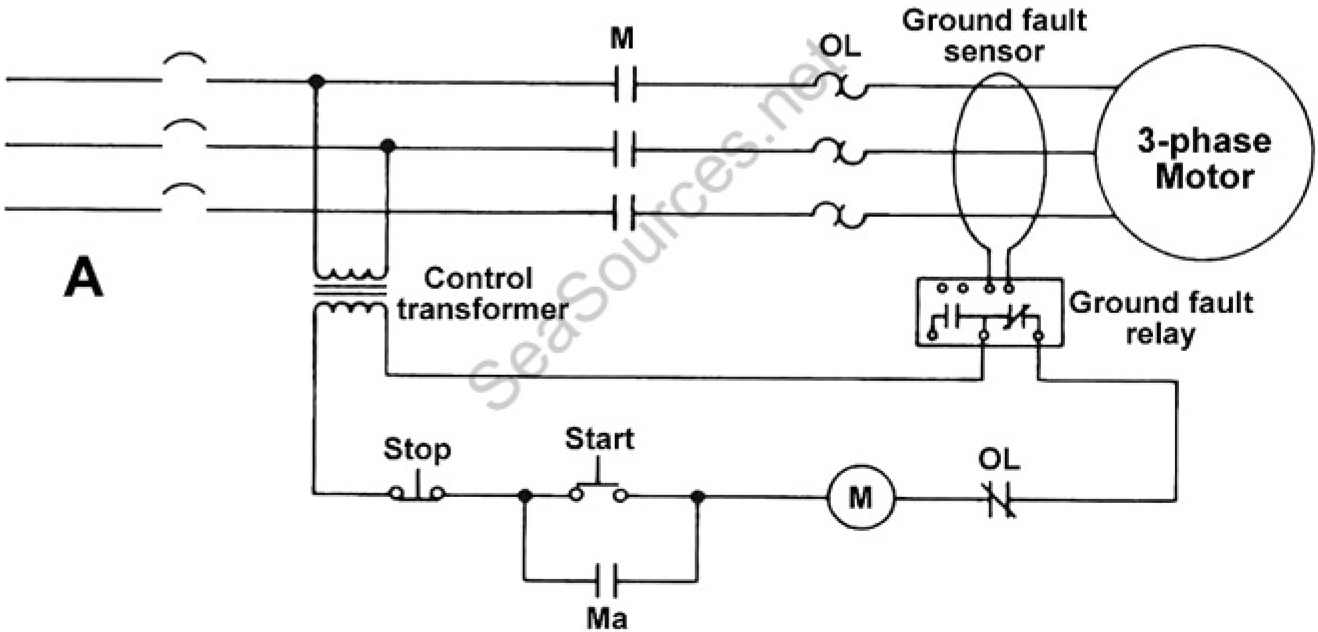

L1
L2
L3
N
CR
L1
L2
L3
Control
relay
Phase
failure
relay
Shunt
trip
coil
Relays shown in
energized position

C


L1
L2
L3
M
M
M
OL
OL
OL
CT
CT
CT
M
1
2
3
4
5
6
7
8
9
10
11
12
120 VAC
60Hz
Supply
Phase
failure
relay
M
L1
L2
Stop
Start
M
OL
Relay is shown in
de-energized position

D

EL-0223


M
OL
Ground fault
sensor
3-phase
Motor
Control
transformer
Ground fault
relay
Stop
Start
M
OL
Ma

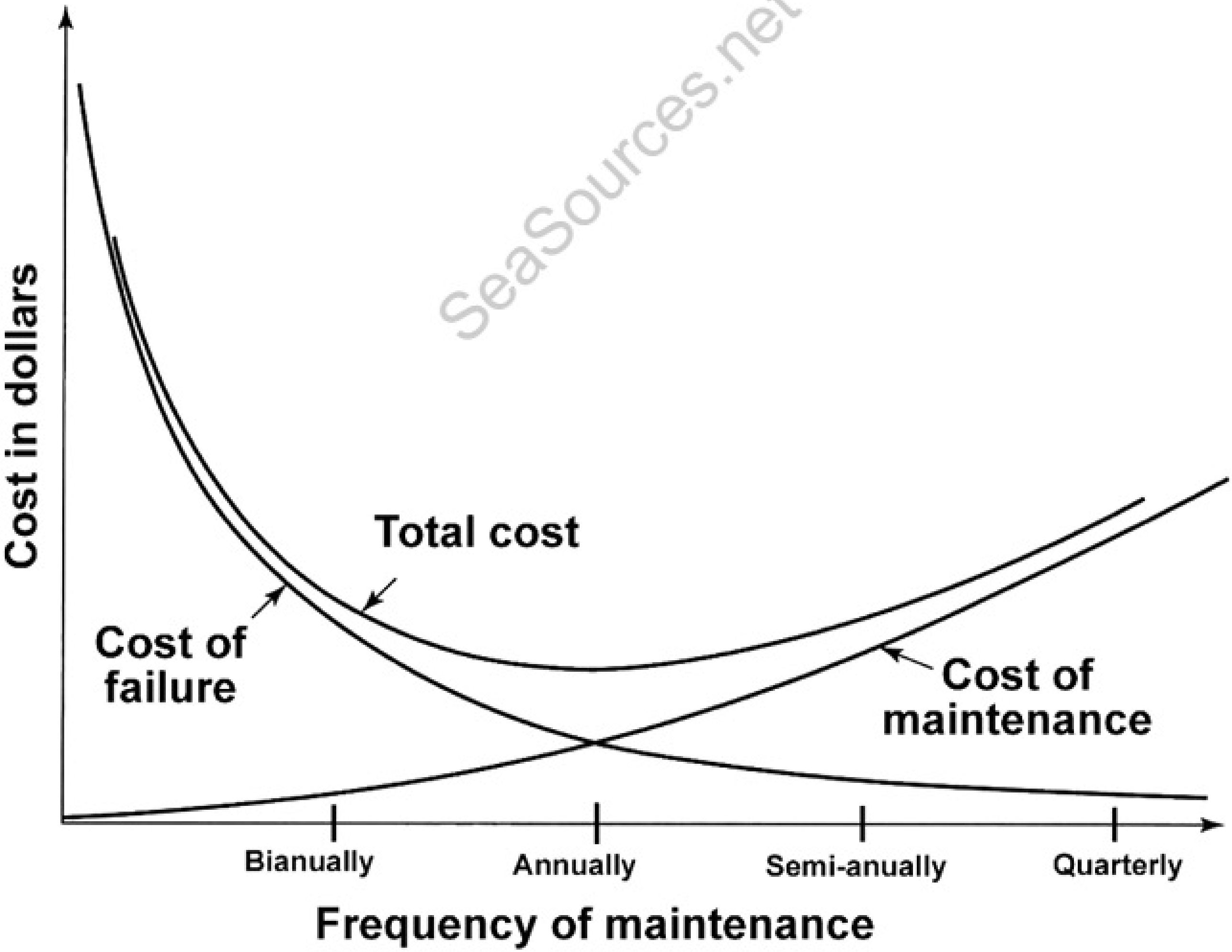
A


Wisco
GROUND - FAULT RELAY
ER 95
TEST
0
.1
.2
.3
.4
ON
.5 CURRENT
.6
.7
RESET
Inx1
.9
.8
In 0-1 A.
0
DELAY
1s.
Supply 220VAC

B

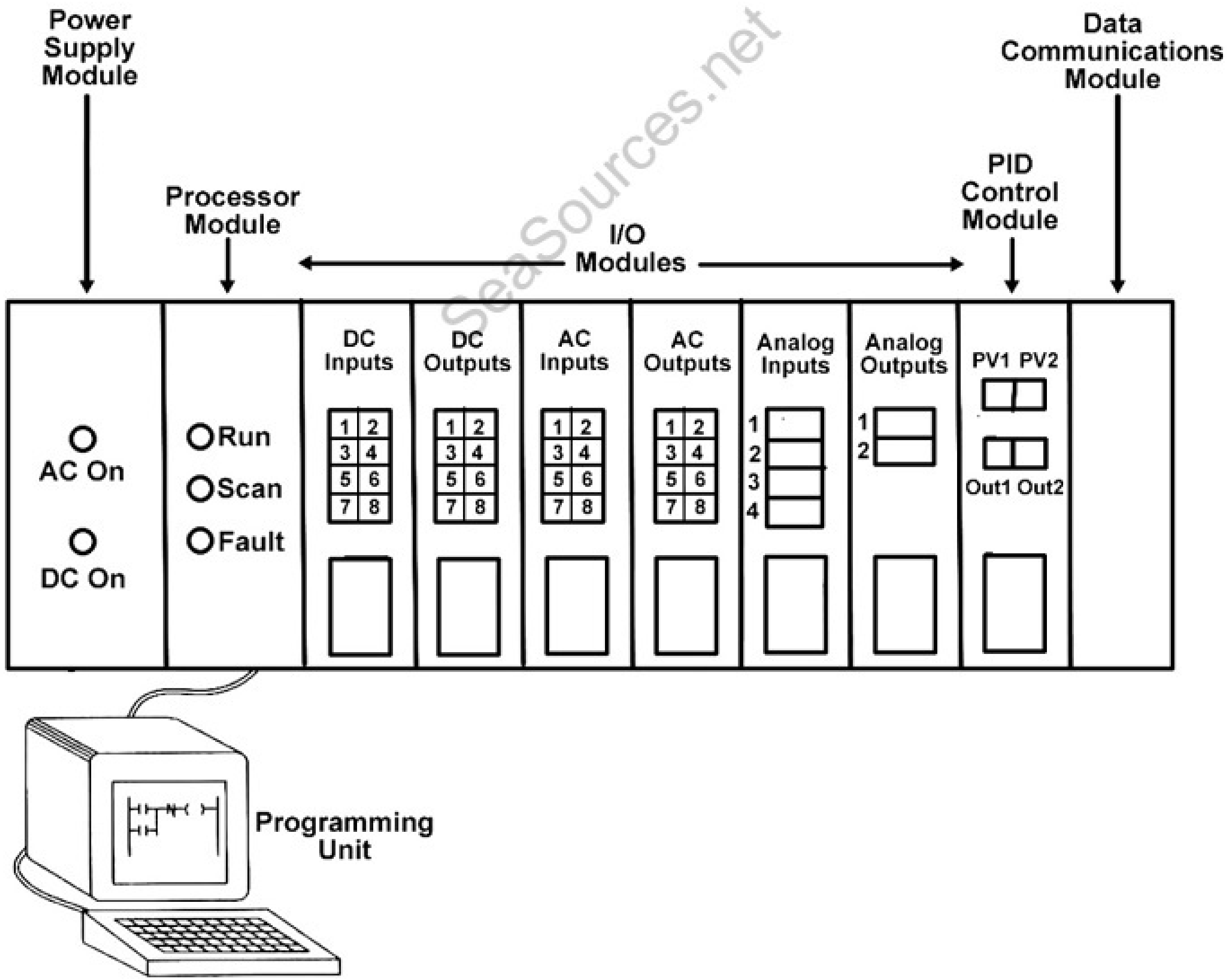
C

EL-0224



Cost in dollars
Total cost
Cost of failure
Cost of maintenance
Bianually
Annually
Semi-anually
Quarterly
Frequency of maintenance

EL-0225

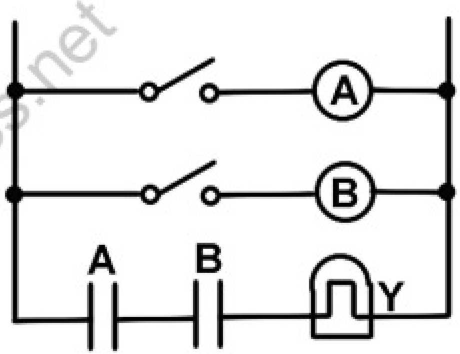


Power Supply Module
Processor Module
I/O Modules
PID Control Module
Data Communications Module
AC On
DC On
Run
Scan
Fault
DC Inputs
DC Outputs
AC Inputs
AC Outputs
Analog Inputs
Analog Outputs
PV1 PV2
Out1 Out2
1 2
3 4
5 6
7 8
1
2
3
4
Programming Unit

