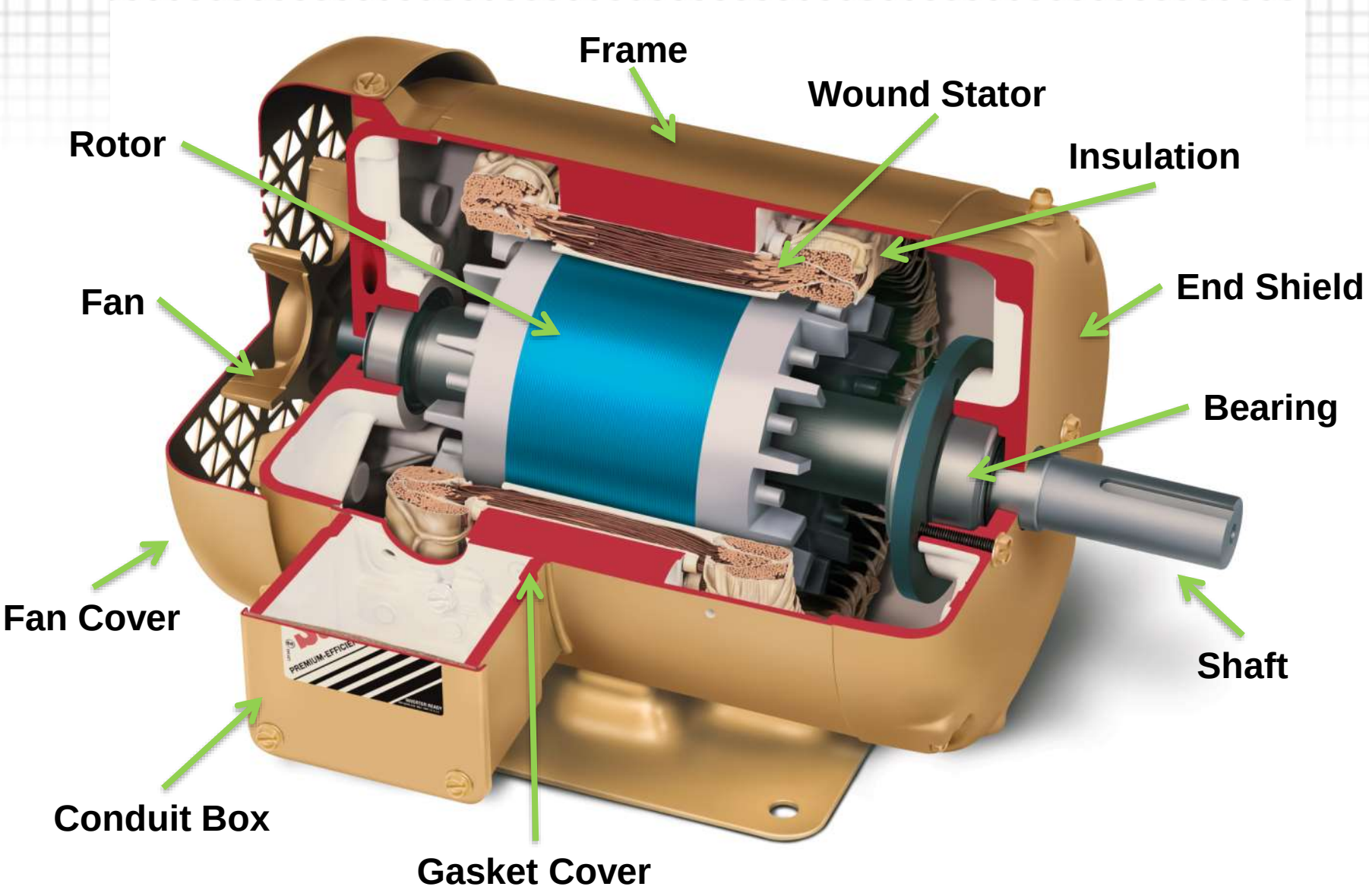
Wisconsin Healthcare Engineering Association

