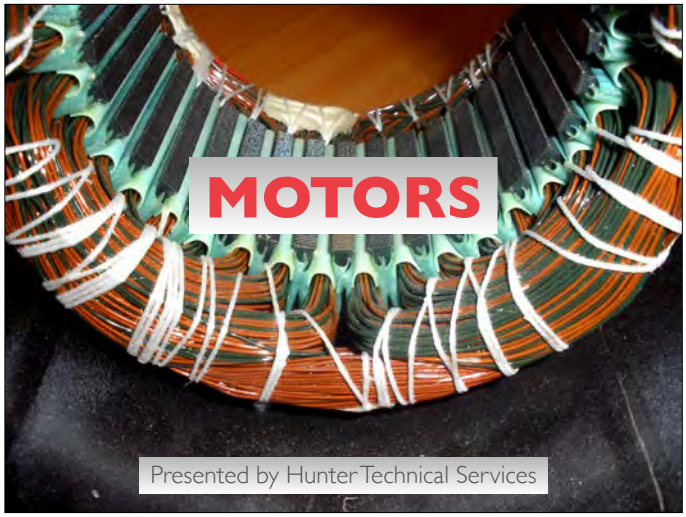
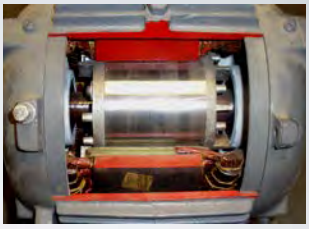
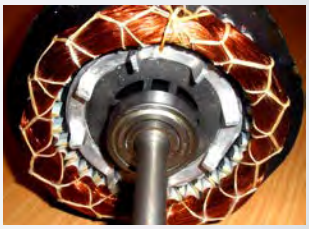


1





2

NEC REFERENCES

All material in the National Electrical Code is copyrighted by the NFPA, and the terms NFPA, NEC, and National Electrical Code are trademarks of the NFPA.

The language and references in today's presentation are not identical to the NEC. Always refer to the adopted version of the NEC for exact language.

3

MOTORS ARE UNIQUE

Motors are an inductive load. Items that produce motion are commonly inductive.

As such, they react to power differently than resistive loads.

4

MOTORS ARE UNIQUE

Power consumption for resistive loads reduces as we have voltage drop, or low voltage conditions.

Example: 100 W incandescent lamp will only produce 70 watts of light if the 120 volts drops down to 100 volts.

5

MOTORS ARE UNIQUE

Resistive examples continued:

A 3.2 KW oven rated for 240 volts will only produce 2.4 KW of heat at 208 volts.

So - if the voltage drops, the resistive load produces less.

6

MOTORS ARE UNIQUE

Resistive examples continued:

7

MOTORS ARE UNIQUE

Inductive loads do not reduce their production. They instead work harder to produce what they are rated to produce.

For example:

A 2HP motor is rated to produce 2HP worth of work.

It does this by drawing a certain amount of current at a rated voltage.

8

MOTORS ARE UNIQUE

Another characteristic of inductive loads is that they have very large inrush currents.

Motors will typically draw at least 6 times their rated current during startup.

This value could be higher depending on the equipment they are connected to.

The duration of this overload also depends on the load on the motor.

9

10

MOTORS ARE UNIQUE

A 2HP single-phase motor is rated to draw 12 amps at 230 volts.

It will draw 13.2 amps at 208 volts, 13.8 at 200 volts and, lastly, 24 amps at 120 volts.

So, as the voltage drops, the current goes up.

11

100 HP
1800 RPM
FLC
@230 = 248A
@460 = 124A

12

MOTORS ARE UNIQUE

When we run a motor that is rated for a certain voltage at a lower voltage, it will draw more current (amps) than it should.

What is the problem with this?

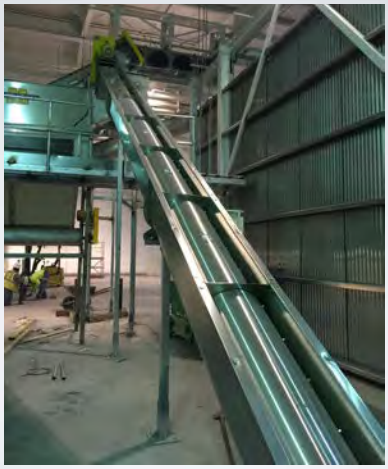
13

MOTORS ARE UNIQUE

When you have a device that is designed for a certain mechanical load, the motor will run just fine.