EL-0226

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

A Truth Table

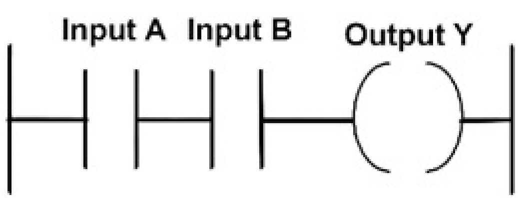


B

Equivalent Relay
Circuit Diagram

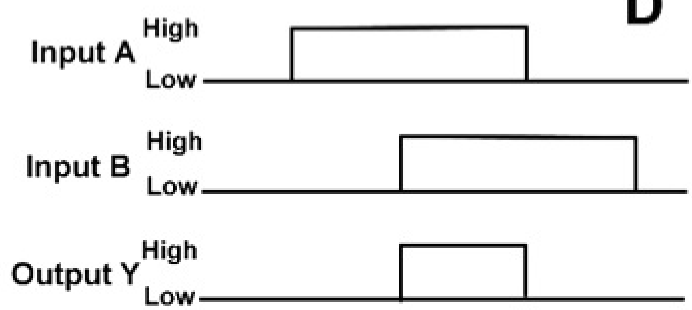
Relay and PLC Logic Compared

C



PLC Ladder Diagram

D



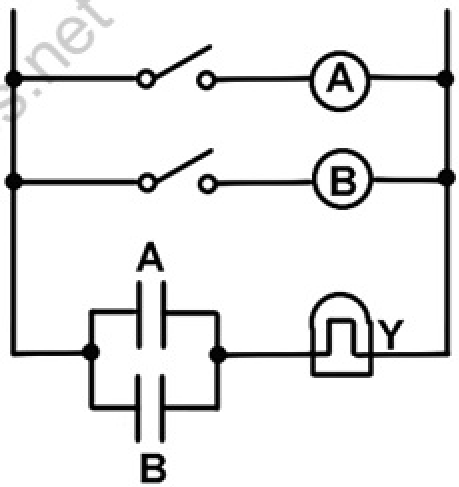
PLC Input/output Diagram

EL-0227

A

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table

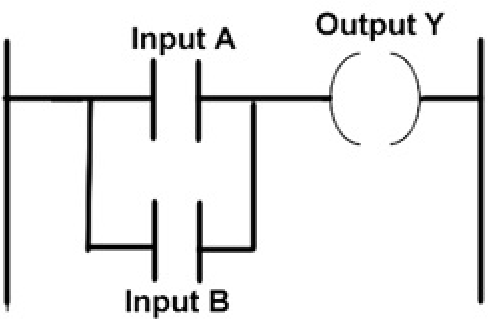


B

Equivalent Relay Circuit Diagram

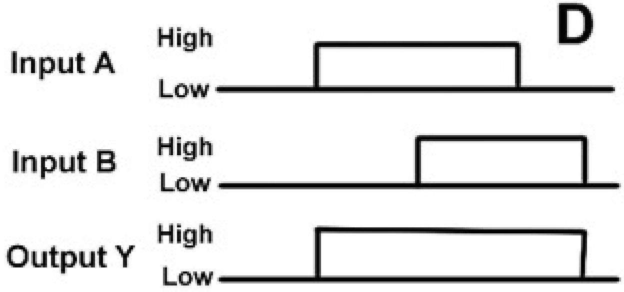
Relay and PLC Logic Compared

C



PLC Ladder Diagram

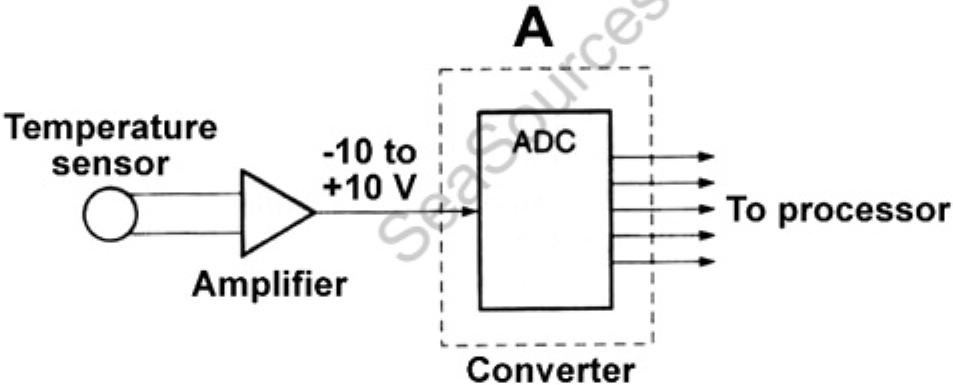
D

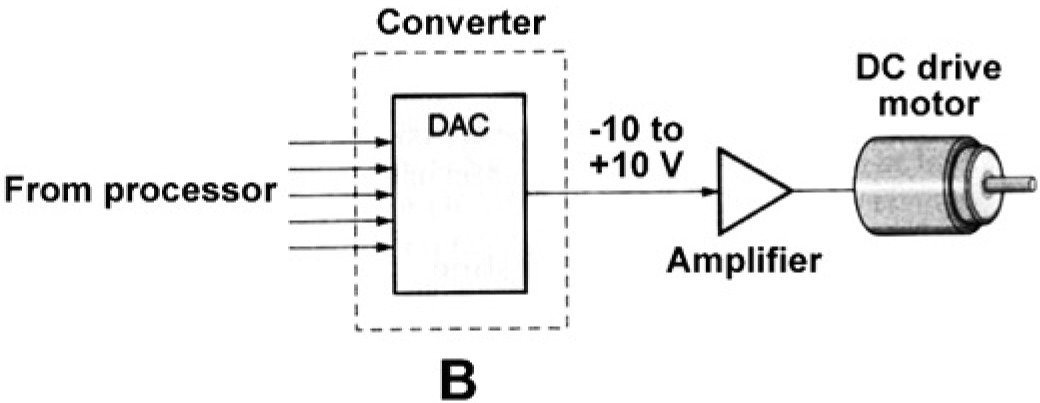


PLC Input/output Diagram

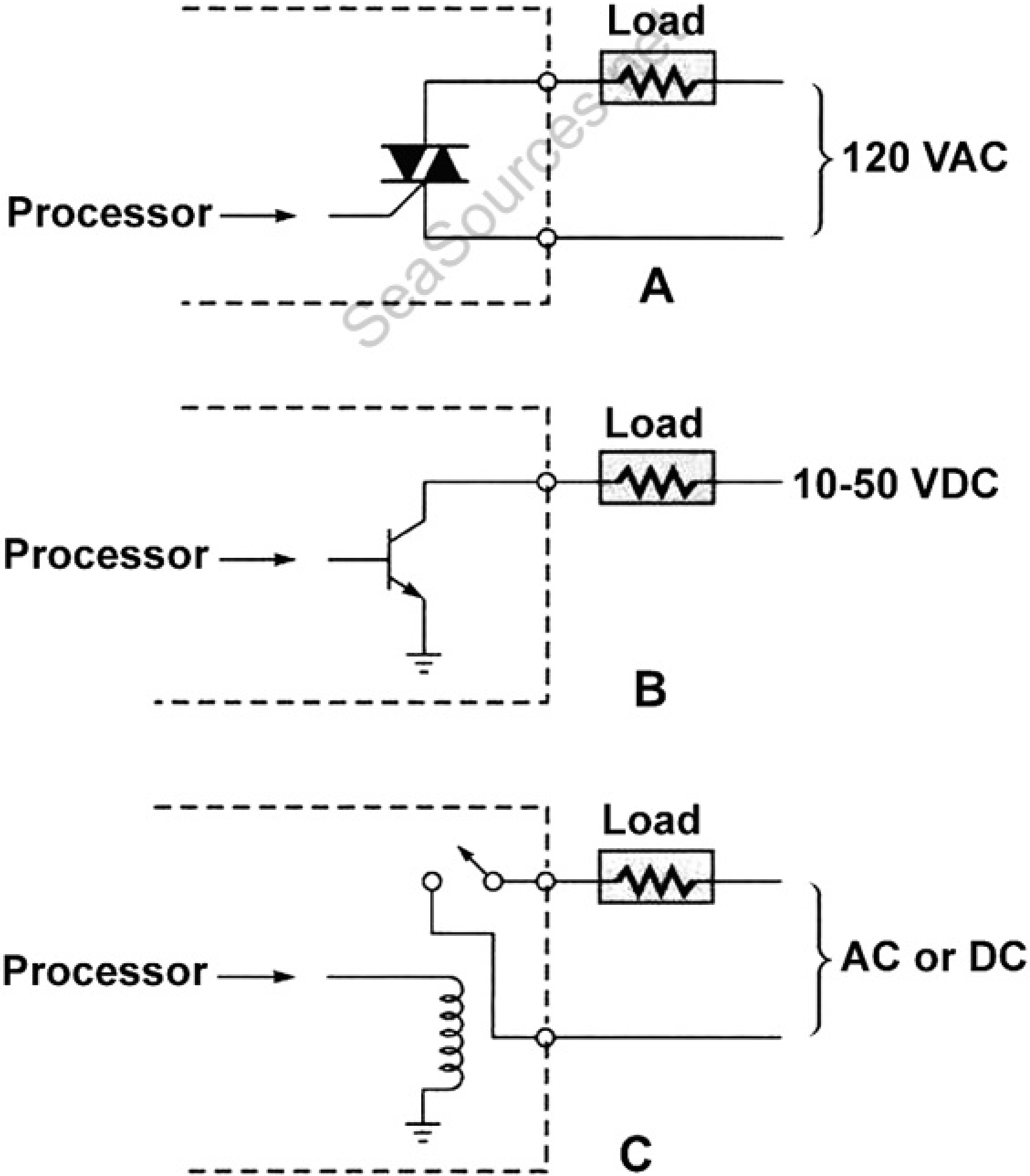
EL-0228

Generic Analog I/O Modules



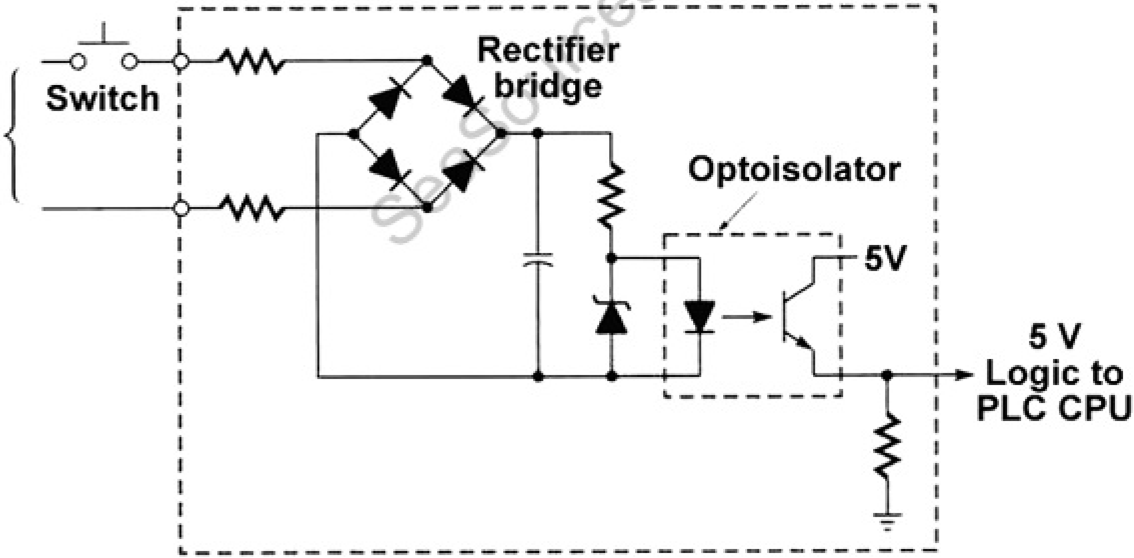


EL-0229

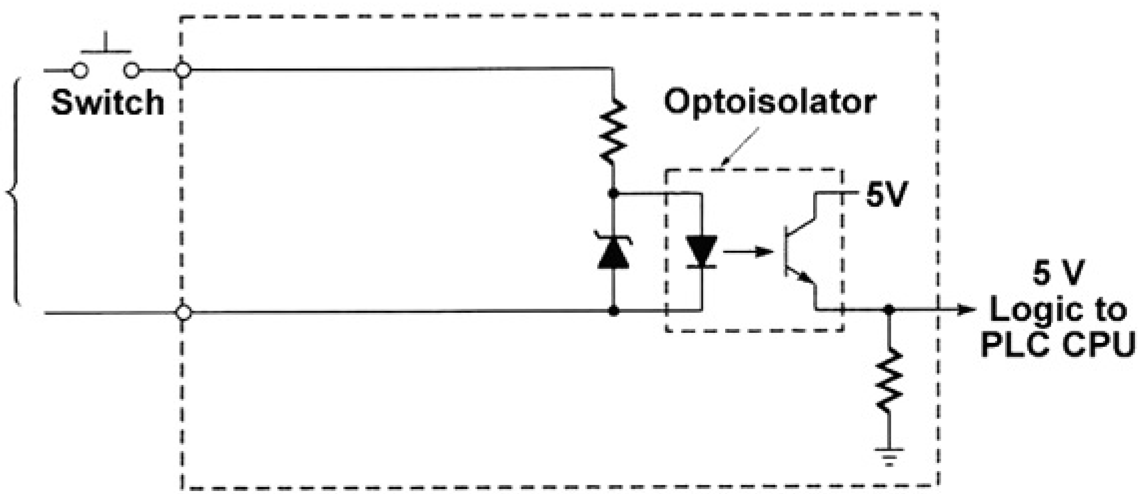


PLC Output Modules

Discrete PLC Input Modules



A



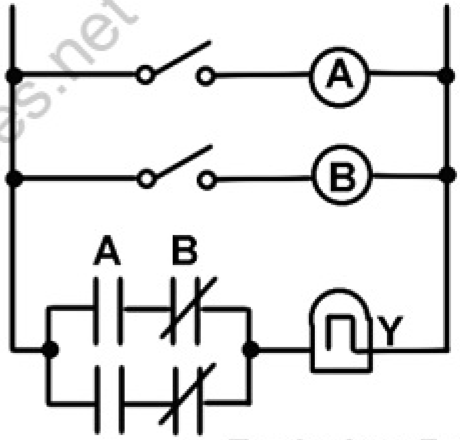
B

EL-0231

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

A

Truth Table

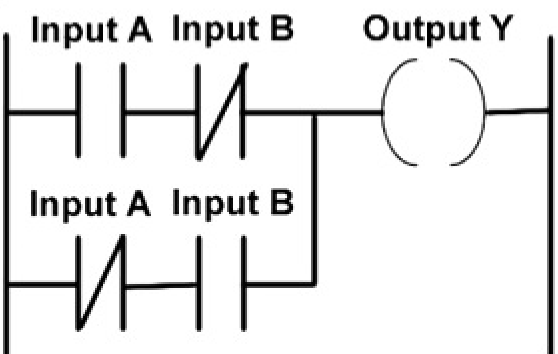


B

Equivalent Relay Circuit Diagram

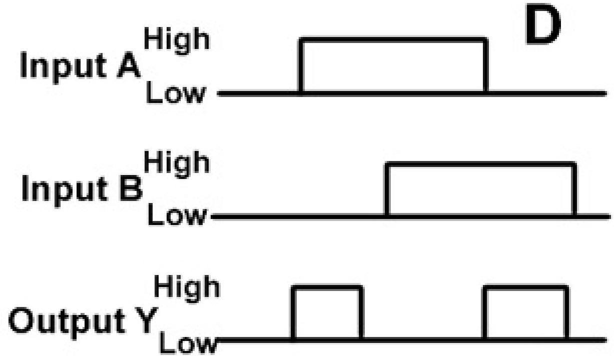
Relay and PLC Logic Compared

C



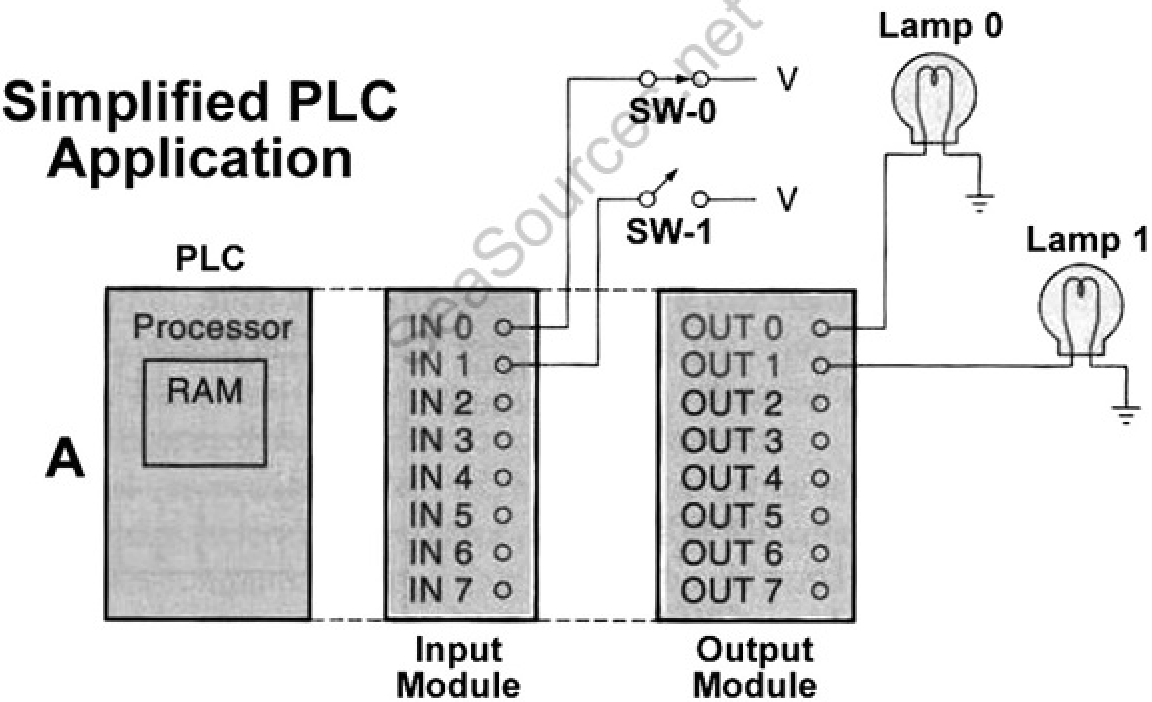
PLC Ladder Diagram

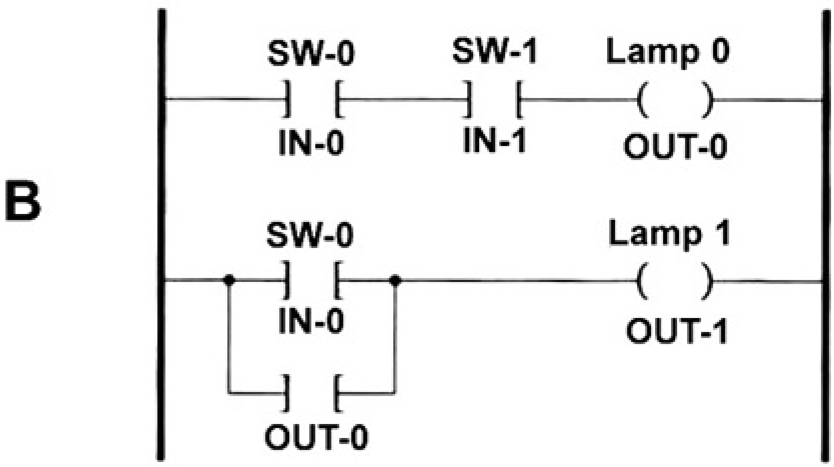
D



PLC Input/output Diagram

EL-0232


Simplified PLC Application
PLC
Processor
RAM
A
IN 0
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
Input Module
OUT 0
OUT 1
OUT 2
OUT 3
OUT 4
OUT 5
OUT 6
OUT 7
Output Module
SW-0
SW-1
V
V
Lamp 0
Lamp 1

