

ECET 211 Electric Machines & Controls

Lecture 2-3 (Part 3 of 3)

Symbols and Drawing for Electric Motor Control Systems

Text Book: Chapter 2. Understanding Electrical Drawings, Electric Motors and Control Systems, by Frank D. Petruzella, published by McGraw Hill, 2015.

Paul I-Hai Lin, Professor of Electrical and Computer Engineering Technology
P.E. states of Indiana & California
Dept. of Computer, Electrical and Information Technology
Purdue University Fort Wayne Campus

Prof. Paul Lin

1

2. Symbols and Drawings for Electric Motor Control Systems

- Chapter 2. Understanding Electrical Drawings
 - Part 1. Symbols-Abbreviations-Ladder Diagram
 - Part 2. Wiring – Single – Block Diagrams
 - Part 3. Motor Terminal Connections
 - **Part 4. Motor Nameplates and Terminology**
 - **Part 5. Manual and Magnetic Motor Starter**

Prof. Paul Lin

2

Part 4. Motor Nameplate and Terminology

■ NEC (National Electrical Code) Required Nameplate Information

- Motor Manufacturer
- Voltage Rating
- Current Rating
- Line Frequency
- Phase Rating
- Motor Speed
- Ambient Temperature
- Temperature Rise
- Insulation Class
- Duty Cycle
- Horsepower Rating
- Code Letter
- Design Letter

Copyright © McGraw-Hill Education.
Permission required for reproduction or display.

The diagram shows a motor nameplate with the following fields:

- Manufacturer
- AC Motor
- Thermally Protected Type
- Style
- Serial
- Frame
- Type
- HP
- Ph
- Housing
- RPM
- Cycles
- S.F. Amps
- Volts
- Amps
- Code
- Deg C Rise
- Hours

Prof. Paul Lin

3

Voltage Rating

■ NEMA standard motor voltages:

- Single-phase motors: 115, 230, 115/230, 277, 460 and 230/460 V
- Three-phase motor up to 125 HP: 208, 230, 460, 230/460, 575, 2300, and 4000 V
- Three-phase motor above 125 HP: 460, 575, 2300, and 4000 V

Nominal System Voltage	Nameplate Voltage
120 V	115 V
208 V	200 V
240 V	230 V
480 V	460 V
600 V	575 V
2,400 V	2,300 V
4,100 V	4,000 V
6,900 V	6,600 V

Prof. Paul Lin

4

NEC Requirement Nameplate Information

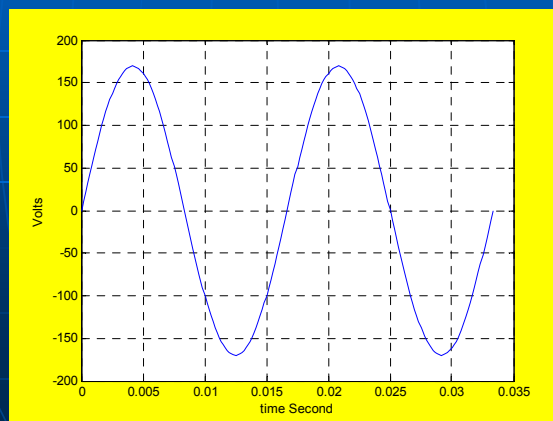
- **Current Rating**
 - Current unit: AMPs or A
 - Nameplate rating: full-load current at rated load, rated voltage, and rated frequency
 - Not fully loaded – draw less current
 - Overloaded – draw more than the rated current
 - Dual voltage motors => Dual current rating
 - 115/230 V, 7.4/3.7 A

Prof. Paul Lin

5

NEC Requirement Nameplate Information

- **Frequency (Hertz, Hz)**
 - 60 Hz – in the U.S
 - 50 Hz – in other countries
- A MATLAB voltage plot: nominal system voltage 120V, peak voltage 170V; $f = 60\text{Hz}$, $T = 1/60 = 16.7\text{ ms}$



6

NEC Required Nameplate Information

- Insulation Class

NEMA classification	Maximum operating temperature
A	221 °F (105°C)
B	266 °F (130°C)
F	311 °F (155°C)
H	356 °F (180°C)

- Duty Cycle (DUTY or TIME rating)

- CONT (Continuous) or INTR (Intermittent-duty)

- Horsepower Rating

- HP rating: 1 HP = 746 Watt
- NEMA established standard motor HP rating: 1 HP to 450 HP
- kW rating: International Electrotechnical Commission (IEC)

Prof. Paul Lin

7

Code Letter (Lock-rotor codes)

- NEC Code Letter for the motor lock-rotor or starting current, kVA per nameplate HP
- Examples:
 - M rating allows for 10.0 to 11.9 kVA per 1 HP

Code	kVA/HP	Code	kVA/HP
A	0-3.14	L	9.0-9.99
B	3.15-3.54	M	10.0-11.19
C	3.55-3.99	N	11.2-12.49
D	4.0-4.99	P	12.5-13.99
E	4.5-4.99	R	14.0-15.99
F	5.0-5.99	S	16.0-17.99
G	5.6-6.29	T	18.0-19.99
H	6.3-7.09	U	20.0-22.39
J	7.1-7.99	V	22.4 & Up
K	8.0-8.99		

Prof. Paul Lin

8

Design Letter

- Five standard designs for polyphase induction motors
 - A, B, C, D, E
 - Indication of the shape of the motor's torque-speed curve
 - Design B
 - Standard industrial-type motor which has
 - reasonable starting torque with moderate current and good overall performance