Let's say we have a conveyor that is intended to move 1000 pounds of material at the designed HP. If we put 1500 pounds of load on it, the motor still tries to move the product. It compensates for the extra load by drawing more current.

14



15

MOTORS ARE UNIQUE

So, when we run a motor that is rated for a certain voltage at a lesser voltage, or we add additional work for it, the motor will draw more current (amps) than it should.

What is the issue with this?

16

MOTORS ARE UNIQUE

Rated current, rated voltage

Nice and cool at rated temp

Low voltage

high amperage

Over heating, burning up

17

MOTORS ARE UNIQUE

To prevent damage to the motor from over heating due to overcurrent issues, we need to provide protection for motors that is above and beyond the normal circuit protection found in other sections of the code.

18

MOTORS ARE UNIQUE

Now that we understand some of the unique characteristics of motors, let's look at how we properly install them per the code for long-lasting and safe installations.

19

ARTICLE 430 SCOPE

430.1 Scope. This article covers

- motors
- motor branch-circuit and feeder conductors and their protection
- motor overload protection
- motor control circuits
- motor controllers
- motor control centers

20

SCOPE CONTINUED

Article 430 does not apply to motors that operate in refrigerant such as hermetic refrigerant motor compressors

Article 440 applies to those motors and equipment that incorporates those types of motors

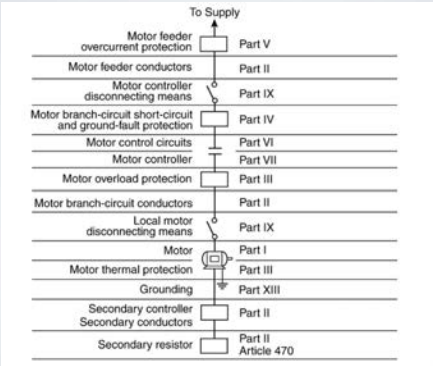
Article 422 covers appliances that could include both standard motors and hermetic refrigerant compressor motors

21

22

ARTICLE 430 OUTLINE

FIGURE 430.1 (PART)



Page 344

23

GENERAL USE OF NEC ARTICLE 430

- Key requirements for general use of NEC Article 430:
  - General Motor Application (Table Values) 430.6
  - Conductor Sizing (Single Motor) 430.22
  - Overload Protection 430.32
  - BC Short-Circuit/Ground-Fault Protection 430.52
  - Disconnects
    - Location 430.102
    - Type 430.109
    - Rating and Interrupting Capacity 430.110
  - Tables 430.247 through 430.251(A) and (B)

24

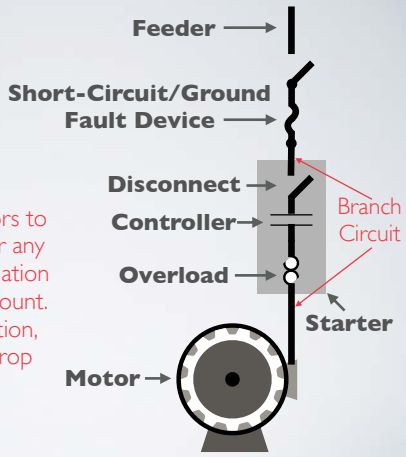
UNIQUE TERMS FOR MOTORS

- Controller
- Control Circuit
- Overload protection
- Short-circuit, Ground-fault protection
- Overcurrent Protection

25

TERMINOLOGY RELATED TO MOTORS AND THE NEC

Branch Circuit Conductors to be sized per 430.22, after any other conditions of installation have been taken into account. (ie. temperature correction, conductor fill, voltage drop etc.)



26

CONTROLLER

Controller, Motor. (Motor Controller)

Any switch or device that is normally used to start and stop a motor by making and breaking the motor circuit current. (CMP-11)

27

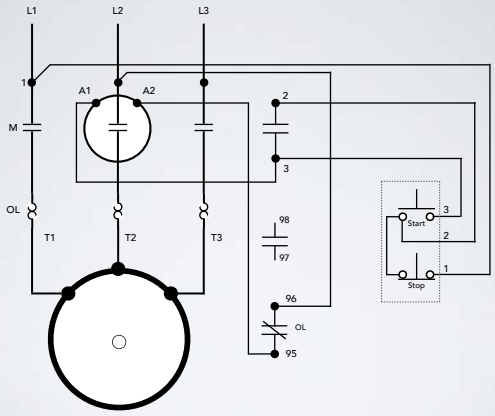
28

CONTROL CIRCUIT

Control Circuit.