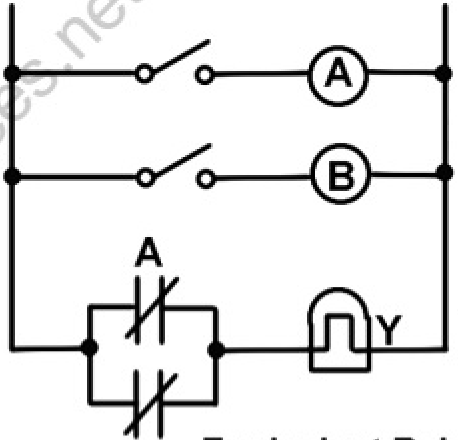

B
SW-0
IN-0
SW-1
IN-1
Lamp 0
OUT-0
SW-0
IN-0
OUT-0
Lamp 1
OUT-1

EL-0233

A

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Truth Table

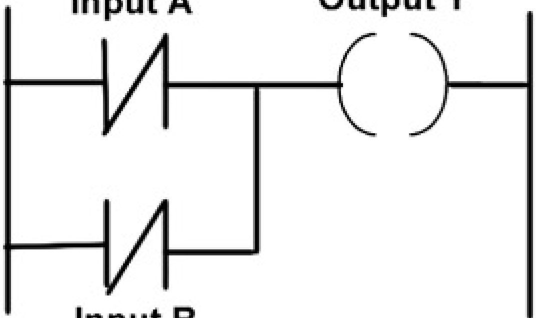


B

Equivalent Relay Circuit Diagram

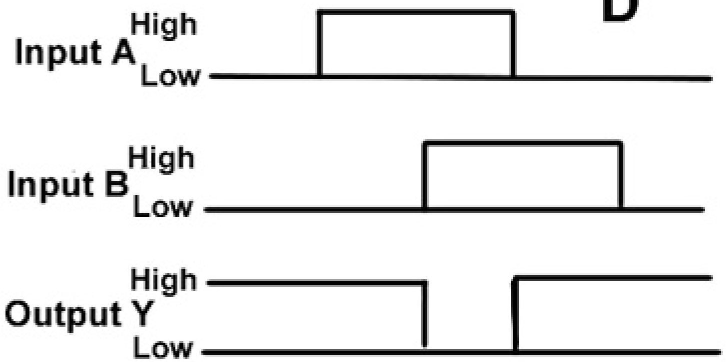
Relay and PLC Logic Compared

C



PLC Ladder Diagram

D



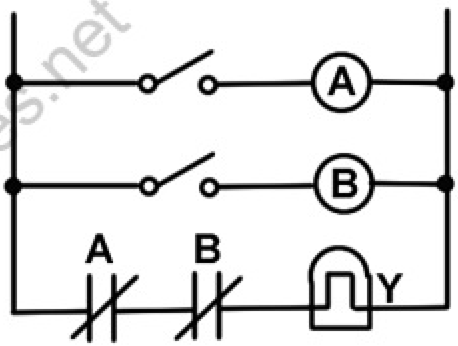
PLC Input/output Diagram

EL-0234

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

A

Truth Table

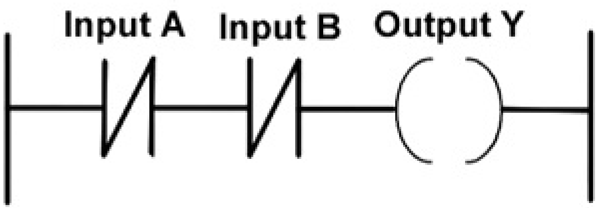


B

Equivalent Relay Circuit Diagram

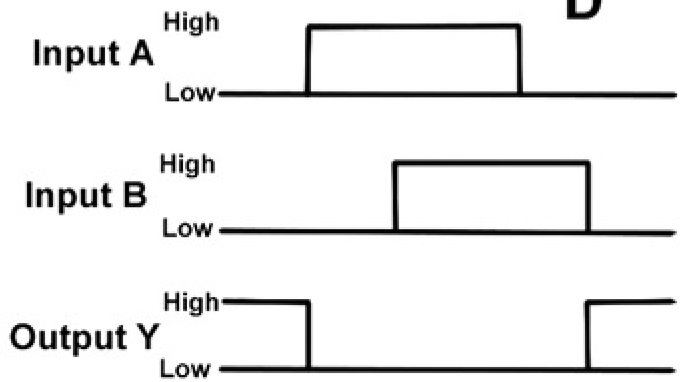
Relay and PLC Logic Compared

C



PLC Ladder Diagram

D



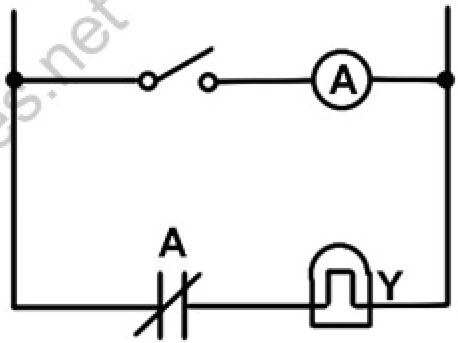
PLC Input/output Diagram

EL-0235

A

A	Y
0	1
1	0

Truth Table

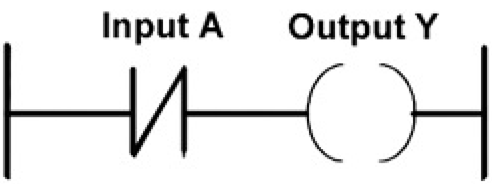


B

Equivalent Relay
Circuit Diagram

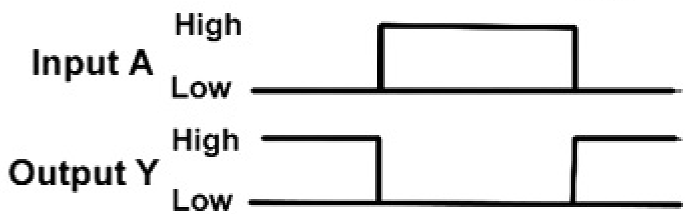
Relay and PLC Logic Compared

C



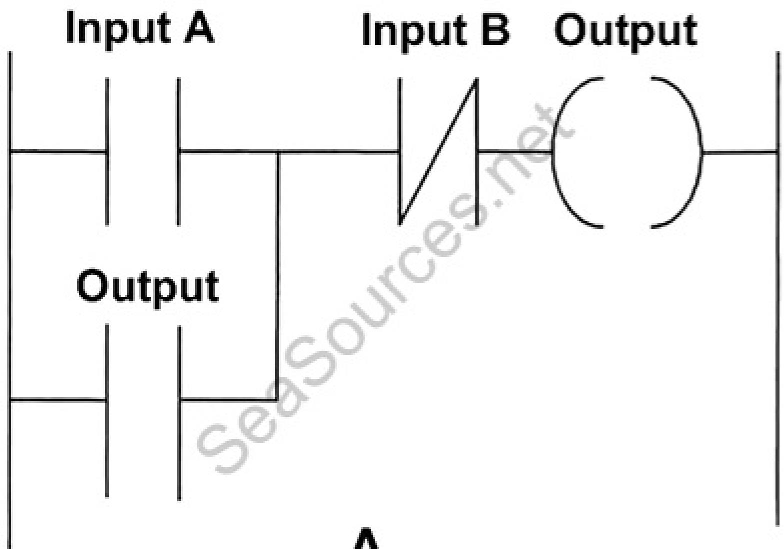
PLC Ladder Diagram

D

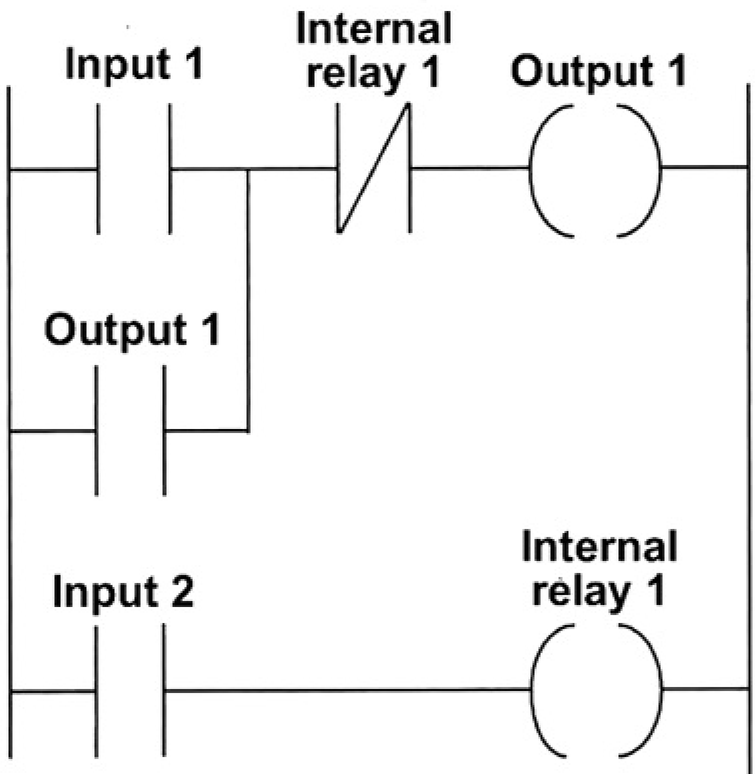


PLC Input/output Diagram

EL-0236

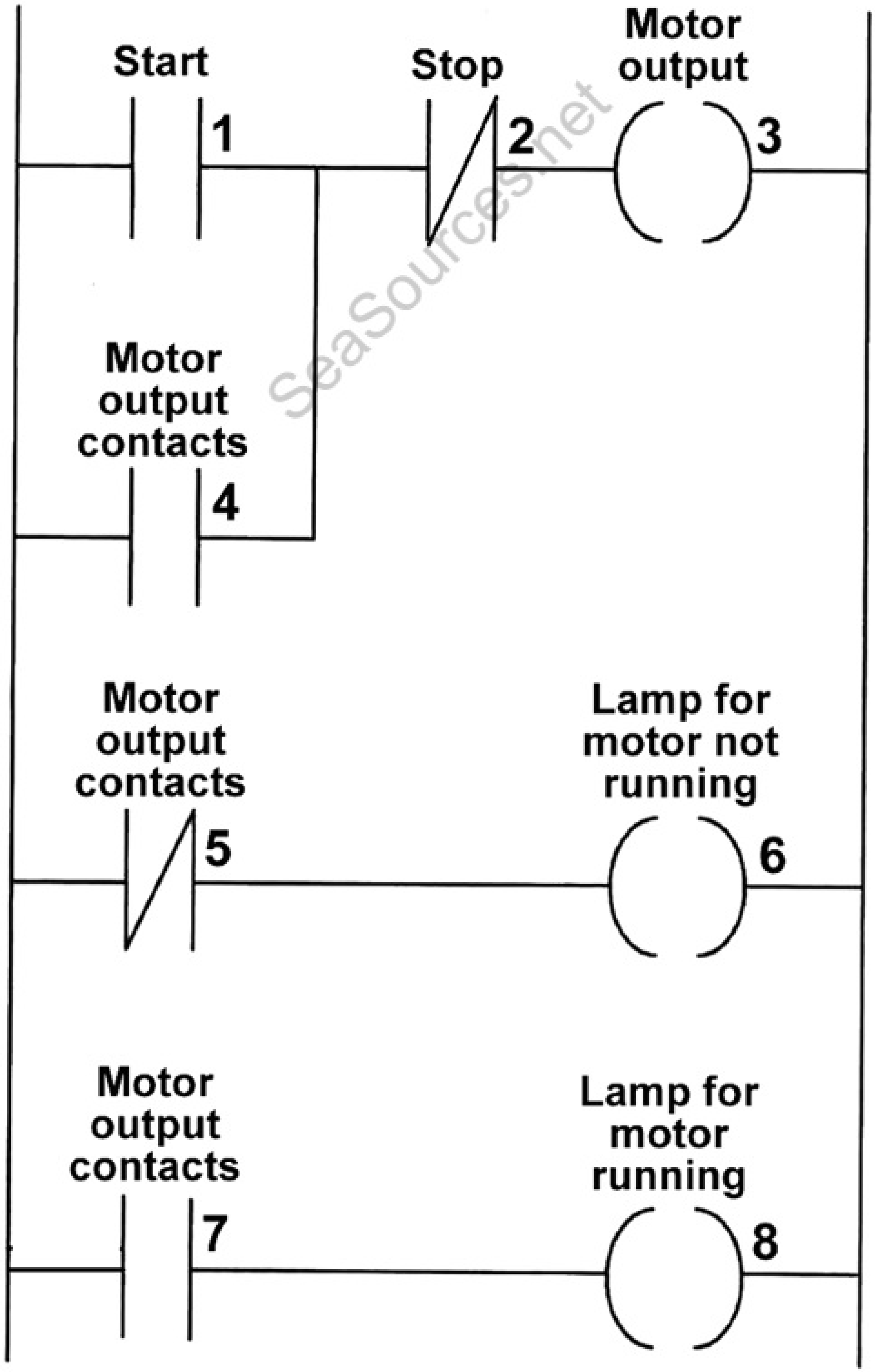

Input A
Input B
Output
Output

A

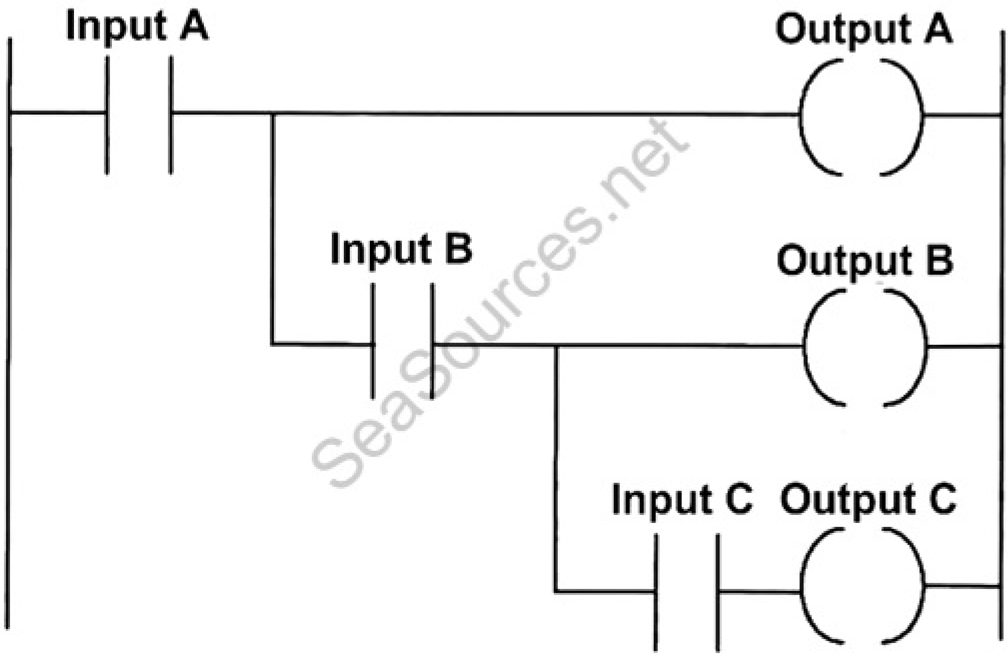

Input 1
Internal relay 1
Output 1