Prof. Paul Lin

9

Optional Nameplate Information

- Service Factor (SF) – overload factor
 - 1.0, 1.15, and 1.25
 - 10 HP motor, SF 1.25 => 12.5 HP overload occasionally
- Motor Enclosure
- Frame Size
- Efficiency
- Power Factor
- Thermal Protection
- Connection Diagram

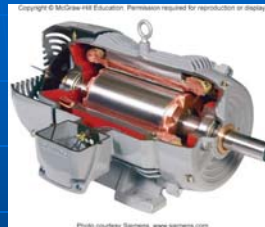


Figure 2-40 Totally enclosed motor

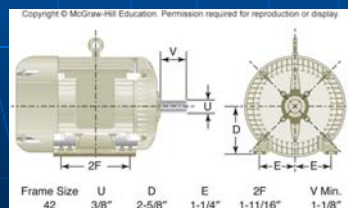


Figure 2-41 Typical NEMA frame and dimensions

Prof. Paul Lin

10

Optional Nameplate Information

- **Efficiency**
 - $\eta = (\text{Power output} / \text{Power input}) * 100\%$
- **Power Factor (P.F.)**
 - Motor – Inductive Load, PF in the range of 0.5 to 0.95
 - P.F. = $\cos\theta$; the angle θ between voltage and current
 - $P = V * I * \text{PF}$ (Single phase)
 - $P = 1.732 * V * I * \text{PF}$ (Three phase)
- **Thermal Protection**
- **Connection Diagram**

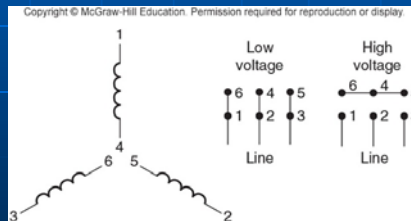


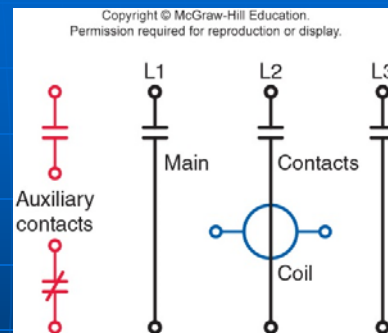
Figure 2-42 Typical dual-voltage motor connection diagram

Prof. Paul Lin

11

Guide to Motor Terminology

- Across-the-line
- Automatic starter
- Auxiliary contact
- Contactor
- Jog
- Lock-rotor-current
- Low-voltage protection (LVP)
- Low-voltage release (LVR)
- Magnetic contactor
- Multispeed starter



Prof. Paul Lin

12

Guide to Motor Terminology

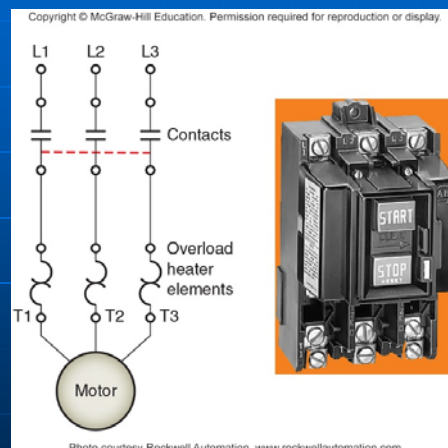
- Overload relay
- Plugging
- Push button
- Reduced voltage starter
- Relay
- Remote control
- Selector switch
- Slip
- Starter
- Timer

Prof. Paul Lin

13

Part 5. Manual and Magnetic Motor Starters

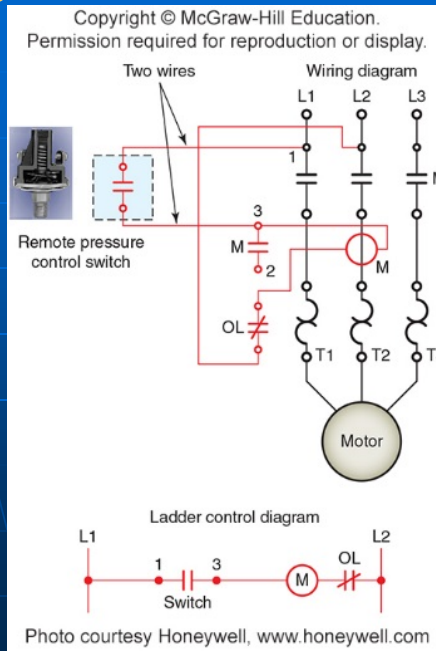
- Figure 2-45 Manual motor starter
 - Motor Control Circuit with manual **“START”** and **“STOP”** button



Prof. Paul Lin

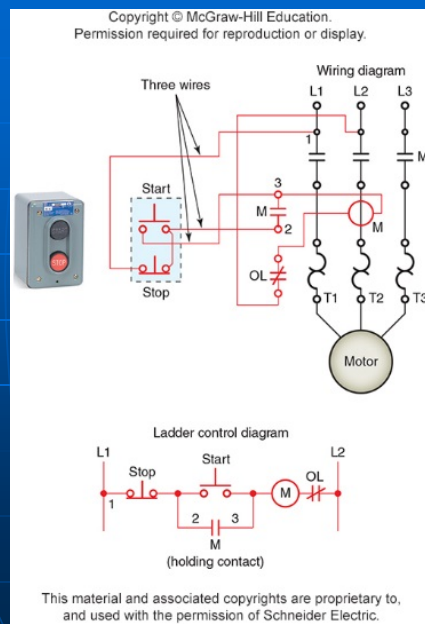
14

Figure 2-47 Two-wire control circuit



15

Figure 2-48 Three-wire control circuit



16

Summary & Conclusion

Questions?

Contact Prof. Lin

- Email: pilin@purdue.edu, lin@ipfw.edu