The circuit of a control apparatus or system that carries the electric signals directing the performance of the controller but does not carry the main power current. (CMP-11)

29



30

MOTOR CALCULATIONS

430.6(A)(1) Table Values.

For most motors, instead of the nameplate value, the values given in Table 430.247, Table 430.248, Table 430.249, and Table 430.250 must be used instead of the actual current rating marked on the motor nameplate to determine the following:

(1) Ampacity of conductors

(2) Current ratings of switches

(3) Current ratings of branch-circuit short-circuit and ground-fault protection

31

MOTOR CALCULATIONS

(2) Nameplate Values. The motor nameplate current ratings shall be used to determine the values for the following:

(1) Separate motor overload protection

(2) For motors built for low speeds (less than 1200 RPM), high torques, canned pumps, or multispeed motors, ...

(3) Large motors exceeding the values in Part XIV shall use the nameplate current rating for conductor sizing.

32

TABLE VALUES

- Part XIV of Article 430 - Ampacity Tables
  - Table 430.247 - FLA for DC Motors
  - Table 430.248 - FLA for AC Motors (Single-Phase)
  - Table 430.249 - FLA for AC Motors (Two-Phase)
  - Table 430.250 - FLA for AC Motors (Three-Phase)
  - Tables 430.251(A) and (B) - Locked-Rotor Tables

33

Table 430.247 Full-Load Current in Amperes, Direct Current Motors *(in part)*

The following values of full-load current* are for motors running at base speed

	Armature Voltage Ratings*					
HP	90 Volts	120 Volts	180 Volts	240 Volts	500 Volts	550 Volts
¼	4.0	3.1	2.0	1.6	—	—
⅓	5.2	4.1	2.6	2.0	—	—
½	6.8	5.4	3.4	2.7	—	—
¾	9.6	7.6	4.8	3.8	—	—
1	12.2	9.5	6.1	4.7	—	—
1½	—	13.2	8.3	6.6	—	—
2	—	17	10.8	8.5	—	—
3	—	25	16	12.2	—	—
5	—	40	27	20	—	—
7½	—	58	—	29	13.6	12.2
10	—	76	—	38	18	16
15	—	—	—	55	27	24
20	—	—	—	72	34	31
25	—	—	—	89	43	38
30	—	—	—	106	51	46
40	—	—	—	140	67	61
50	—	—	—	173	83	75
60	—	—	—	206	99	90
75	—	—	—	255	123	111

*These are average dc quantities

34

Table 430.248 Full-Load Current in Amperes, Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 volts.

HP	115 Volts	200 Volts	208 Volts	230 Volts
⅙	4.4	2.5	2.4	2.2
¼	5.8	3.3	3.2	2.9
⅓	7.2	4.1	4.0	3.6
½	9.8	5.6	5.4	4.9
¾	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8.0
1½	20	11.5	11.0	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17
5	56	32.2	30.8	28
7½	80	46.0	44.0	40
10	100	57.5	55.0	50

35

Table 430.250 Full-Load Currents in Amperes, Three-Phase Alternating-Current Motors *(in part)*

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 1000 volts.

	Induction-Type Squirrel Cage and Wound Rotor *(Amperes)*						
HP	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
½	4.4	2.5	2.4	2.2	1.1	0.9	—
¾	6.4	3.7	3.5	3.2	1.6	1.3	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—
1½	12.0	6.9	6.6	6.0	3.0	2.4	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—
3	—	11.0	10.6	9.6	4.8	3.9	—
5	—	17.5	16.7	15.2	7.6	6.1	—
7½	—	25.3	24.2	22	11	9	—
10	—	32.2	30.8	28	14	11	*16 (60)
15	—	48.3	46.2	42	21	17	*20 (75)
20	—	62.1	59.4	54	27	22	*26 (100)
25	—	78.2	74.8	68	34	27	*31 (125)
30	—	92	88	80	40	32	*37 (150)
40	—	120	114	104	52	41	*49 (200)

* *Values given under the 2300 Volt column are for 60, 75, 100, 125, 150, and 200 HP rated motors respectively.*

36

Table 430.250 Full-Load Currents in Amperes, Three-Phase Alternating-Current Motors *(in part)*

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 1000 volts.