Output 1
Input 2
Internal relay 1

B

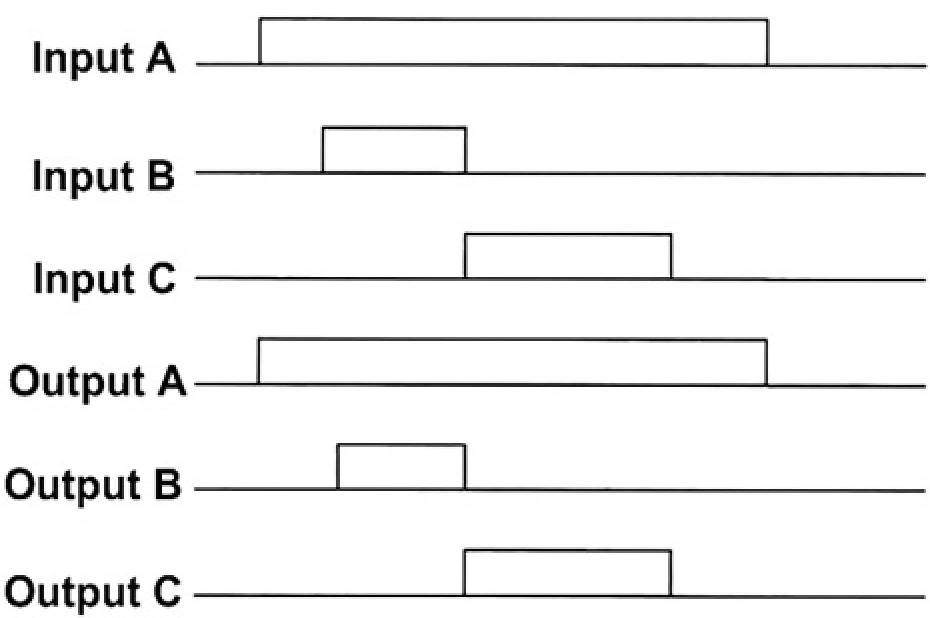
EL-0237


Start
1
Stop
2
Motor output
3
Motor output contacts
4
Motor output contacts
5
Lamp for motor not running
6
Motor output contacts
7
Lamp for motor running
8

EL-0239

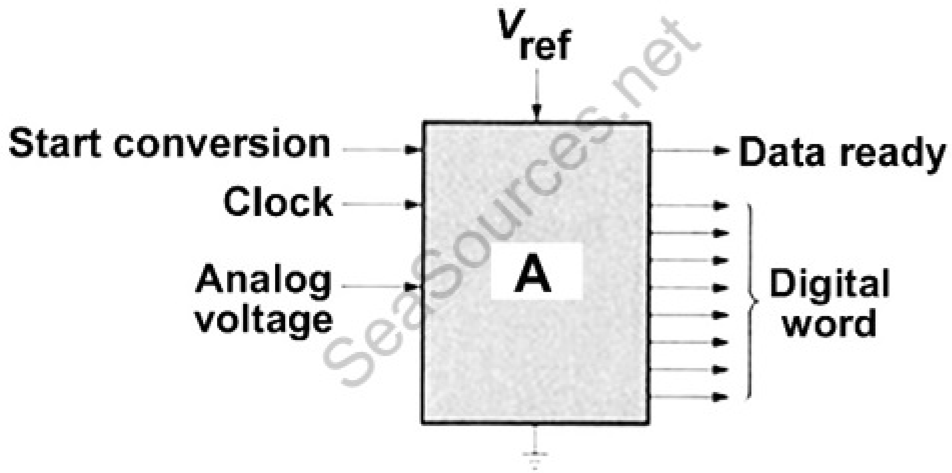


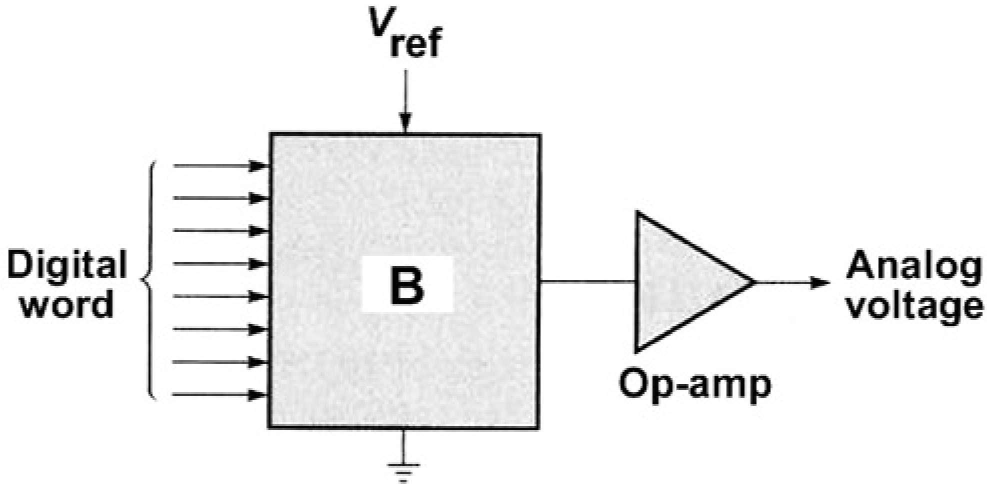
1 PLC Ladder Diagram



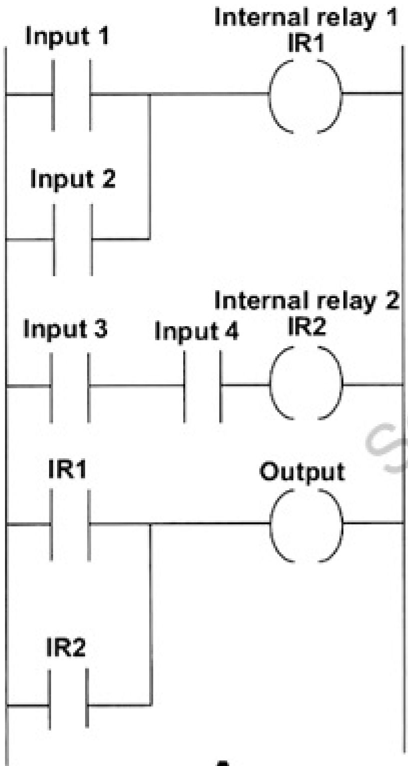
2 PLC Input/output Diagram

EL-0240

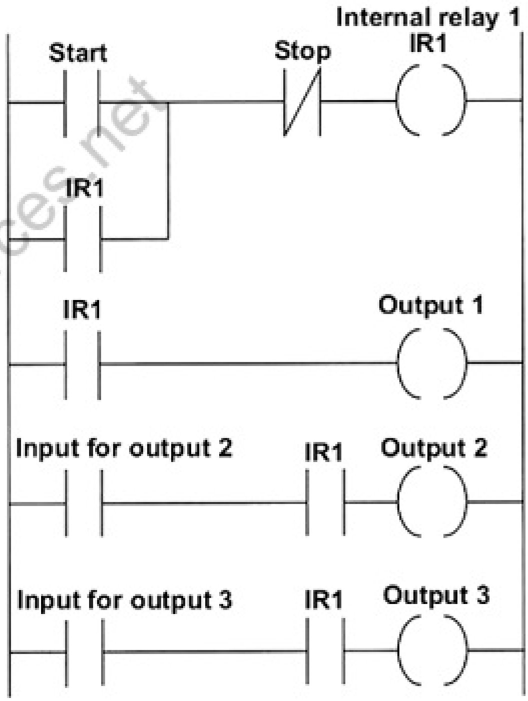

V_{ref}
Start conversion
Clock
Analog voltage
A
Data ready
Digital word


V_{ref}
Digital word
B
Op-amp
Analog voltage

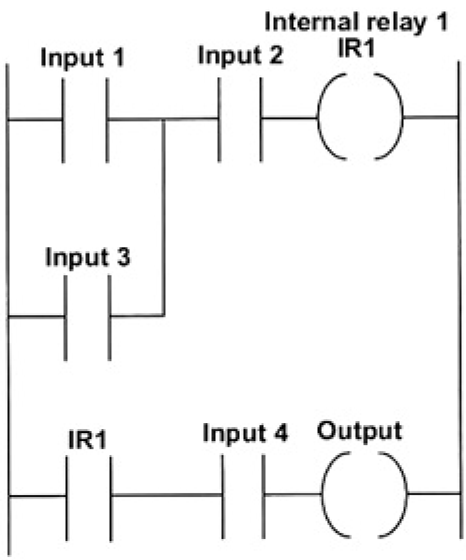
EL-0241


Input 1
Internal relay 1
IR1
Input 2
Input 3
Input 4
Internal relay 2
IR2
IR1
Output
IR2

A


Start
Stop
Internal relay 1
IR1
IR1
IR1
Output 1
Input for output 2
IR1
Output 2
Input for output 3
IR1
Output 3

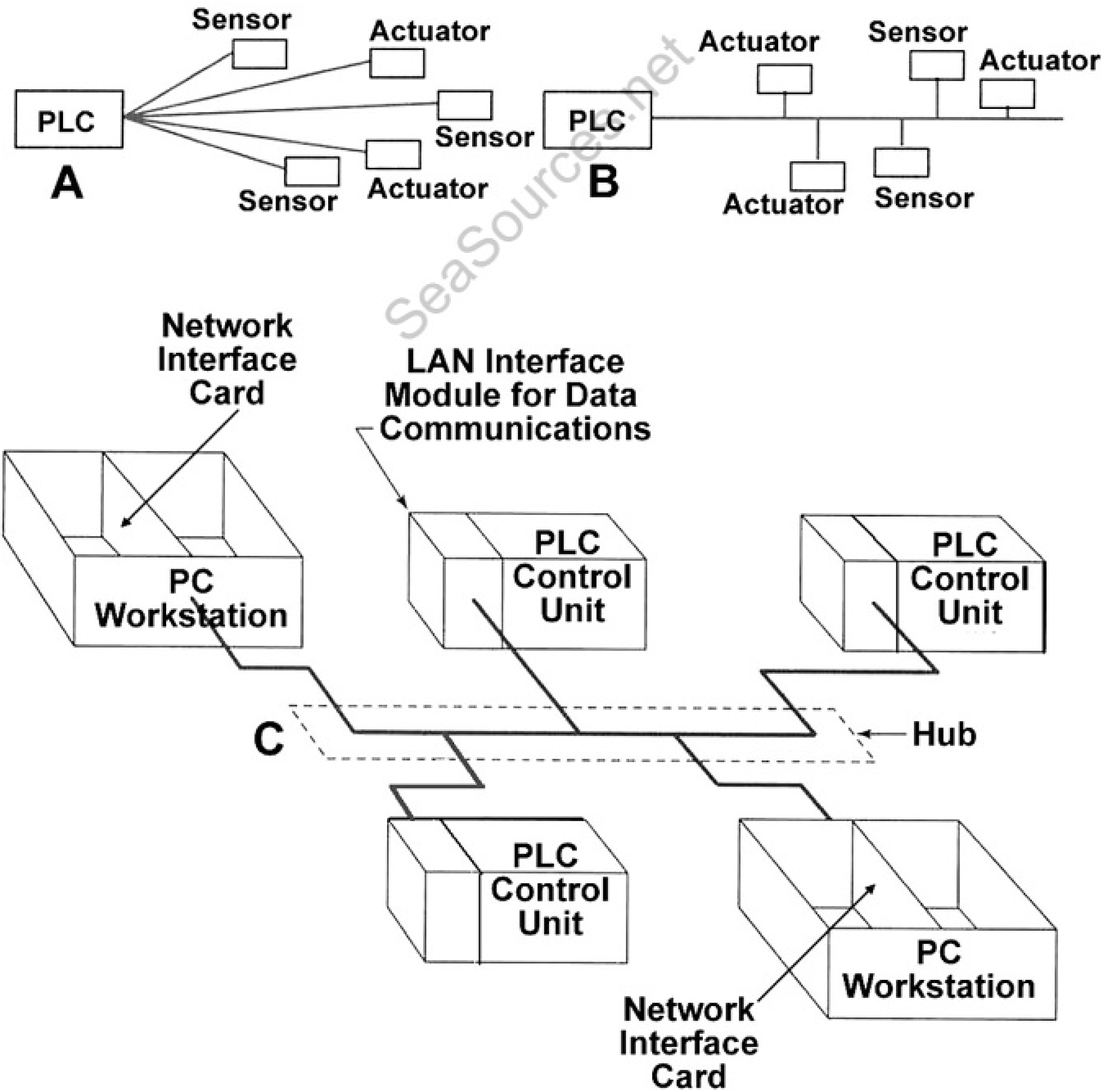
B


Input 1
Input 2
Internal relay 1
IR1
Input 3
IR1
Input 4
Output

C

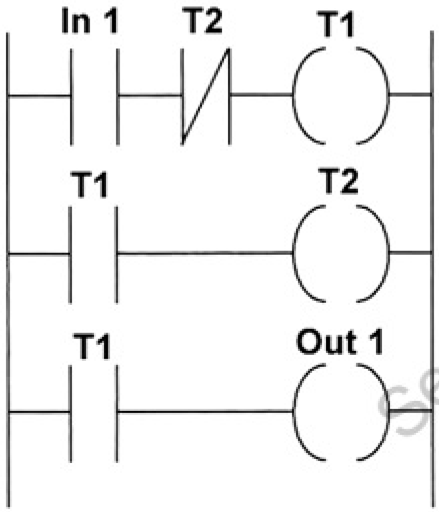
EL0242: The new Illustration associated with this question has not yet been made available to the public from the National Maritime Center even though they are already using them in the exam room. We hope to have them posted soon.