Technical Training 11/10/22

AC motor training

JMB & ASSOCIATES

AC Motor Components

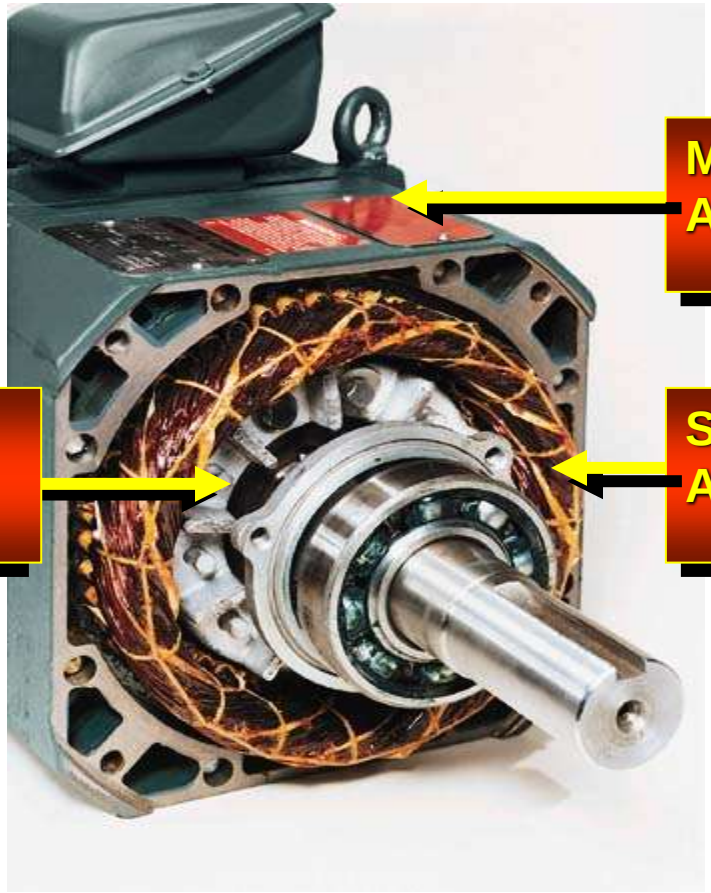


Two Basic Parts of any AC Motor

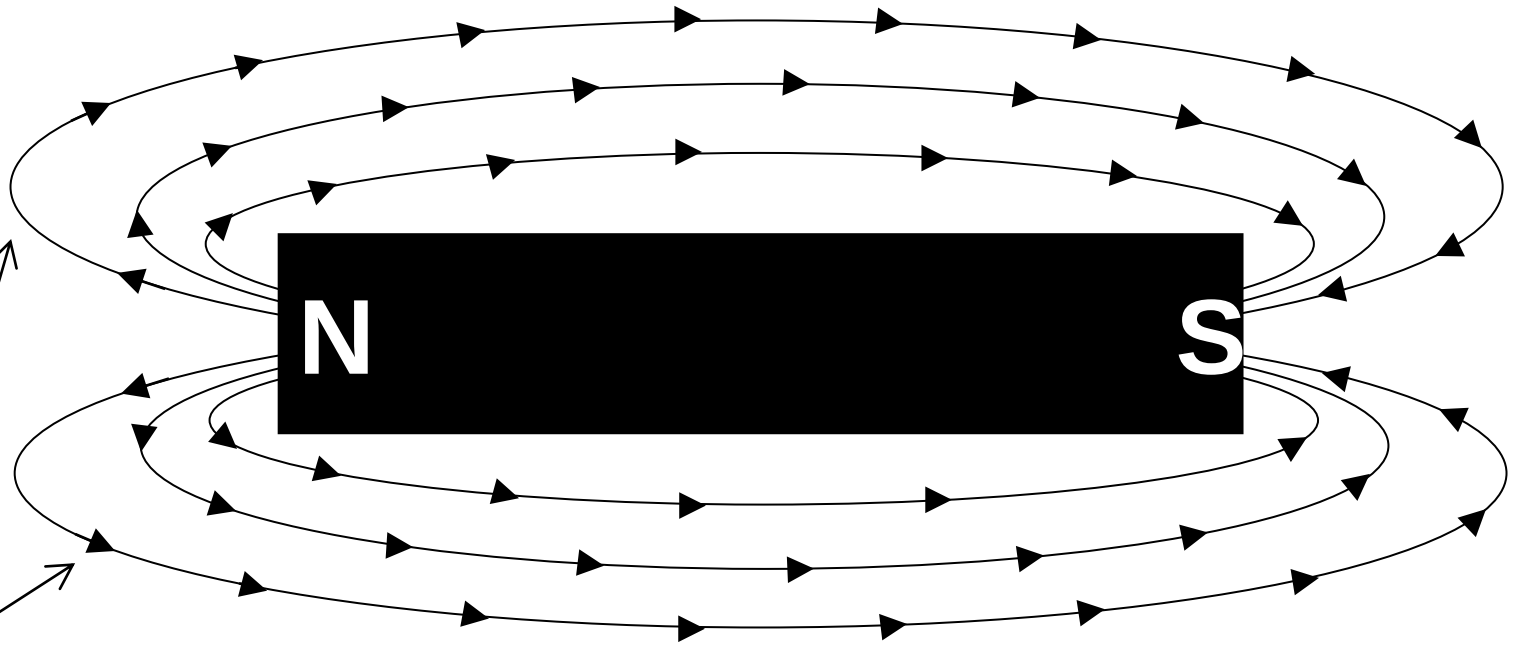
- Stator
  - Winding in electrical steel
  - Pressed into the frame of motor
  - Not mechanically connected to the load

- Rotor and Shaft
  - Rotating unit mounted on bearings
  - Provides mechanical power transmission
  - Mechanically connected to the load