	Synchronous-Type Utility Power Factor* *(Amperes)*			
HP	**230 Volts**	**460 Volts**	**575 Volts**	**2300 Volts**
10	—	—	—	—
15	—	—	—	—
20	—	—	—	—
25	53	26	21	—
30	63	32	26	—
40	83	41	33	—
50	104	52	42	—
60	123	61	49	12
75	155	78	62	15
100	202	101	81	20
125	253	126	101	25
150	302	151	121	30
200	400	201	161	40
250	—	—	—	—

** For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.*

37

ADDITIONAL LABEL INFORMATION, MOTOR DESIGN LETTERS

- Design letters indicate a motor's speed/torque characteristic curve (not to be confused with code letters)
- Code letters are "locked-rotor indicating code letters" (Code letters marked on motor nameplates to show motor input with locked rotor)
- Design letters reflect characteristics inherent in motor design, such as locked-rotor current, slip at rated load, and locked-rotor and breakdown torque
- See ANSI/NEMA MG 1 and IEEE 100 for information on motor design letter definitions

38

Table 430.7(B) Locked-Rotor Indicating Code Letters

Code Letter	Kilovolt-Amperes per Horsepower with Locked Rotor
A	0–3.14
B	3.15–3.54
C	3.55–3.99
D	4.0–4.49
E	4.5–4.99
F	5.0–5.59
G	5.6–6.29
H	6.3–7.09
J	7.1–7.99
K	8.0–8.99
L	9.0–9.99
M	10.0–11.19
N	11.2–12.49
P	12.5–13.99
R	14.0–15.99
S	16.0–17.99
T	18.0–19.99
U	20.0–22.39
V	22.4 and up

39

MOTOR LABEL ADDITIONAL INFORMATION, 430.7

Some to be aware of:

(13) A motor provided with a thermal protector complying with 430.32(A)(2) or (B)(2) must be marked "Thermally Protected." When rated 100 watts or less and complying with 430.32(B)(2), these motors are permitted to use the abbreviation marking "TP".

(15) Motors equipped with electrically powered condensation prevention heaters must be marked with the rated heater voltage, number of phases, and the rated power in watts.

40

MOTOR CIRCUIT CONDUCTORS

430.21 General. Part II specifies ampacities of conductors capable of carrying the motor current without overheating under the specified conditions.

Part II does not apply to motor circuits rated over 1000 volts.

41

MOTOR CIRCUIT CONDUCTORS

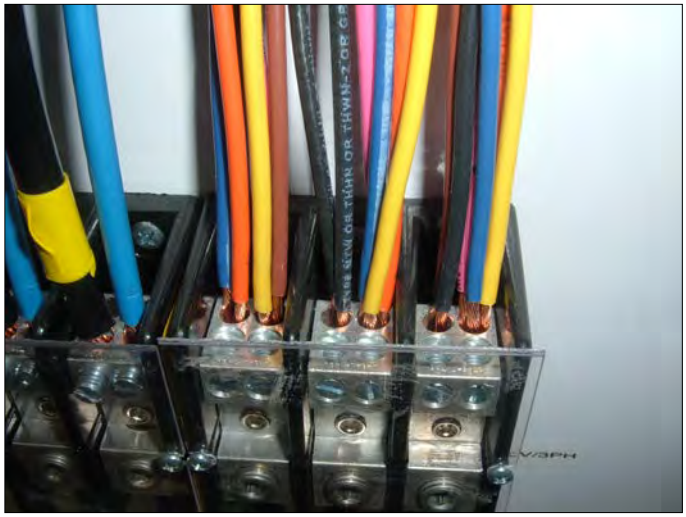
430.22 Single Motor. Conductors that supply a single motor used in a continuous duty application must have an ampacity not less than 125 percent of the motor full-load current rating, as determined by either:

1) 430.6(A)(1)

2) or not less than specified in 430.22(A) through (G)

Note: 430.6(A)(1) is the reference to the table values.