EL-0243

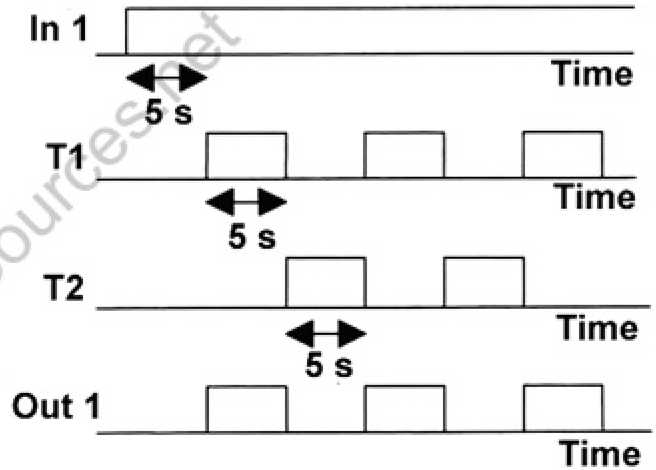


Sensor
Actuator
PLC
Sensor
Actuator
Sensor
A
PLC
Actuator
Sensor
Actuator
B
Actuator
Sensor
Network Interface Card
LAN Interface Module for Data Communications
PC Workstation
PLC Control Unit
PLC Control Unit
C
Hub
PLC Control Unit
PC Workstation
Network Interface Card