AC MOTOR CONSTRUCTION

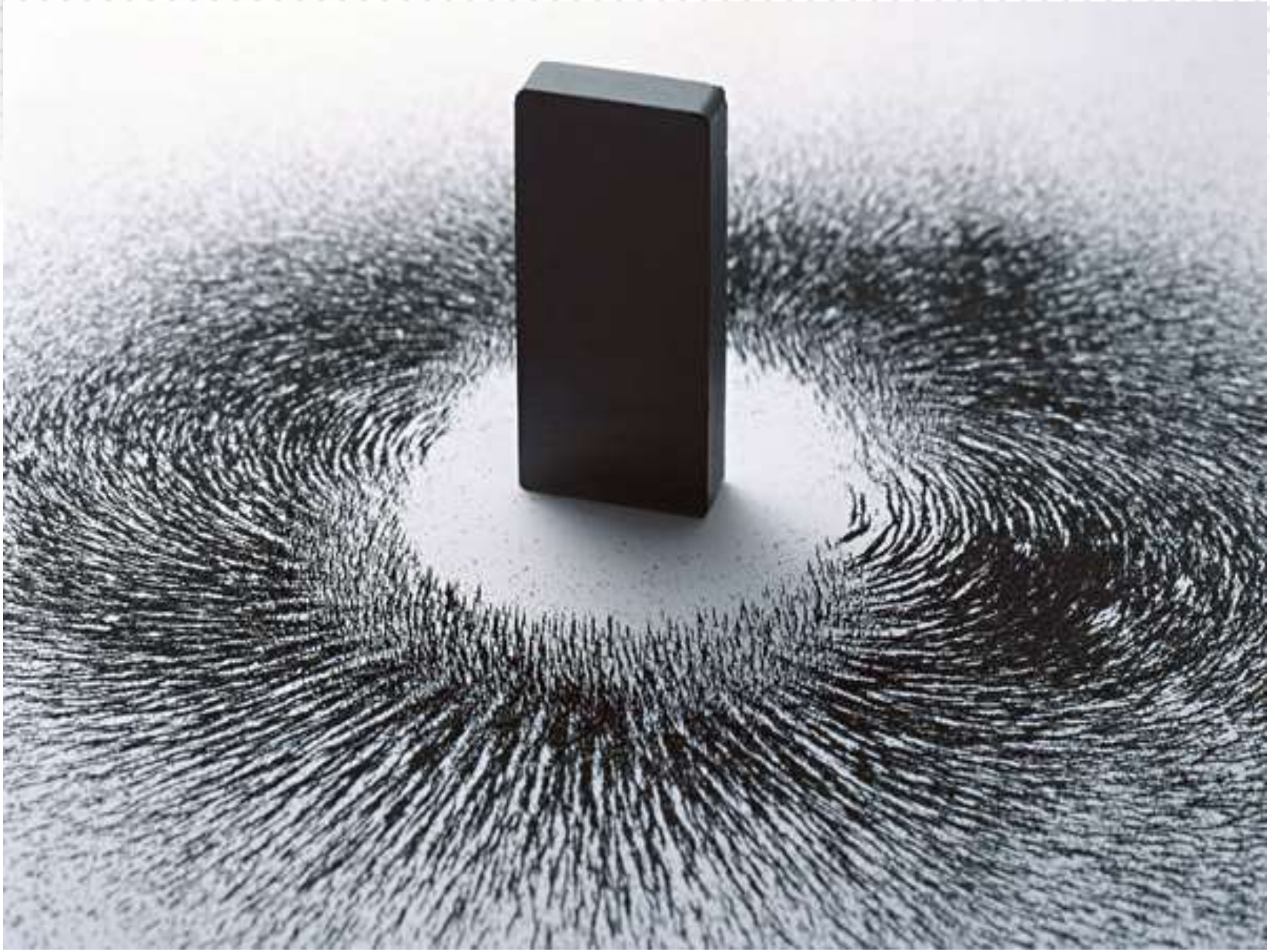


Bar Magnet



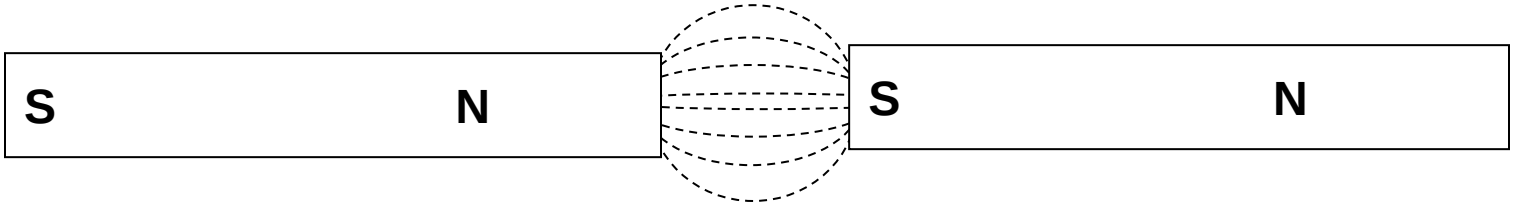
Lines of Flux

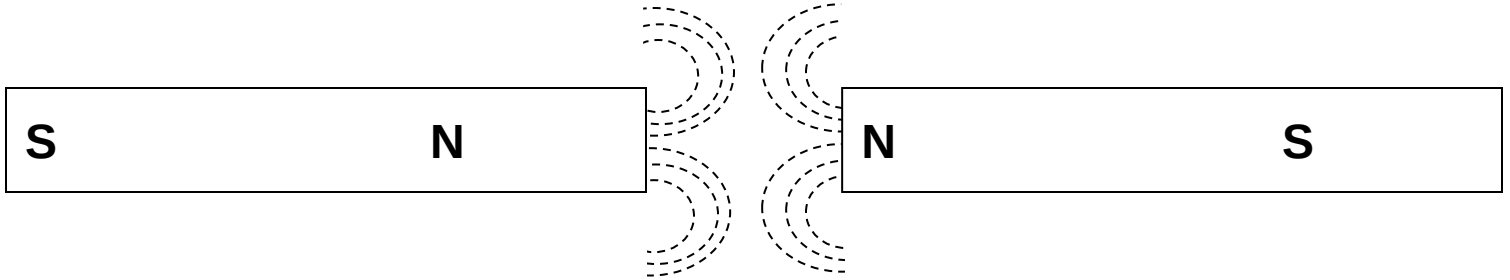
Flux Density =
# of Flux Lines / per unit area



Magnetic Poles

Unlike Poles Attract

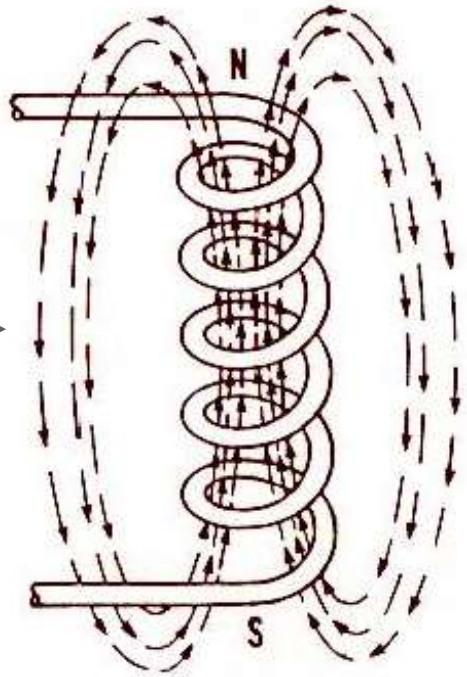




Like Poles Repel

Electromagnetic Coil

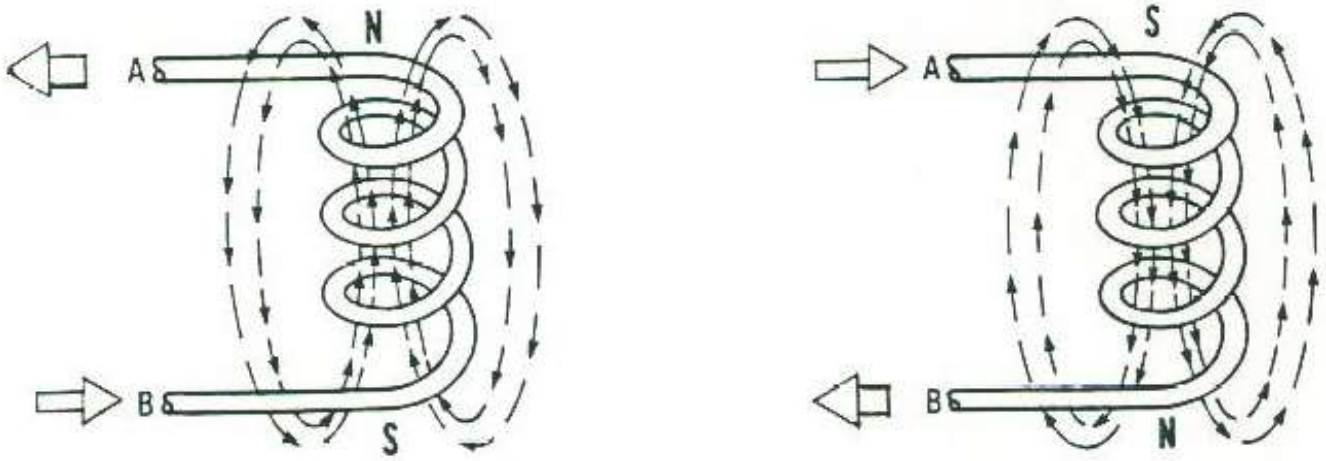
Lines of Flux



Flux Density Dependant on:

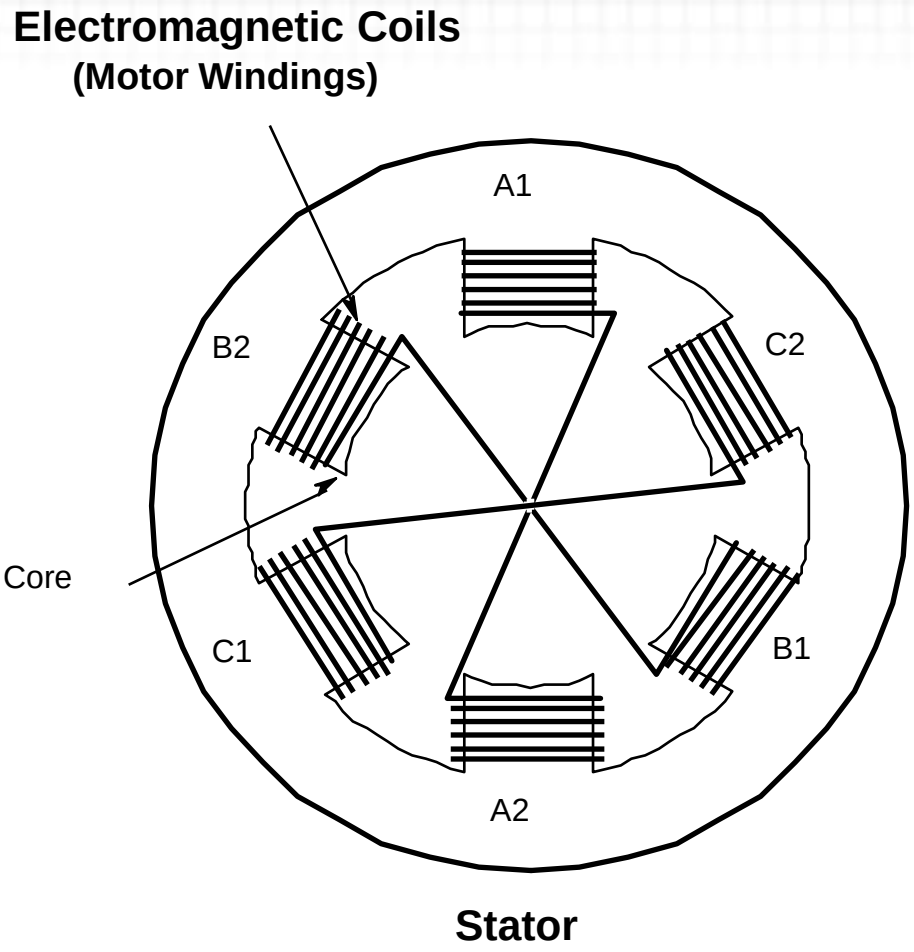
- Current
- # of Coils
- Core Material

Electo-magnetic Coils



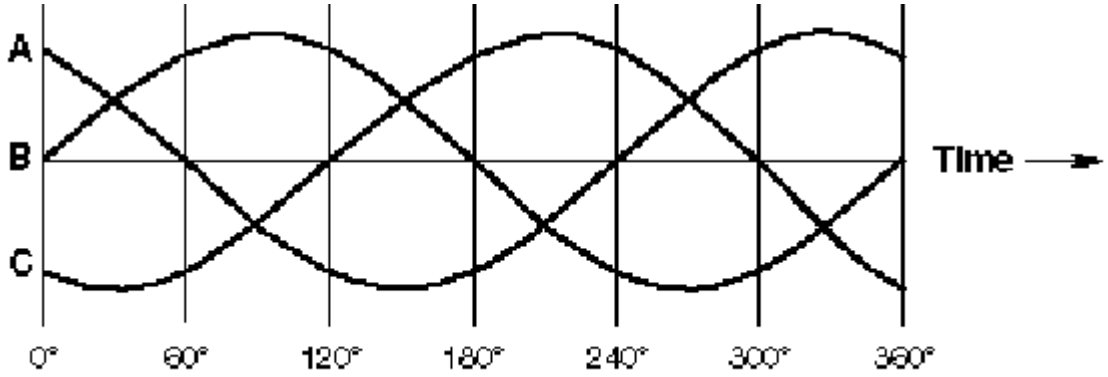
Direction of Current determines Magnetic Polarity

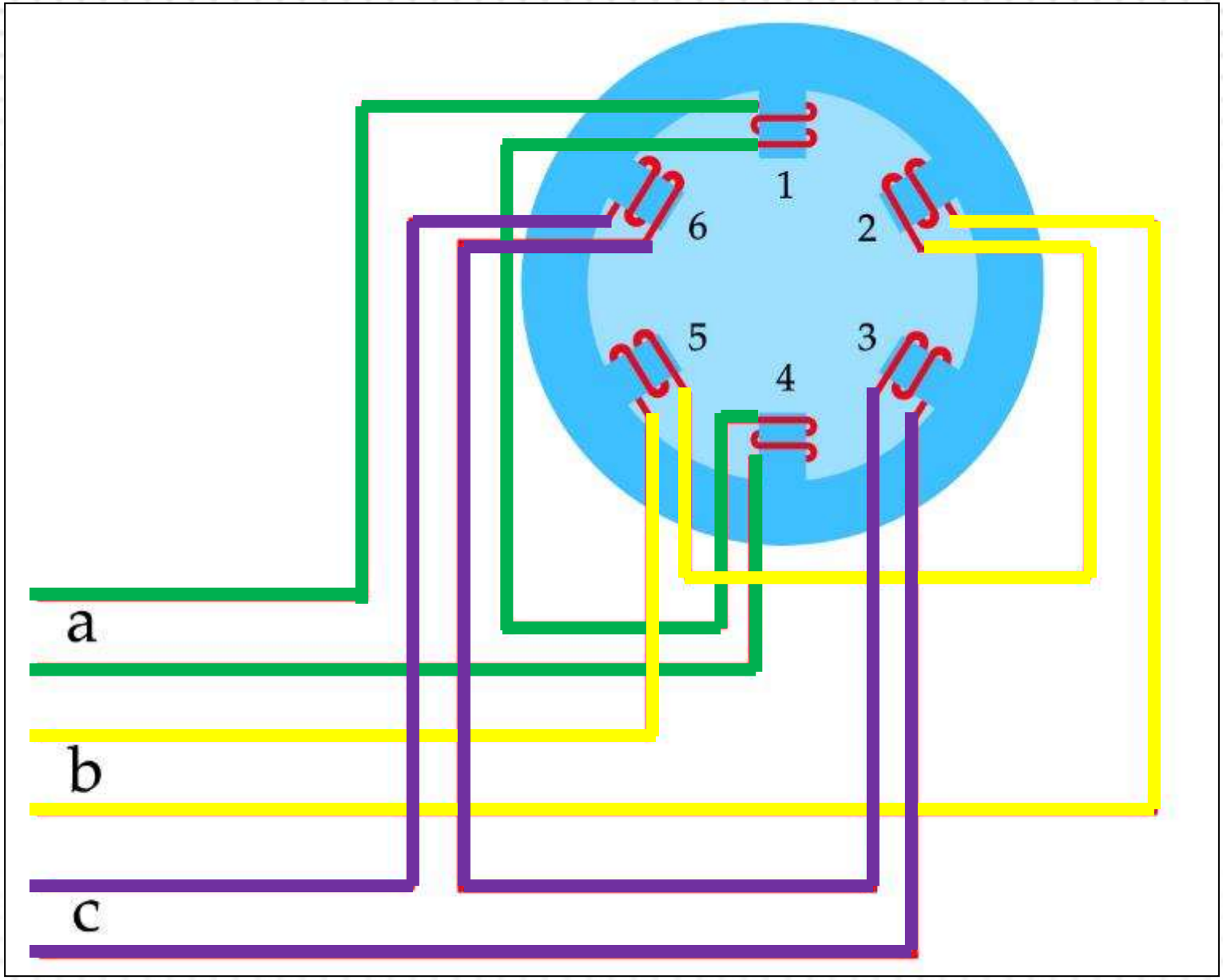
Stator Windings



3 Phase AC Power

Each phase is displace 120°




1
2
3
4
5
6
a
b
c

Synchronous Speed

Synchronous Speed - The speed of the stator's magnetic field rotation

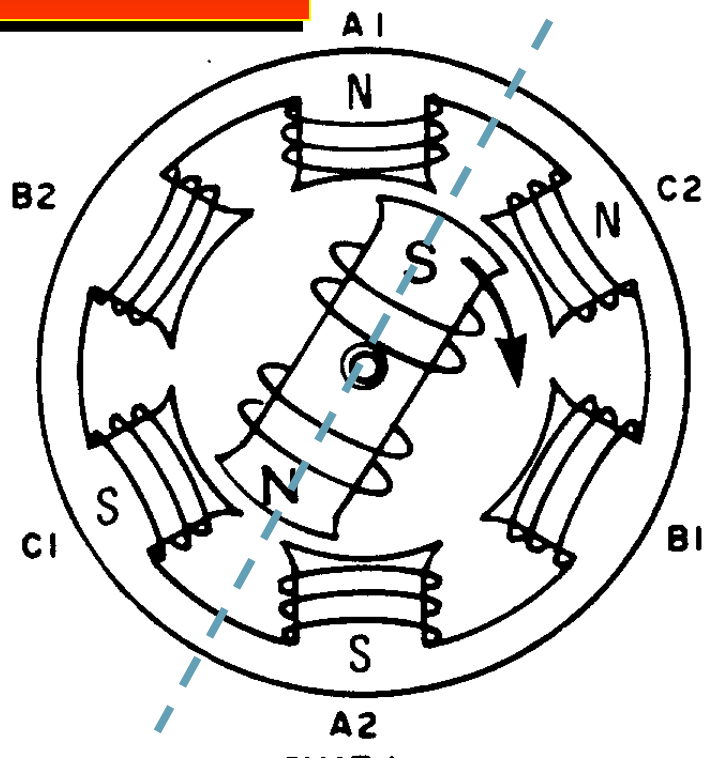
$$RPM = \frac{120 \times F}{P}$$

F is Applied Frequency

P is Number of Poles per Phase

AC Motor Basics

2 Pole Motor



Motor RPM is equal to:

$$\frac{120 * \text{Frequency}}{\text{\# Motor Poles}}$$

Note that Frequency is the only variable to affect motor speed

Rotating Magnetic Field of a 2 Pole AC Induction Motor

Synchronous Speed

$$\text{Synchronous Speed (60 Hz)} = \frac{7200}{\text{\# of Poles}}$$

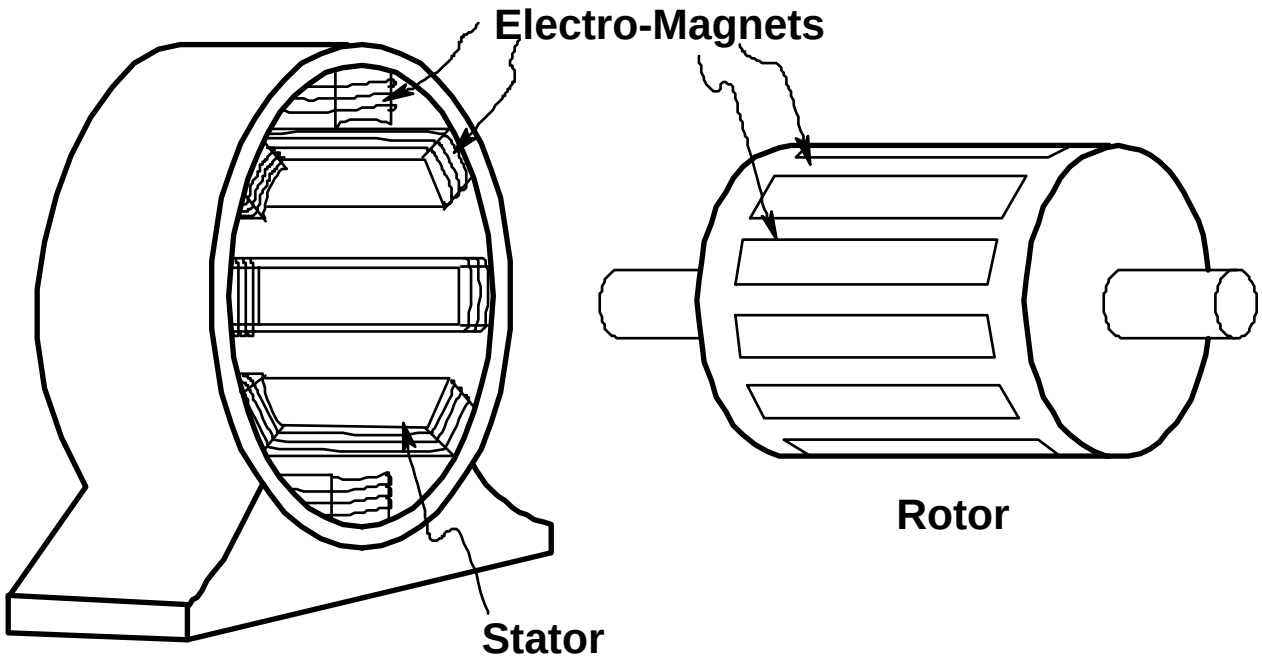
2 pole AC motor = 3600 rpm

4 pole AC motor = 1800 rpm

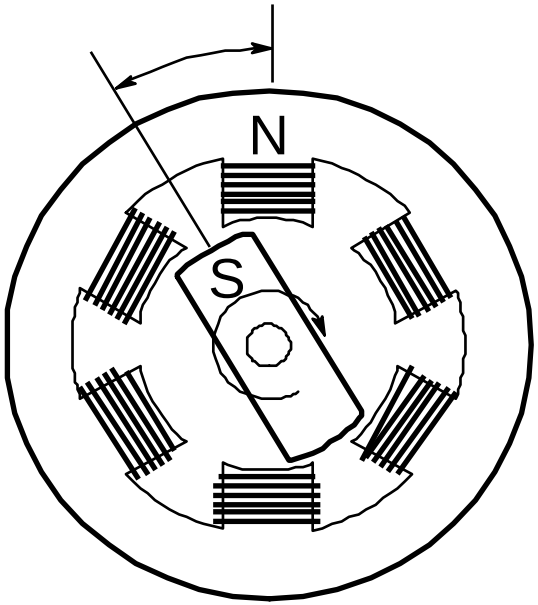
6 pole AC motor = 1200 rpm

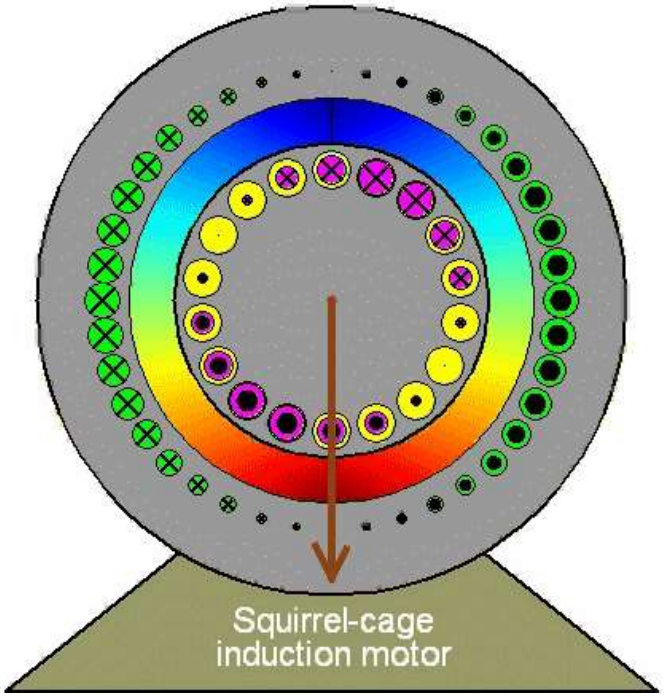
8 pole AC motor = 900 rpm

Parts of an AC Motor



Motor Slip

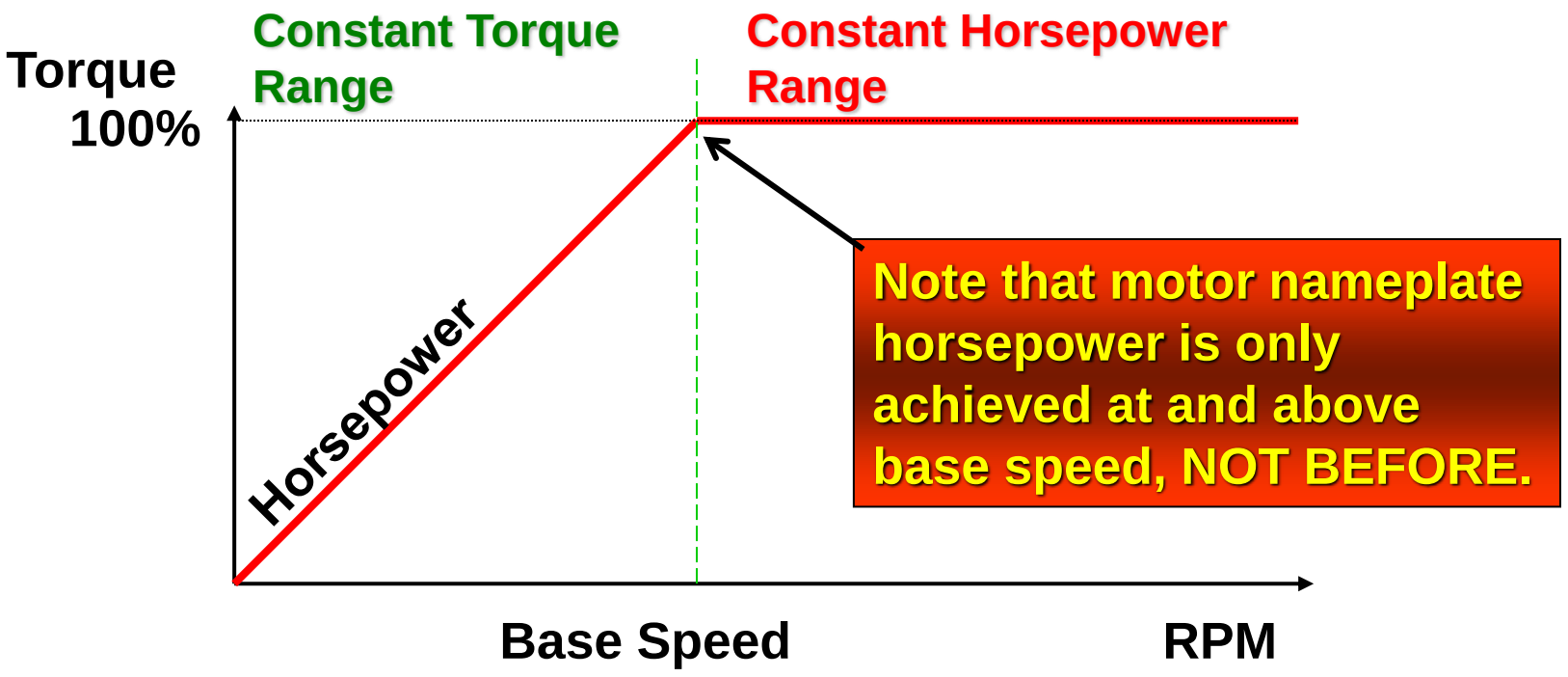