42



43

430.22 OTHER MOTORS

- Other provisions address these type of motors:
  - DC Motor rectified
  - Multi-speed Motors
  - Wye-start, Delta Run Motors
  - Part-winding Motors
  - Other Than continuous duty motors
  - Conductors for small motors

44

ONE TYPE TO MAKE SPECIAL NOTE OF ARE DUTY-CYCLE SERVICE MOTORS

Table 430.22(E) Duty-Cycle Service

Classification of Service	Nameplate Current Rating Percentages			
	5-Minute Rated Motor	15-Minute Rated Motor	30- & 60-Minute Rated Motor	Continuous Rated Motor
Short-time duty operating valves, raising or lowering rolls, etc.	110	120	150	—
Intermittent duty freight and passenger elevators, tool heads, pumps, drawbridges, turntables, etc. (for arc welders, see 630.11)	85	85	90	140
Periodic duty rolls, ore- and coal-handling machines, etc.	85	90	95	140
Varying duty	110	120	150	200

Note: Any motor application shall be considered as continuous duty unless the nature of the apparatus it drives is such that the motor will not operate continuously with load under any condition of use.

45

MOTOR CIRCUIT CONDUCTORS

When sizing our conductors what column do we use from Table 310.16?

Do we use the 60°C, 75°C or the 90°C column?

Where do we find that answer?

110.14(C)(1)(a)(4) informs us that:

For motors marked with design letters B, C, or D, conductors having an insulation rating of 75°C (167°F) or higher shall be permitted to be used, provided the ampacity of such conductors does not exceed the 75°C (167°F) ampacity.

46

MOTOR CIRCUIT CONDUCTORS

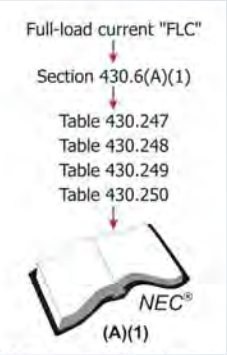
For all of our calculations we are going to assume we are using B, C, or D motors

Given a 20 HP three phase motor, operating at 480 volts, what size THWN conductor would we use for the branch circuit conductors?

47

MOTOR CONDUCTOR SIZING

- Always use the table values when figuring conductor size, short-circuit, ground-fault protection for motors.



48

Table 430.250 Full-Load Currents in Amperes, Three-Phase Alternating-Current Motors *(in part)*

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 1000 volts.

	Induction-Type Squirrel Cage and Wound Rotor *(Amperes)*						
HP	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
½	4.4	2.5	2.4	2.2	1.1	0.9	—
¾	6.4	3.7	3.5	3.2	1.6	1.3	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—
1½	12.0	6.9	6.6	6.0	3.0	2.4	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—
3	—	11.0	10.6	9.6	4.8	3.9	—
5	—	17.5	16.7	15.2	7.6	6.1	—
7½	—	25.3	24.2	22	11	9	—
10	—	32.2	30.8	28	14	11	*16 (60)
15	—	48.3	46.2	42	21	17	*20 (75)
20	—	62.1	59.4	54	27	22	*26 (100)
25	—	78.2	74.8	68	34	27	*31 (125)
30	—	92	88	80	40	32	*37 (150)
40	—	120	114	104	52	41	*49 (200)

* *Values given under the 2300 Volt column are for 60, 75, 100, 125, 150, and 200 HP rated motors respectively.*

49

	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW,	Types TBS, SA, SIS, FEP, FEPB, MI, PFA, RHH, RHW-2, THHN, THHW,	Types TW, UF
Size AWG or kcmil	COPPER			
18*	—	—	14	—
16*	—	—	18	—
14*	15	20	25	—
12*	20	25	30	15
10*	30	35	40	25
8	40	50	55	35
6	55	65	75	40
4	70	85	95	55
3	85	100	115	65
2	95	115	130	75
1	110	130	145	85
1/0	125	150	170	100
2/0	145	175	195	115
3/0	165	200	225	130
4/0	195	230	260	150

50

MOTOR CIRCUIT CONDUCTORS

Using Table 430.250 to find the amperage for the motor, we find the FLC is 27 amps. We take that figure and multiply it by 125% per 430.22.

27 amps x 1.25 = 33.75 - round up to 38 amps

Go to Table 310.16 and find THWN in the 75° column: the conductor that can carry 38 amps is 8 AWG copper, which is good for 50 amps.