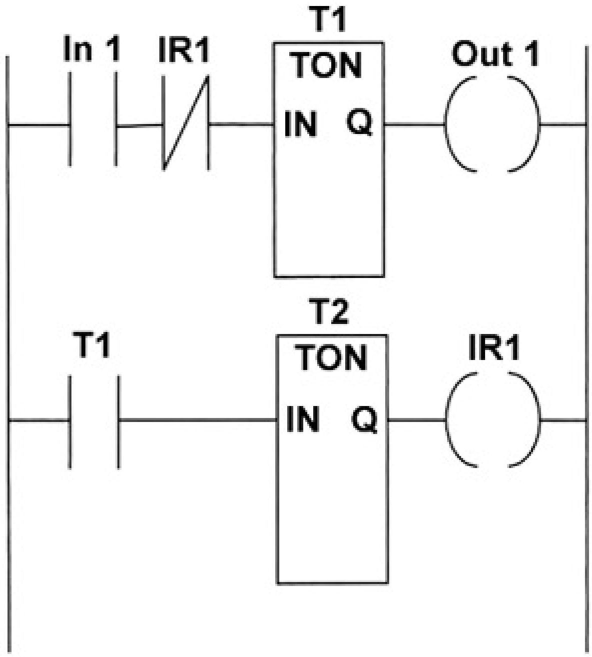
EL-0244



A PLC Ladder Diagram

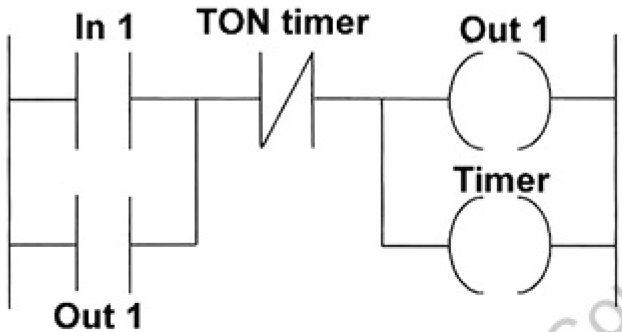


B PLC Input/output Timing Diagram

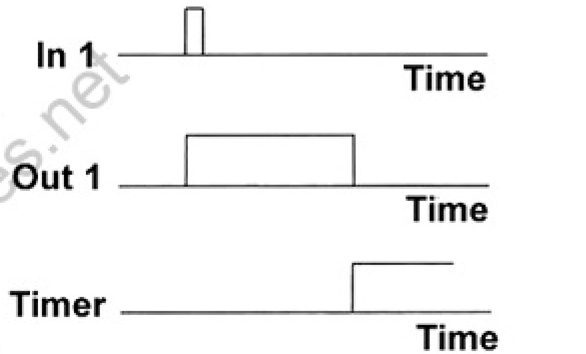


C PLC Ladder Diagram

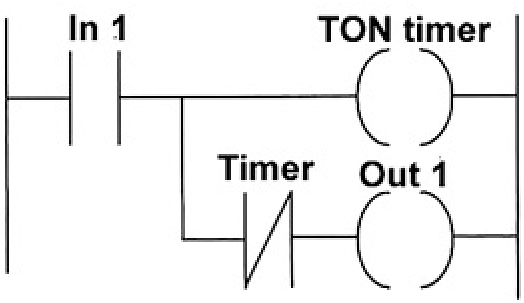
EL-0245



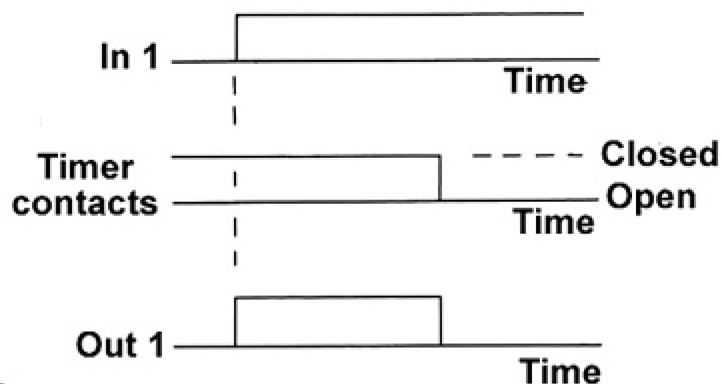
A PLC Ladder Diagram



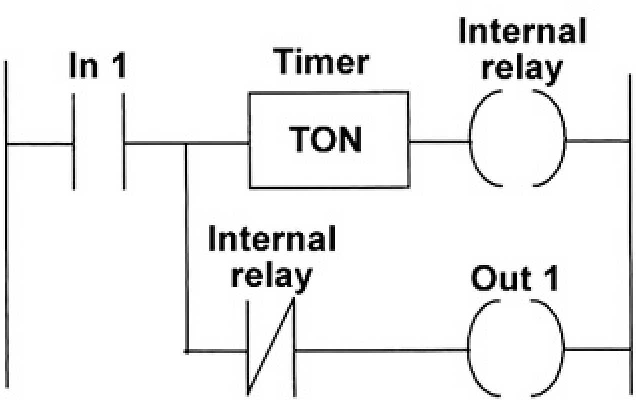
B PLC Input/output Timing Diagram



C PLC Ladder Diagram

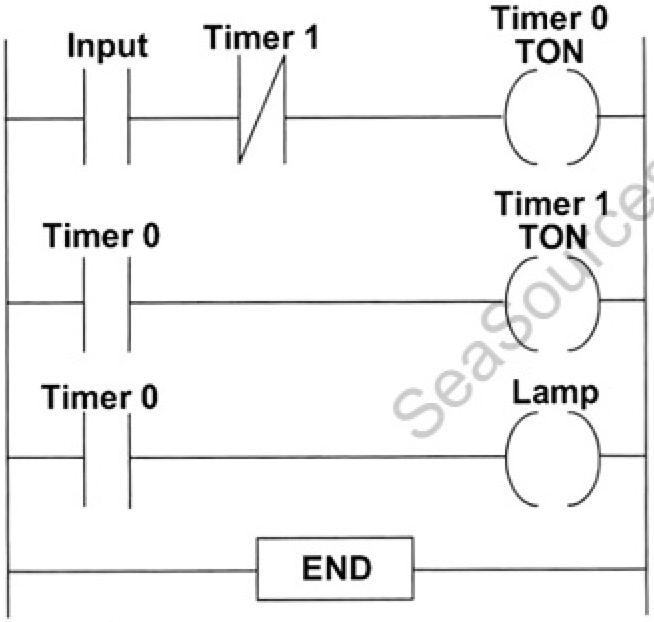


D PLC Input/output Timing Diagram

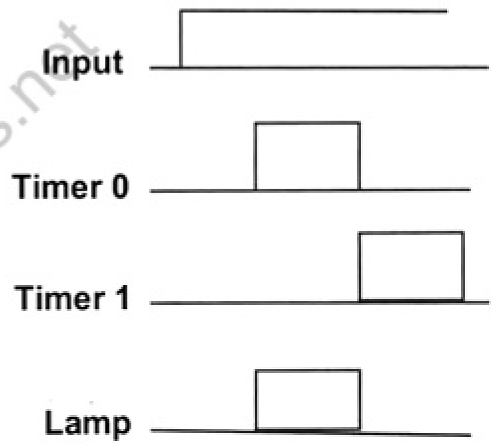


E PLC Ladder Diagram

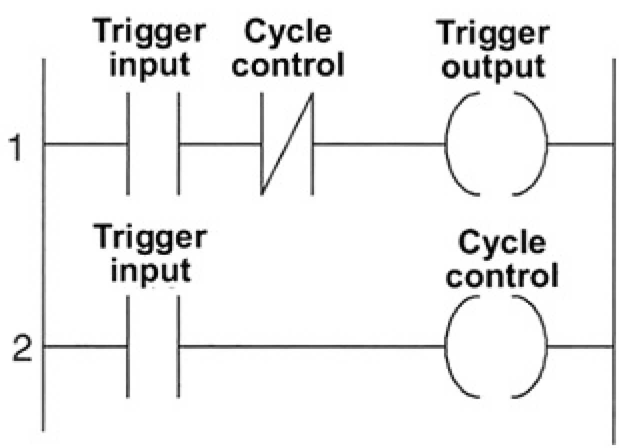
EL-0246



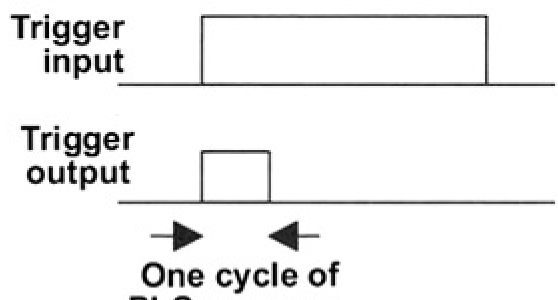
A PLC Ladder Diagram



B PLC Input/output Timing Diagram

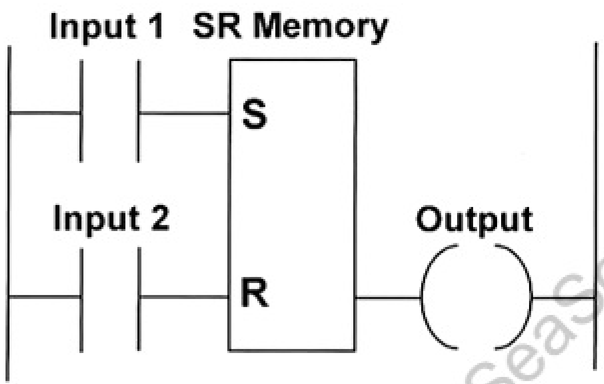


C PLC Ladder Diagram

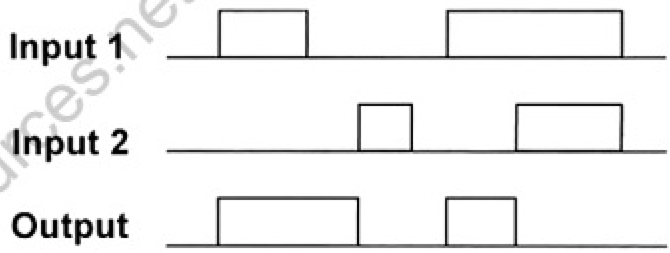


D PLC Input/output Timing Diagram

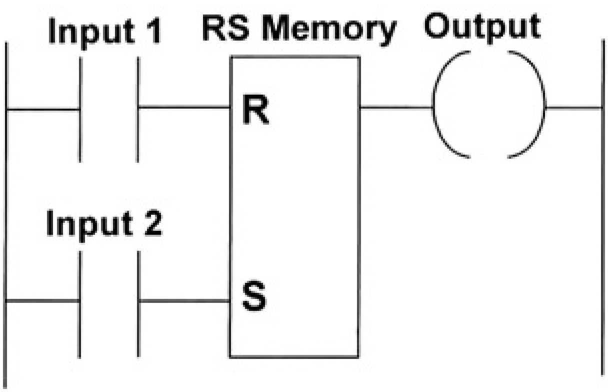
EL-0247



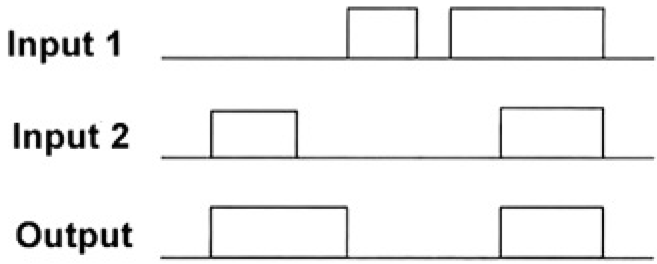
A PLC Ladder Diagram



B PLC Input/output Diagram

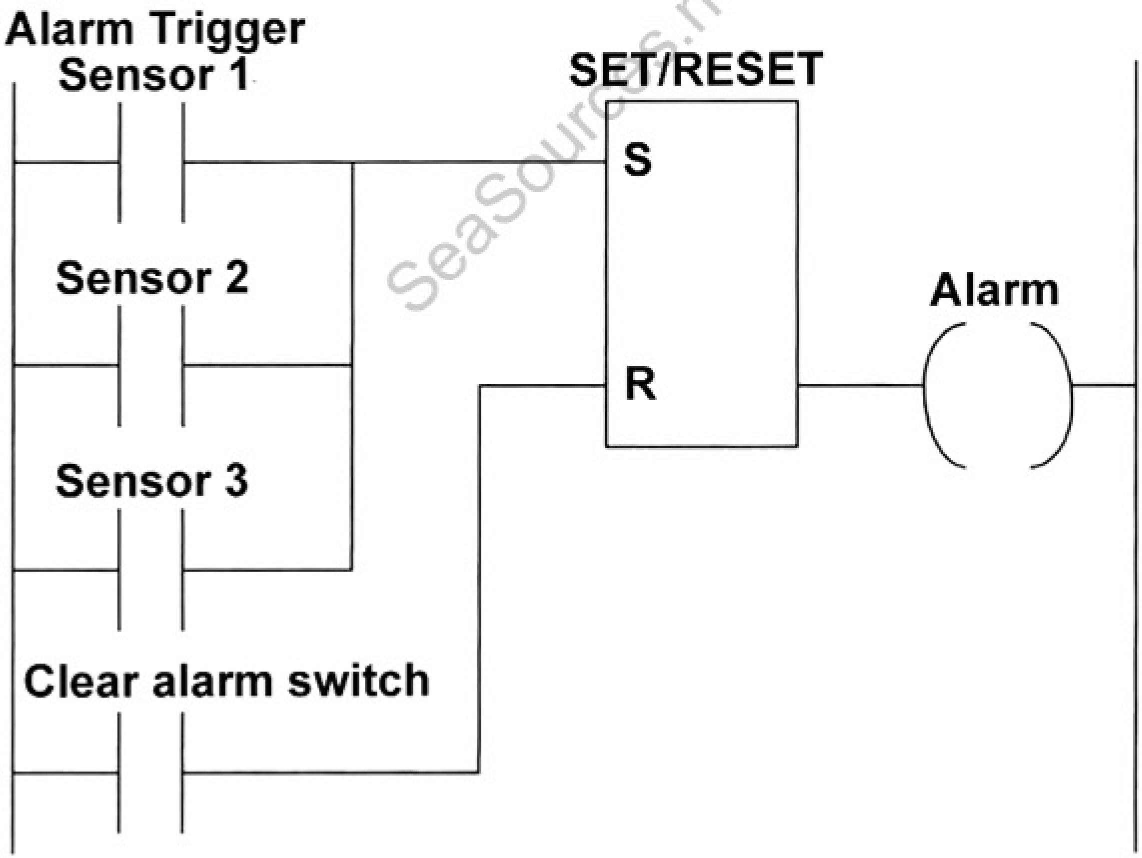


C PLC Ladder Diagram

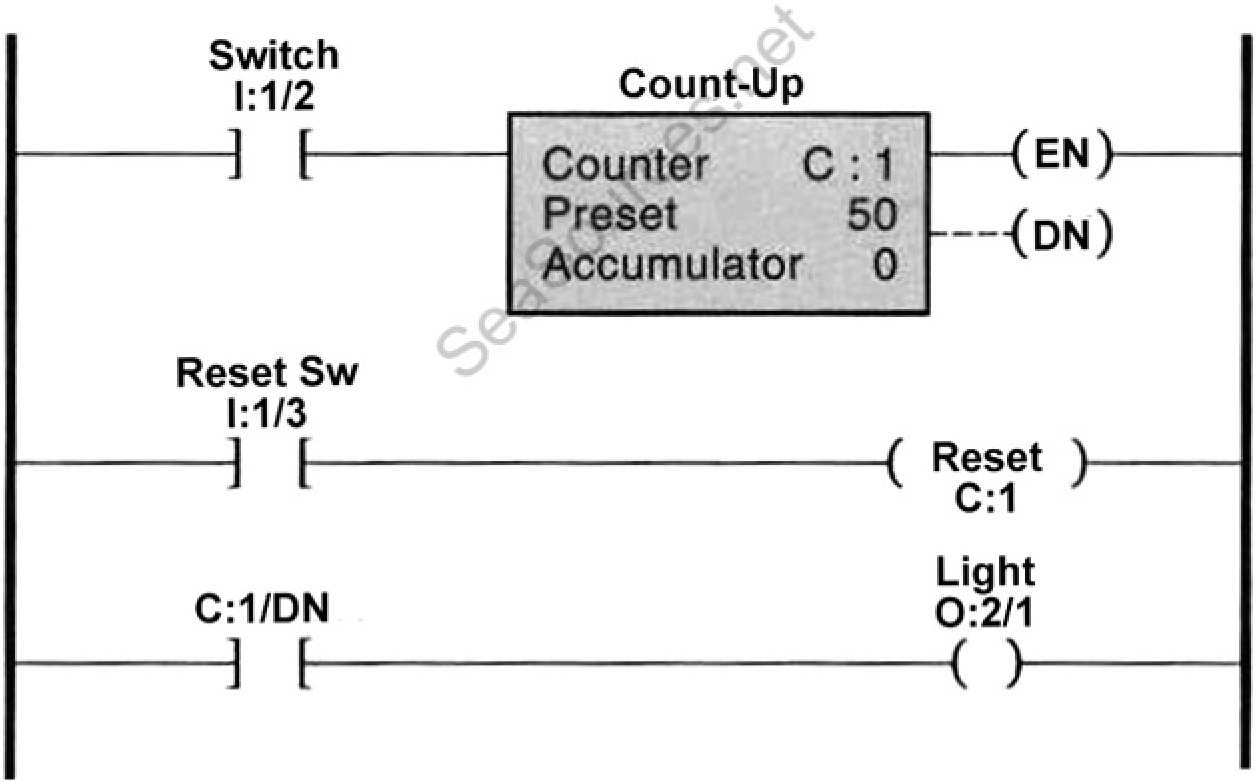


D PLC Input/output Diagram

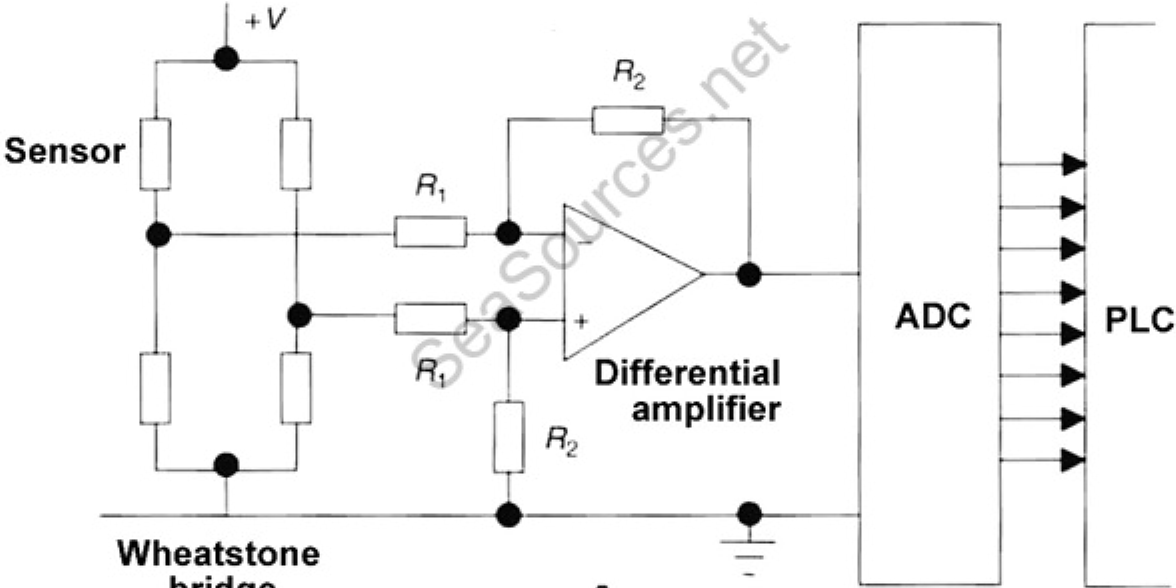
EL-0248


Alarm Trigger
Sensor 1
Sensor 2
Sensor 3
Clear alarm switch
SET/RESET
S
R
Alarm

EL-0249

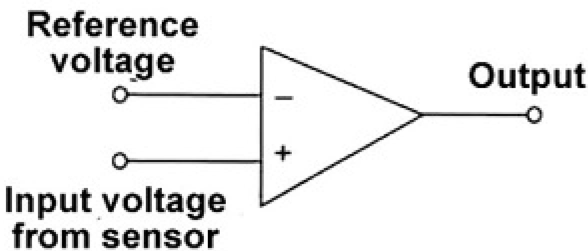

Switch
I:1/2
Count-Up
Counter C : 1
Preset 50
Accumulator 0
(EN)
(DN)
Reset Sw
I:1/3
Reset
C:1
C:1/DN
Light
O:2/1

EL-0250



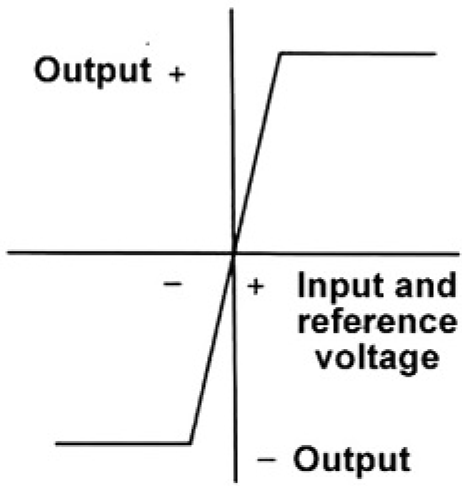
+V
Sensor
R_2
R_1
R_1
R_2
Differential amplifier
Wheatstone bridge
ADC
PLC

A



Reference voltage
Output
Input voltage from sensor

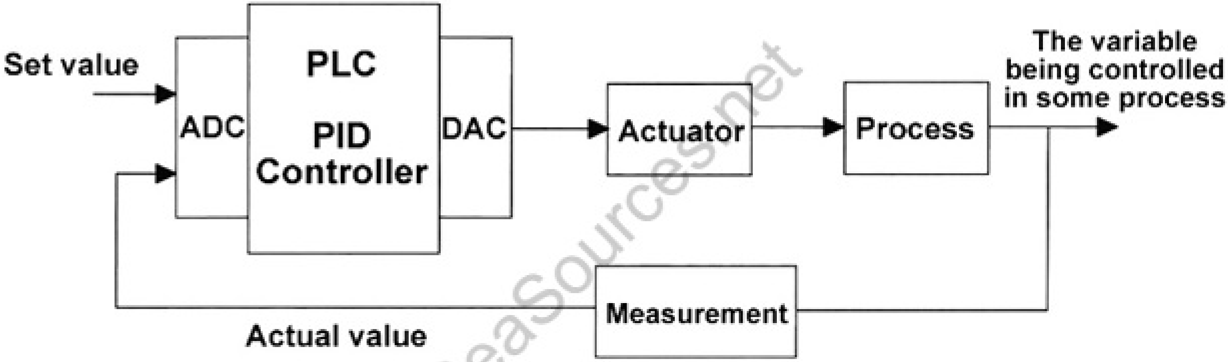
B



Output +
− + Input and reference voltage
− Output

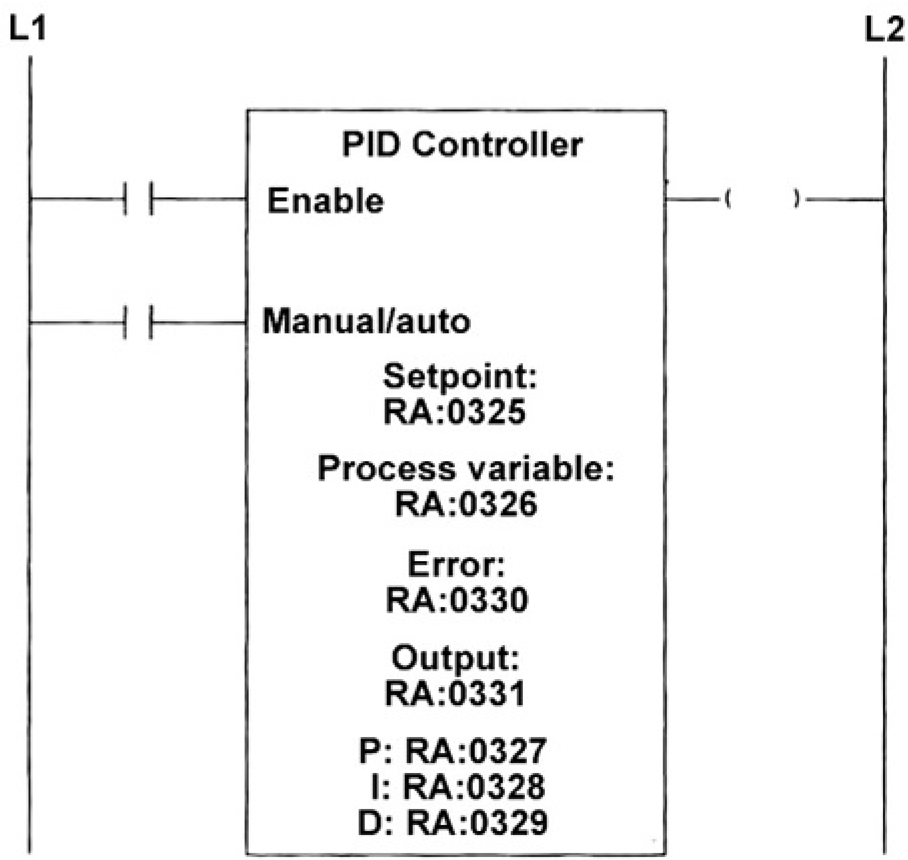
C

EL-0251



Set value
ADC
PLC
PID
Controller
DAC
Actuator
Process
The variable
being controlled
in some process
Measurement
Actual value

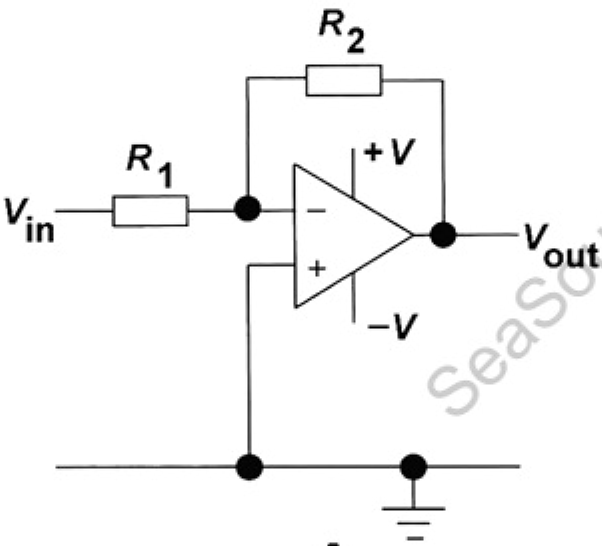
A



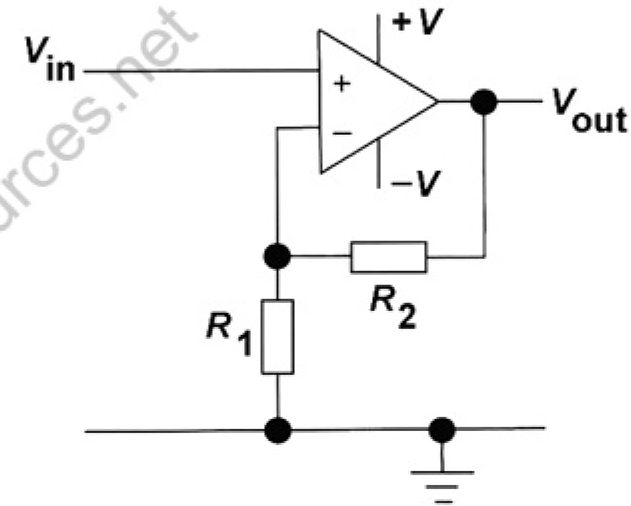
L1
L2
PID Controller
Enable
Manual/auto
Setpoint:
RA:0325
Process variable:
RA:0326
Error:
RA:0330
Output:
RA:0331
P: RA:0327
I: RA:0328
D: RA:0329