Slip Speed = Synchronous Speed – Rotor Speed

Motor nameplate Horsepower is achieved at Base RPM:

HP = Torque * Speed / 5252



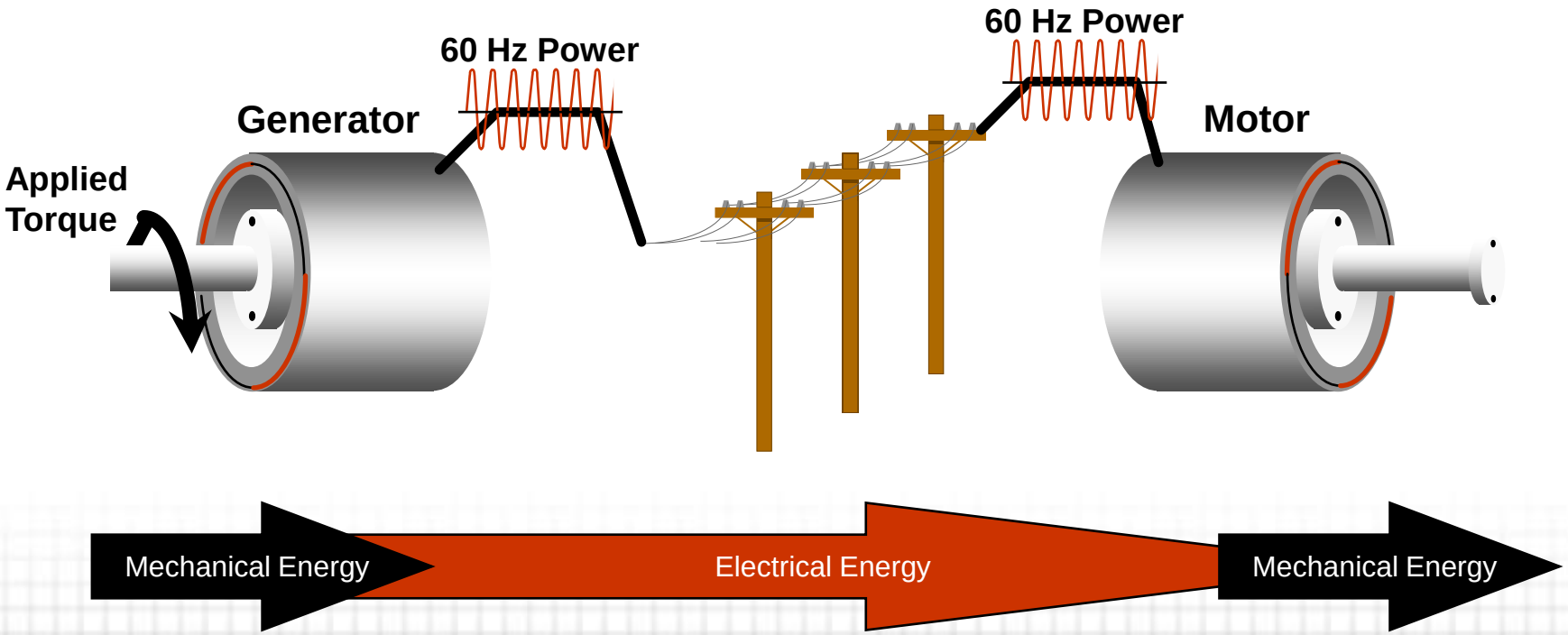
Review of How Motor Works

- Motor converts Electrical Energy to Rotating Mechanical Energy
- Coils placement in motor creates rotating, magnetic field in stator
- Rotating magnetic field cuts rotor bar and induces current in rotor
- Rotor current creates magnetic field on rotor
- Attraction of rotor to stator creates torque and, hence, horsepower

Motors Fundamentals

- Fundamental Concept #2-

  A Motor Is Basically A Generator Running Backwards.