51

MOTOR CIRCUIT CONDUCTORS

Lets try a few more:

A 5 HP three phase motor, operating at 208 volts, what size THW conductor would we use for the branch circuit?

A 200 HP three phase motor, operating at 460 volts, what size THHN conductor for the branch circuit?

A 10 HP single phase motor, operating at 240 volts, what size XHHW conductor would we use?

52

MOTOR CIRCUIT CONDUCTORS

A 5 HP three phase motor, operating at 208 volts, Table value for FLC is 16.7 x 125% = 20.875 (21 amps). Number 12 THW that is good for 25 amps would be selected.

A 200 HP three phase motor, operating at 460 volts, Table value for FLC is 240 x 1.25 = 300 amps. Conductor from 75° column would be a 350 kcmil, which is good for 310 amps.

A 10 HP single phase motor, operating at 240 volts, table FLC is 50 x 125% = 62.5 (63 amps). 6 AWG XHHW, which is good for 65 amps, would work.

53

MOTOR CIRCUIT CONDUCTORS

This is all there is to selecting the branch circuit conductors for motors.

Simply make sure you use the right table values, take 125% of that value.

Then match it up to the selected conductor type used.

All of these examples are assuming no conductors adjustments have to be made for conductor fill or temperature adjustments.

54

MOTOR CIRCUIT CONDUCTORS

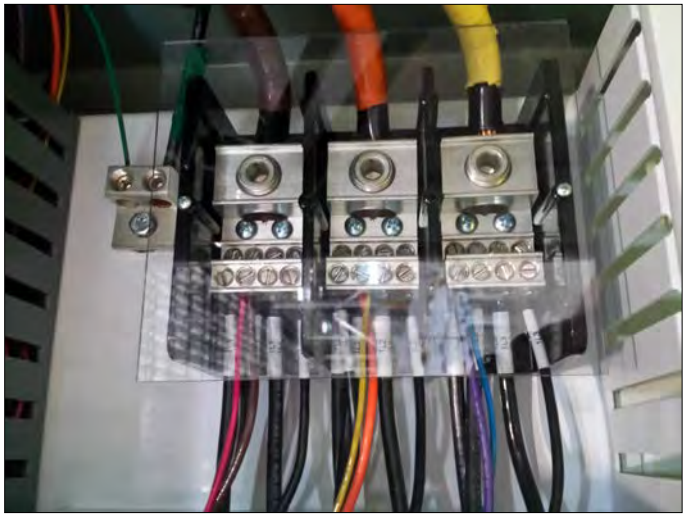
430.22(G) Conductors for Small Motors

Conductors for small motors must be 14 AWG or larger, unless otherwise permitted.

The other permissions are as small as 18 AWG as long as the conductors do not leave a cabinet or enclosure.

Or, the motors draw 3.5 amps or less, has class 20 overload protection and protection is provided as per 240.4(D)(2).

55



56

CONDUCTORS SUPPLYING SEVERAL MOTORS

430.24 Several Motors or a Motor(s) and Other Load(s).

Conductors supplying several motors, or a motor(s) and other

load(s), must have an ampacity equal to or greater than the sum of the following:

(1) 125 percent of the full-load current rating of the highest rated motor, as determined by 430.6(A)

(2) Sum of the full-load current ratings of all the other motors in the group, as determined by 430.6(A)

(3) 100 percent of the noncontinuous non-motor load

(4) 125 percent of the continuous non-motor load.

57

430.17 HIGHEST RATED OR SMALLEST RATED MOTOR

- In determining compliance with 430.24, 430.53(B), and 430.53(C) (several motors or loads on one branch circuit), the highest rated or smallest rated motor shall be based on the rated full-load current as selected from:
  - Table 430.247 (FLC – Direct-Current Motors)
  - Table 430.248 (FLC – Single-Phase ac Motors)
  - Table 430.249 (FLC – Two-Phase ac Motors)
  - Table 430.250 (FLC – Three-Phase ac Motors)
  - Note: See “Article 430- Motor Tables” at latter part of this presentation

58

CONDUCTORS FOR MOTOR GROUPS

- Branch-circuit conductors supplying a group of motors used in a continuous duty application shall have an ampacity of not less than 125% of the full-load current of the highest rated motor in the group plus the sum of the full-load currents of all other motors in the group
- The following group of 460-volt, 3-phase motors would require a conductor with what minimum ampacity?