B

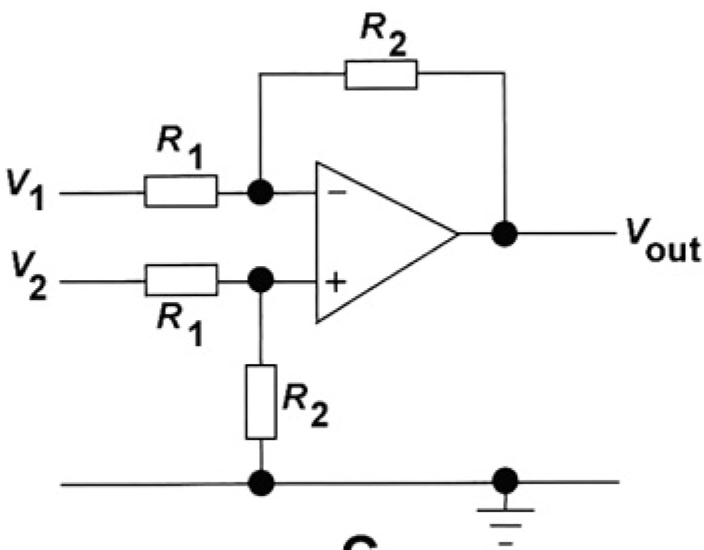
EL-0252



A



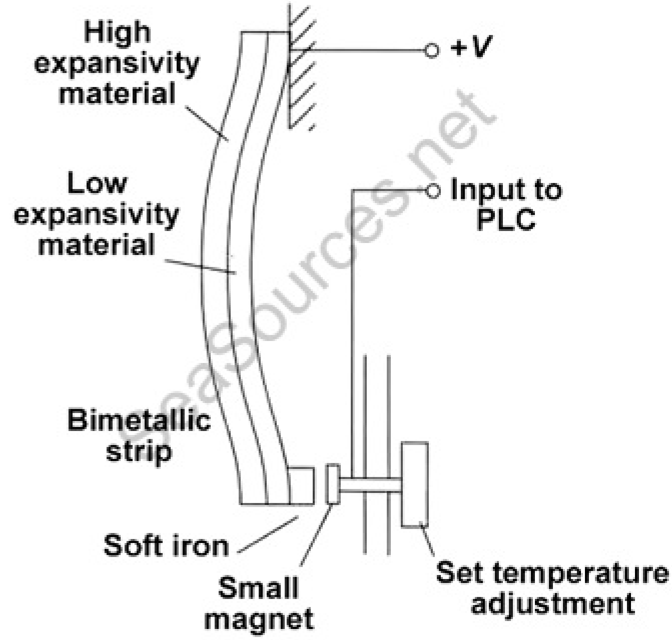
B



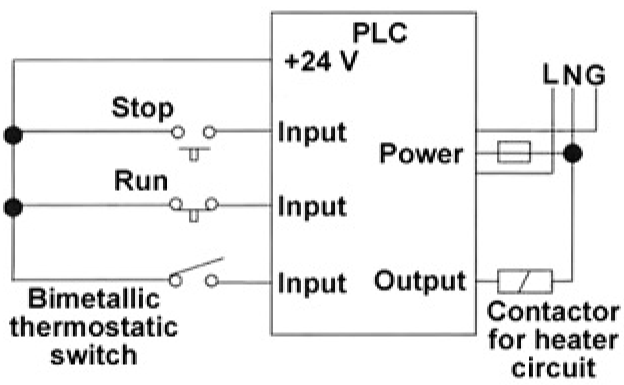
C

EL-0253

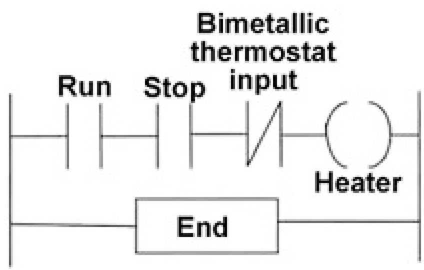
A



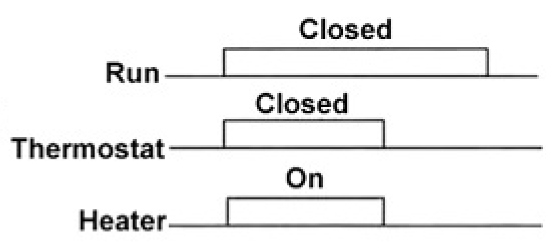
B



C

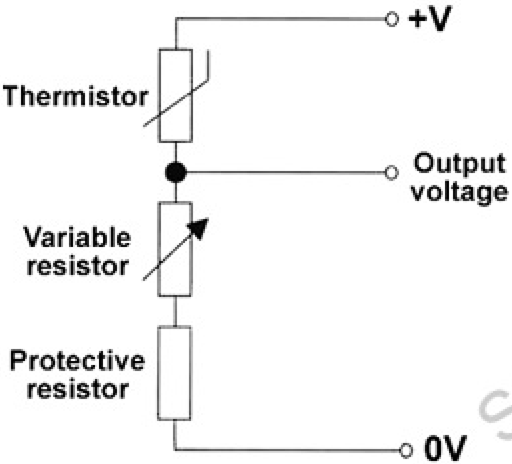


D

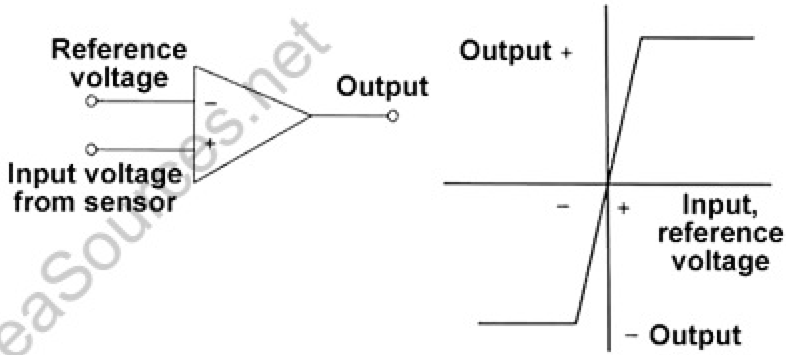


Input/output timing diagram

EL-0254

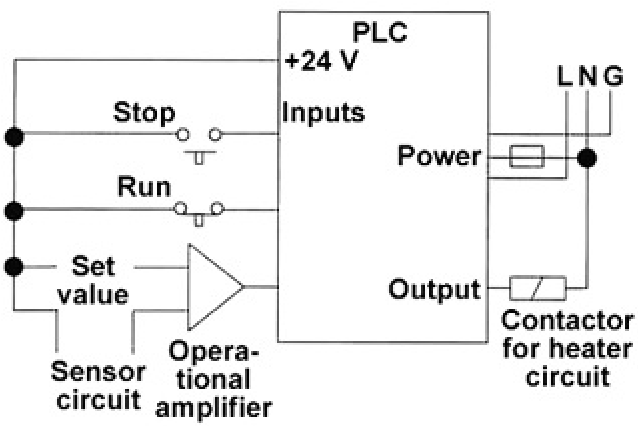


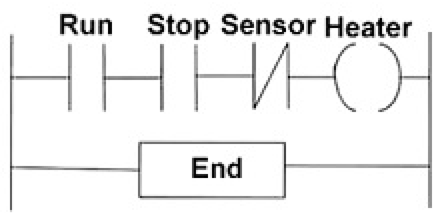
A



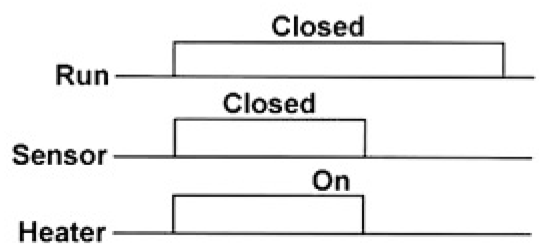
B

C



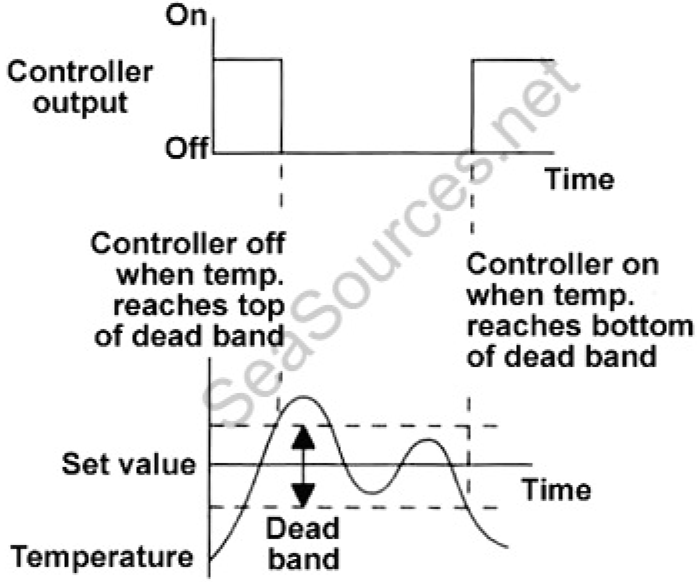


D

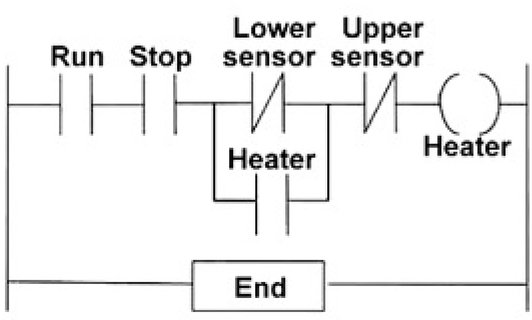


E

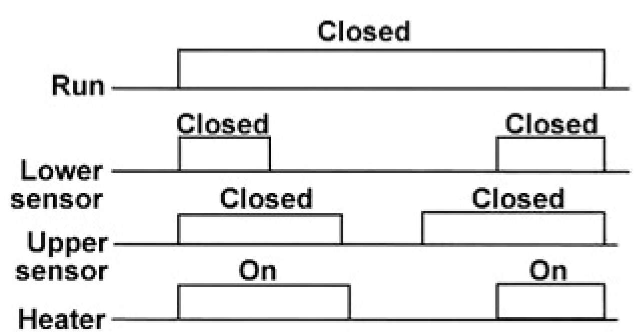
EL-0255


On
Controller output
Off
Time
Controller off when temp. reaches top of dead band
Controller on when temp. reaches bottom of dead band
Set value
Time
Dead band
Temperature