BALDOR • RELIANCE
SEVERE DUTY XT
CLASS I – DIV 2 –
CLASS I – ZONE 2 –
GROUPS A,B,C,D
GROUPS IIA,IIB,IIC
CAT. NO. XT3156T
54
I.P.
SPEC. 10–0001432
TEFC
ENCL
FRAME 284T
H.P. 15
VOLTS 230/460
P.F. 77 %
BASE
F.L. AMPS 38.8/19.4
40C AMB–CONT
RATING
R.P.M. 1180
USABLE @ 208V 42
AMPS
HZ. 60
PH. 3
CLASS F
SER. F. 1.15
DES. B
SL HZ 1
NEMA NOM. EFF. 91.7
WK2 6.61
LB FT2
BEARINGS DE 6311
ODE 6309
NEMA Premium
MAG.CUR. 17.2/8.6
INVERTER DUTY @ 1.0 S.F.
INV TYPE PWM
CHP
60 TO 90 HZ
T3C
T.CODE
CT 1 TO 60 HZ
VT 0 TO 60 HZ
CC 010A
SN
USABLE AT 50HZ 10HP 190/380V
32/16A SF1.0
C US
Energy Verified
MC 183051
ABB MOTORS AND MECHANICAL INC. FT. SMITH, AR. MFG. IN U.S.A.
NP4163L

Testing motors

- Safety is critical!
- Follow proper safety protocols for lockout / tagout
- PPE when testing
- Mechanical Hazards too!
  - Stack effect
  - Supply / return

Testing motors

- Testing motors is mechanical and electrical in nature

  - Mechanical
    - Does the shaft spin freely
    - Any grinding noise
    - Is the shaft straight
    - Belt slipping / too tight
  - Electrical
    - Connections!
      - Use your eyes and nose
    - Internal connections
      - Voltage
      - Delta-Wye

Motor Testing

- **Test for Balanced voltage**
  - Phase to phase (across the line systems)
  - If VFD controlled, disconnect motor wires, run to 60Hz in Hand and measure phase to phase. Regardless of value, it need to be balanced to + or – 2VAC max
- **Test for balanced current**
  - A 1% voltage unbalance causes 6-10% current unbalance
  - Poor connections can cause unbalanced current

Motor Testing

- Ohm test with motor disconnected (motor disconnect?)
  - Acceptable values change with HP (typ .3 to 2 ohms)
  - Phase to phase should be the same

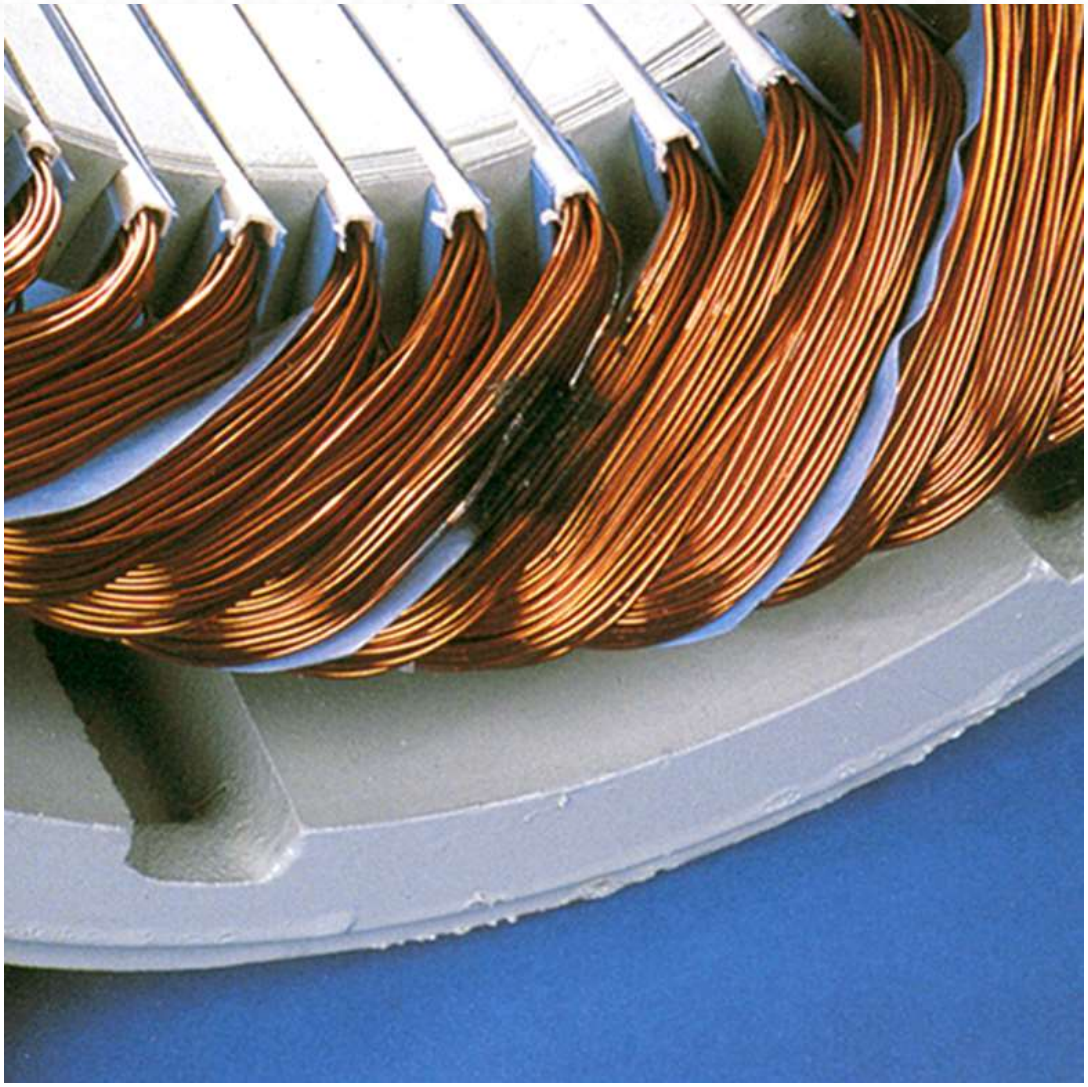
- High voltage insulation test (megger) phase to **ground**
  - Always use 1,000V (especially if VFD controlled)
  - Test one phase to ground
  - Acceptable values change
    - With HP (higher number with higher HP's)
    - With temperature (higher temp, lower reading)
    - With humidity (will have a lower reading)
    - Common "good" number is 10Meg or higher (I like 100M)

Motor Failure Modes

(single phased)