1@10 hp

2@50 hp

3@75 hp

1@100 hp

59

CONDUCTORS FOR MOTOR GROUPS

Use Table 430.250 to derive full-load currents for these 460-volt, 3-phase motors

10 hp = 14 A, 50 hp = 65 A, 75 hp = 96 A, and 100 hp = 124 A

124 A x 125% = 155 A (highest rated motor in the group)

14 A + (2 x 65 A) + (3 x 96 A) + (124 A x 1.25) = 587 amperes

14 A + 130 A + 288 A + 155 A = 587 amperes

Conductors must be sized to carry 587 amperes minimum, what size THW for this feeder?

Parallel runs of THW 350 kcmil

60

CONDUCTORS FOR MOTOR GROUPS

Lets look at one more feeder with motors that are 480 V, 3 phase

5 @ 10 hp

1 @ 50 hp

1 @ 100 hp

50 Amps misc loads

100 amps of lighting

61

CONDUCTORS FOR MOTOR GROUPS

First step is to get our FLC from the tables.

5 @ 10 hp — 7.6 x 5 = 38 amps

1 @ 50 hp — 65 amps

1 @ 100 hp — 96 amps x 125% = 120 amps

50 Amps misc loads

100 amps of lighting (continuous) x 125% = 125 amps

38 + 65 + 120 + 50 + 125 = 398 amps, what size THWN?

Table 310.16 gives us 600 kcmil (420 amps)

62

MOTOR AND BRANCH-CIRCUIT OVERLOAD PROTECTION

430.31 General.

Part III specifies overload devices intended to protect:

- motors,

- motor-control apparatus

- motor branch-circuit conductors against excessive heating due to motor overloads and failure to start

These provisions do not require overload protection where a power loss would cause a hazard, such as in the case of fire pumps.

The provisions of Part III do not apply to motor circuits rated over 1000 volts, nominal.

63

64

- So far, we have talked about the size of the conductors and no requirements have been discussed regarding the protection of these conductors.

- This is done for a very logical reason - the conductors receive adequate protection once the entire motor circuit is completed.

65

WHAT IS AN OVERLOAD?

- An overload is commonly defined as any current that is in excess of the rated current of a piece of equipment.

- Typically up to 6 to 10 times the rated current of the equipment.

66

OVERLOAD

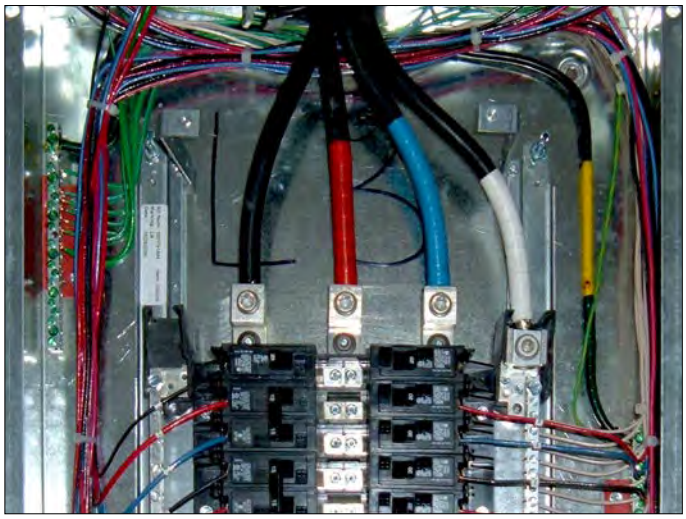
From Article 100, the definition of Overload is: Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.

430.31 General. Part III specifies overload devices intended to protect motors, motor-control apparatus, and motor branch-circuit conductors agains excessive heating due to motor overloads and failure to start.

OVERCURRENT PROTECTION

Overcurrent Protective Device, Branch-Circuit.