A

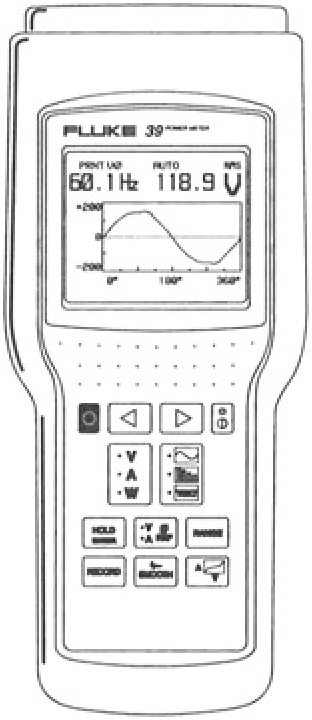

Run
Stop
Lower sensor
Upper sensor
Heater
Heater
End

B

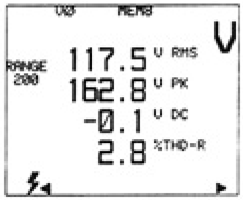

Closed
Run
Closed
Closed
Lower sensor
Closed
Closed
Upper sensor
On
On
Heater

C

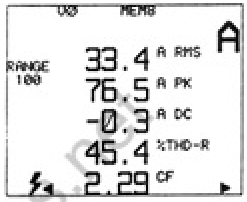
EL-0256



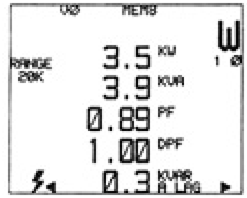
A



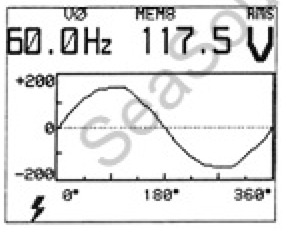
B



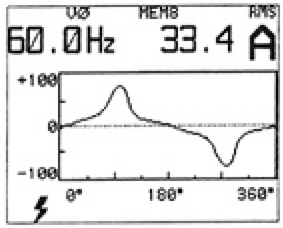
C



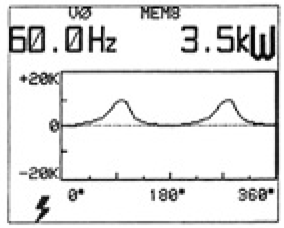
D



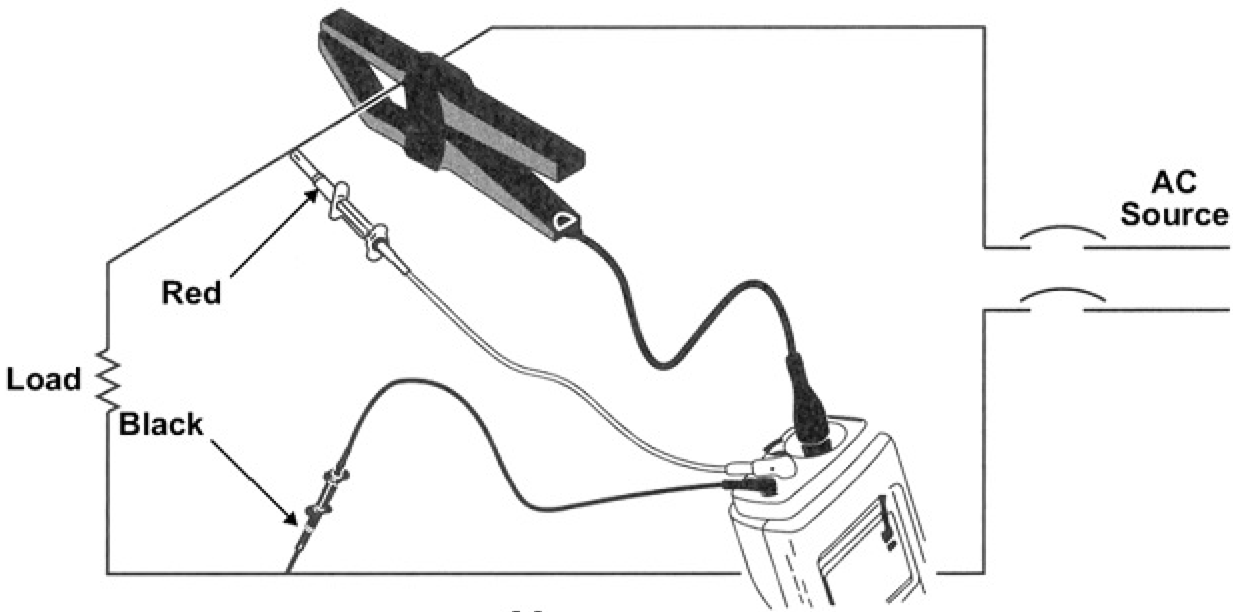
E



F



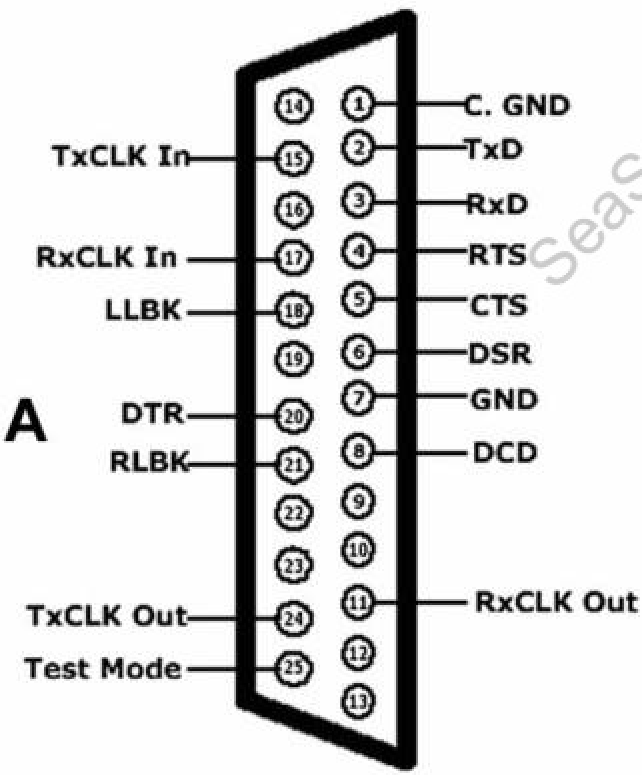
G



H

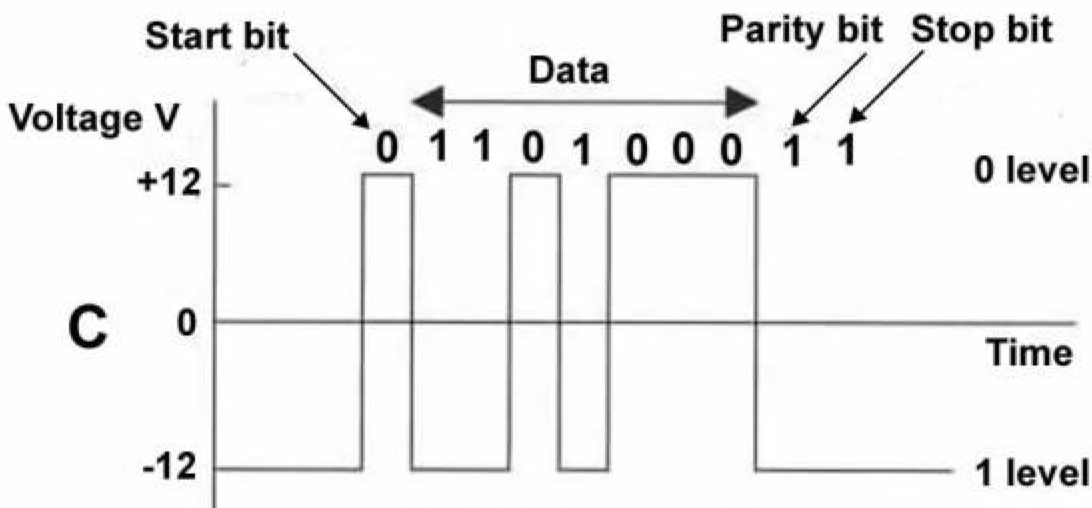
EL-0257

RS-232 Synchronous DB-25 Male Pinout



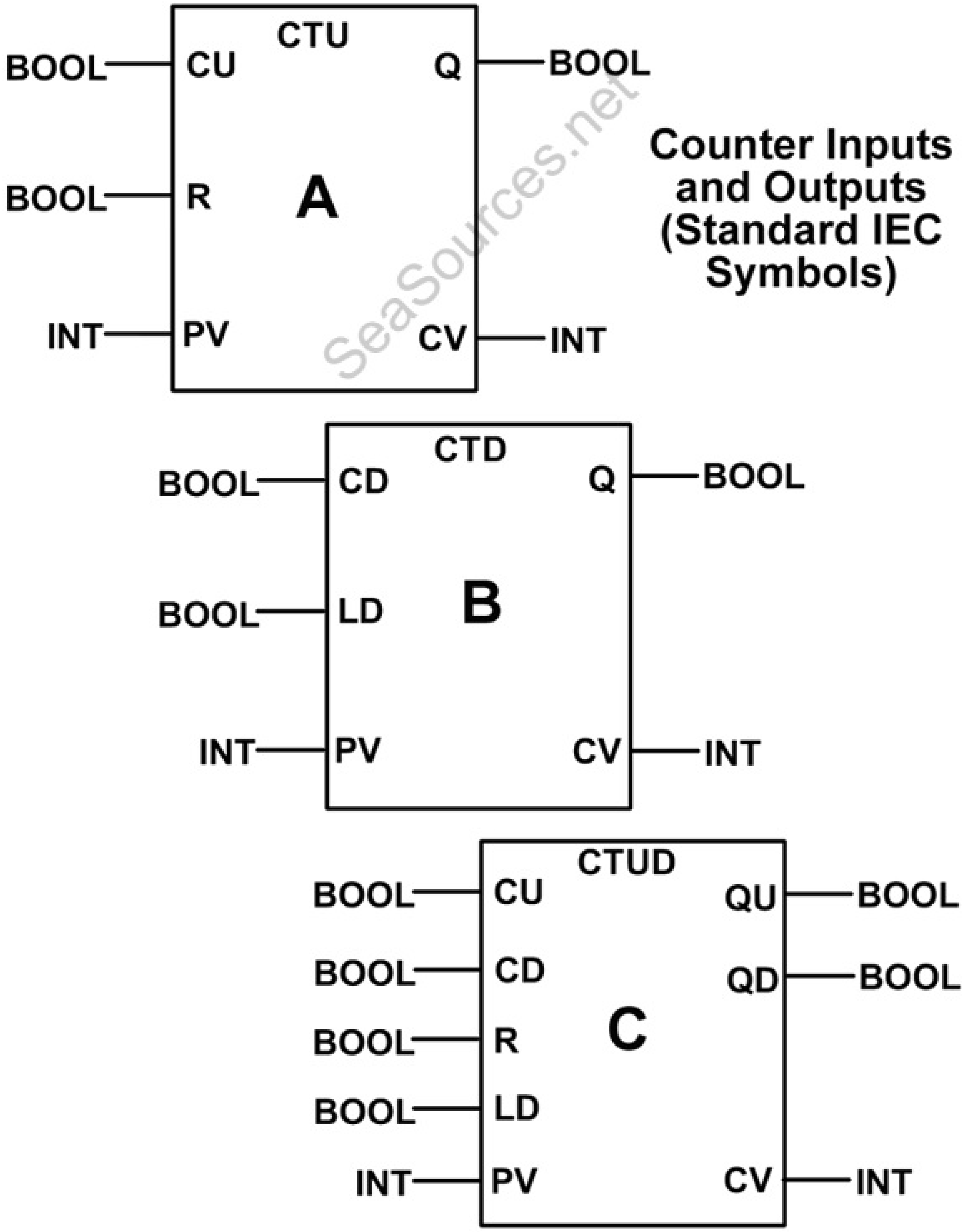
B

Pin 1 Chassis Ground
Pin 2 Transmit Data
Pin 3 Receive Data
Pin 4 Request to Send
Pin 5 Clear to Send
Pin 6 Data Set Ready
Pin 7 Signal Ground
Pin 8 Carrier Detect
Pin 11 Receive Clock Out
Pin 15 Transmit Clock In
Pin 17 Receive Clock In
Pin 18 Local Loopback
Pin 20 Data Terminal Ready
Pin 21 Remote Loopback
Pin 24 Transmit Clock Out
Pin 25 Test Mode



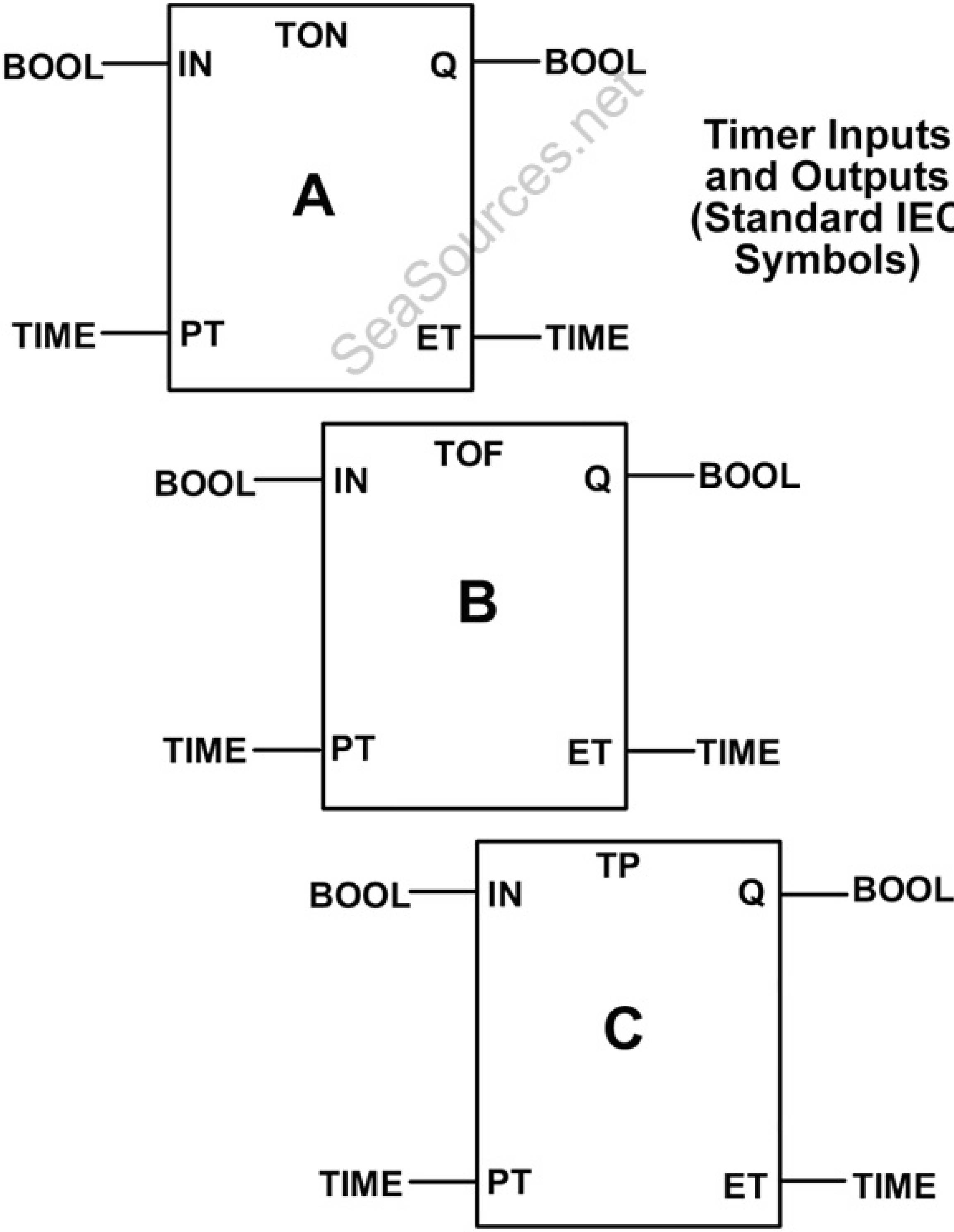
RS-232 Signal Levels

EL-0258



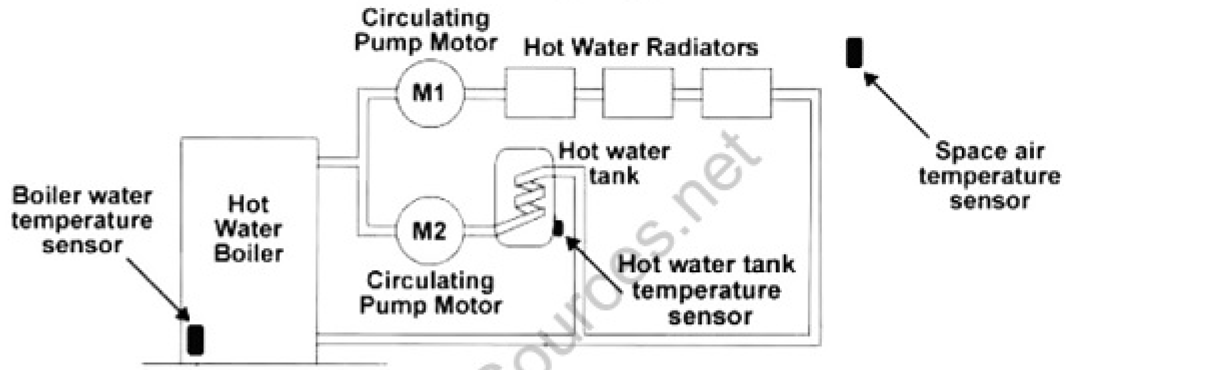
Counter Inputs and Outputs (Standard IEC Symbols)

EL-0259

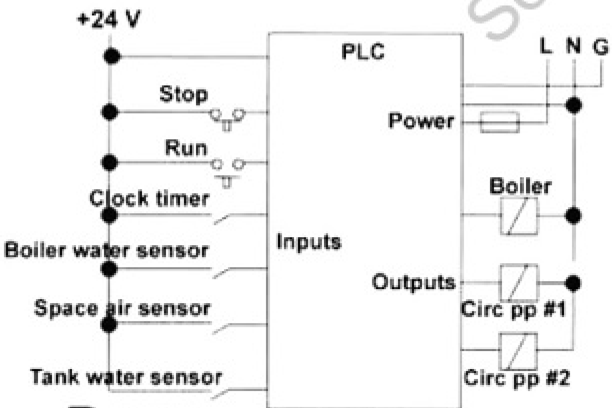


Timer Inputs and Outputs (Standard IEC Symbols)

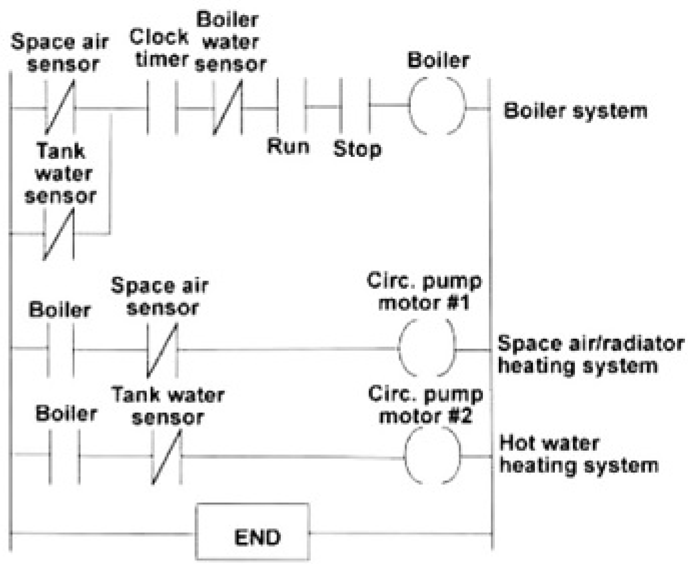
EL-0260



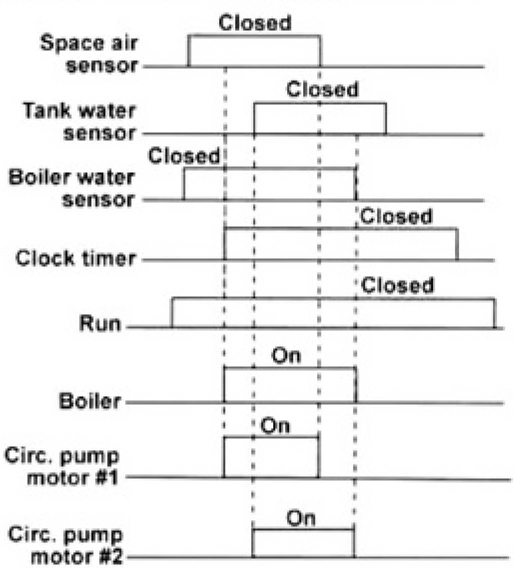
A PLC Controlled Heating System Piping



B PLC Controller Wiring Diagram



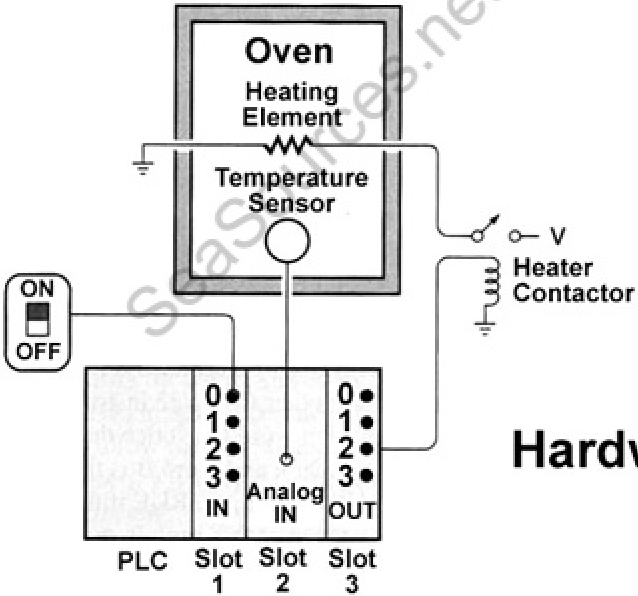
C PLC Controlled Heating System Ladder Diagram



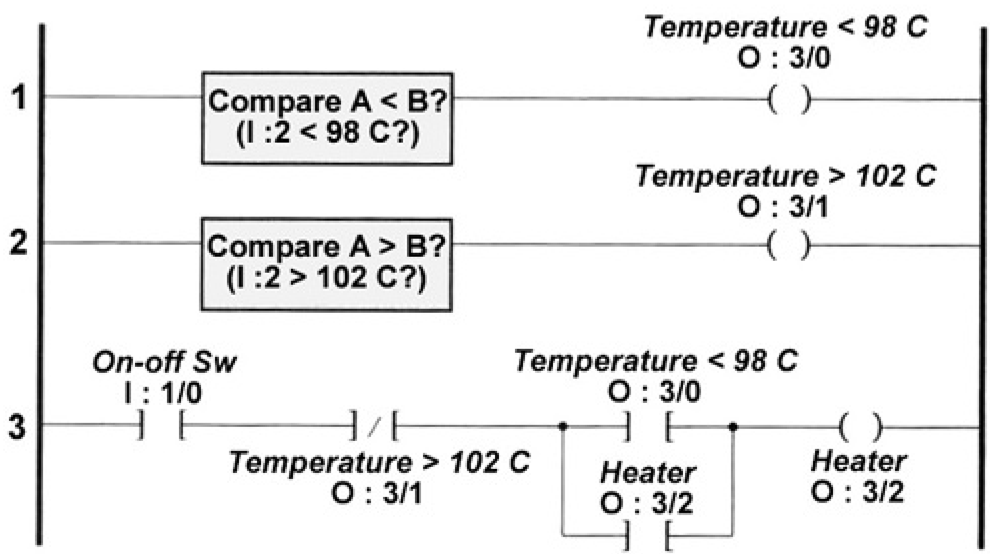
D PLC Controlled Heating System Timing Diagram

EL-0261

PLC Used as a 2-Point Controller



Hardware



Ladder Diagram