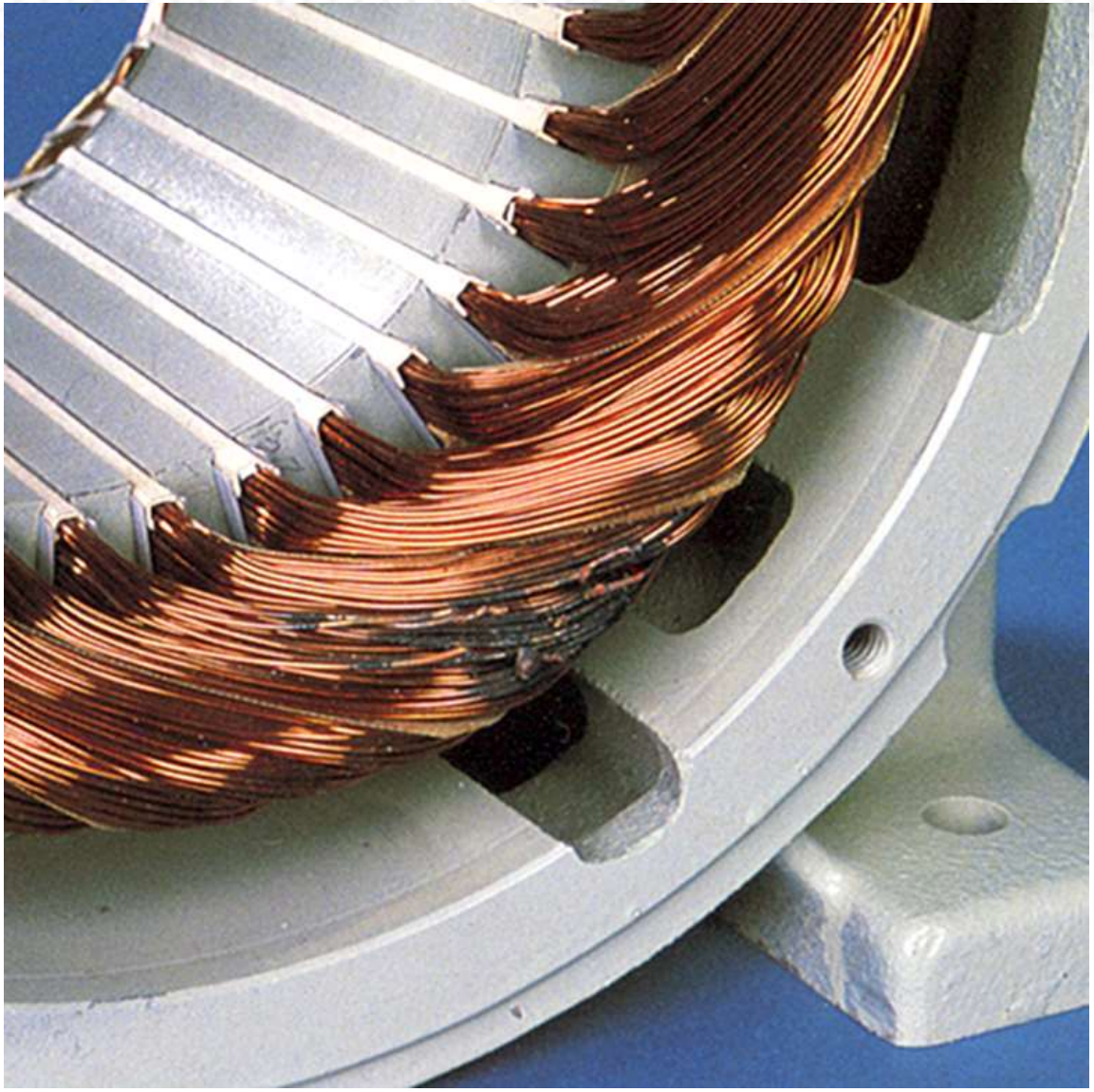
Motor Failure Modes

(phase to phase short (VFD induced))



Motor Failure Modes

(Turn to Turn (VFD/Abrasion))

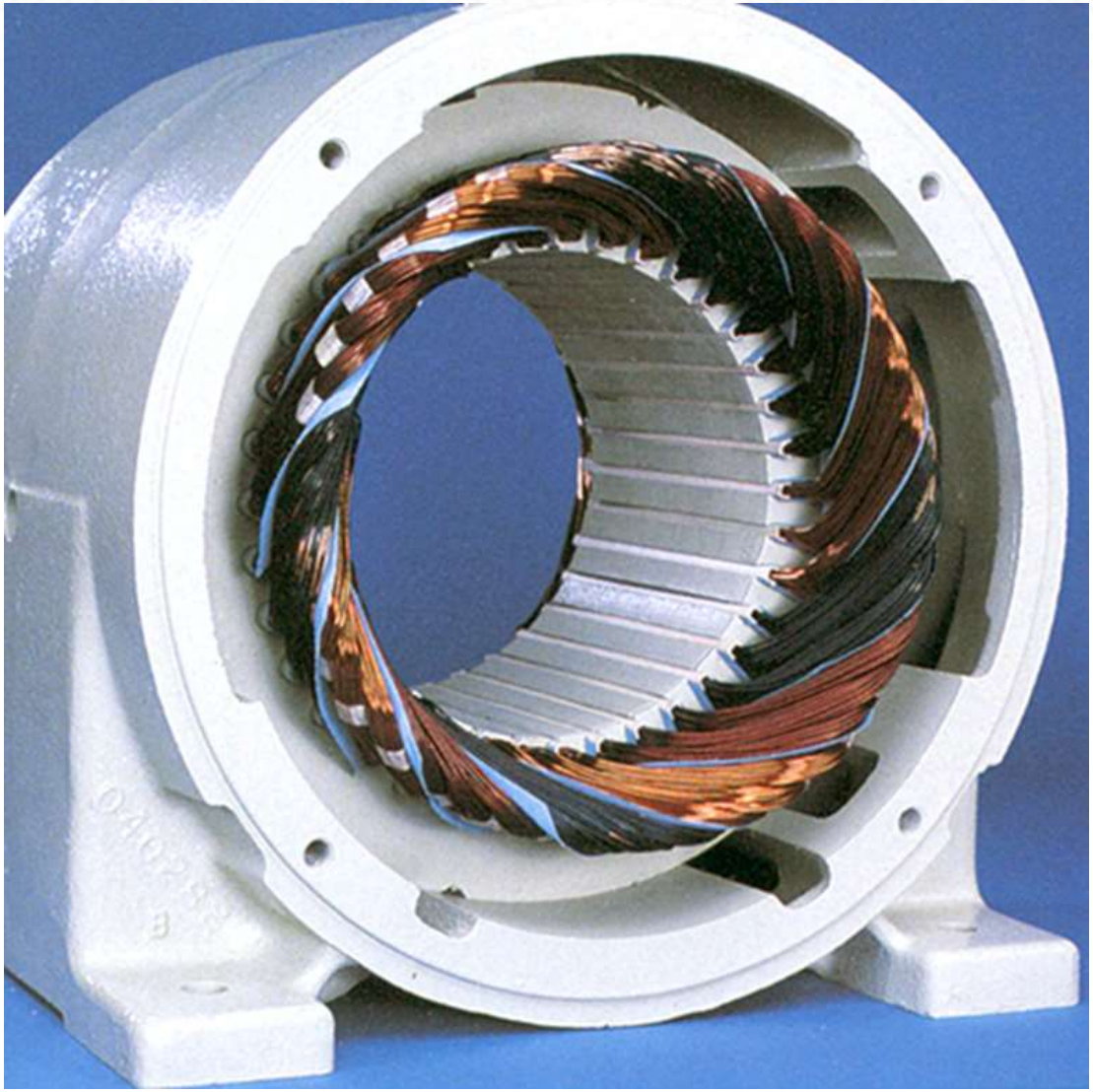


Motor Failure Modes

(Shorted Coil (vibration, VFD, Transient))

Motor Failure Modes

(Unbalanced voltage)



Motor Failure Modes

(Overload)

MINIMUM SPEED on VFD's

Shaft Grounding for VFD Controlled Motors

Maintenance – clean
Large HP – front and back

Golden nuggets

- NEMA MG1, Part 31 for VFD driven motors
  - Add shaft grounding, coated bearings or ceramic bearings)
- Don’t use service factor amps with VFD’s (per NEMA!)
- Three phase, PLUS GROUND
- Sealed vs grease bearings
  - (Did you know sealed bearings are only good for **4-5 years** continuous use)
    - ECM motors, small HP, etc
  - Grease, but do NOT over grease!
- “Over-speeding” of motors
  - Bearings and balance

One more slide!

- **P**ermanent **M**agnet motors
  - Several variations (low RPM)
  - Requires VFD
- **E**lectronically **C**ommutated **M**otors
  - Nano drive / motor combination
    - Typically sold with fan as package
- Switched Reluctance Motors
  - Requires VFD
- Many variations!
  - Even standard induction motors (non-standard HP’s)
  - Ownership issues

Thank You!

JMB
& ASSOCIATES

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