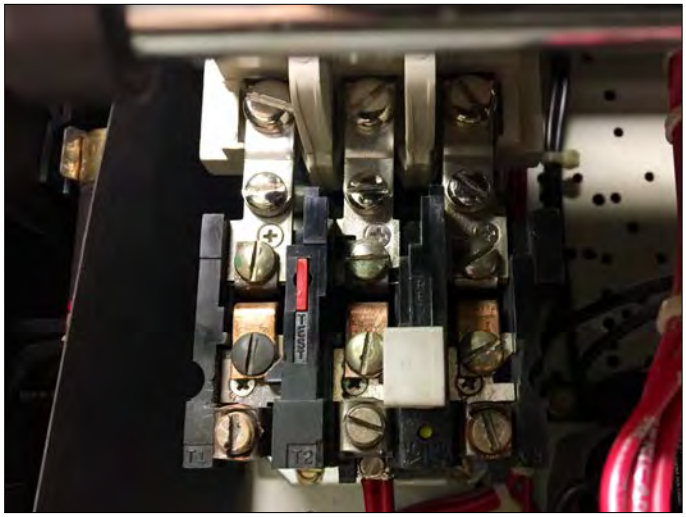
A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. (CMP-10)



- Overload protection for normal circuits is generally done within the same device that performs our short-circuit, ground-fault protection, and considers overloads a 6 to 10 times the rating of the device.
- When we get to motors we uniquely separate the approach to overload and short-circuit, ground-fault protect - they are often totally separate devices.

- For a motor, if we allow it to operate at 6 to 10 times its rating for any length of time, we will simply destroy the motor.
- That is why we separate the approach to overload and short-circuit, ground-fault protection - to provide much tighter overload protection.

73



74

MOTOR AND BRANCH-CIRCUIT OVERLOAD PROTECTION

430.32 Continuous-Duty Motors.

(A) More Than 1 Horsepower. Motors that are used in continuous duty applications and rated more than 1 hp must be protected against overload by one of the methods in 430.32(A)(1) through (A)(4).

(1) Separate Overload Device. A separate overload device that is responsive to motor current. The device must be selected to trip or be rated at no more than the following percent of the motor nameplate full-load current rating:

Motors with a marked service factor 1.15 or greater———125%

Motors with a marked temperature rise 40°C or less———125%

All other motors ————————————————115%

75

MOTOR AND BRANCH-CIRCUIT OVERLOAD PROTECTION

430.32 Continuous-Duty Motors.

(2)Thermal Protector. A thermal protector integral with the motor and approved for use with the motor ... that will prevent dangerous overheating of the motor due to overload and failure to start. The ultimate trip current of a thermally protected motor must not exceed the following percentage of motor full-load current given in the FLC tables:

Motors full-load current 9 amperes or l————170%

Motors full-load current from 9.1 amperes, ——— 156%

and including, 20 amperes

Motors full-load current greater that 20 amperes—115%

76

77

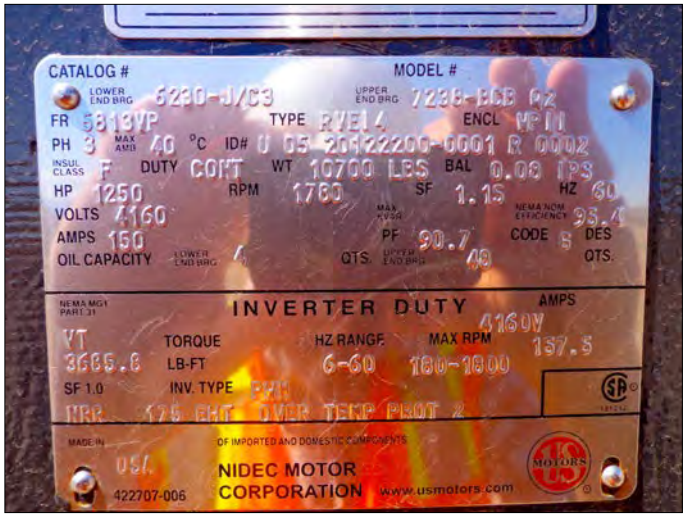
MOTOR AND BRANCH-CIRCUIT OVERLOAD PROTECTION

430.32 Continuous-Duty Motors.

(3) Integral with Motor. A protective device that is integral with a motor and protects the motor against damage due to failure to start is permitted if the motor is part of an approved assembly that does not normally subject the motor to overloads.

(4) Larger Than 1500 Horsepower. For motors larger than 1500 hp, a protective device having embedded temperature detectors that interrupt current to the motor when the motor attains a temperature rise greater than what is marked on the nameplate in an ambient temperature of 40°C.

78



79

MOTOR AND BRANCH-CIRCUIT OVERLOAD PROTECTION

430.32 Continuous-Duty Motors.

(B) Is for motors 1 hp or less, automatically started.

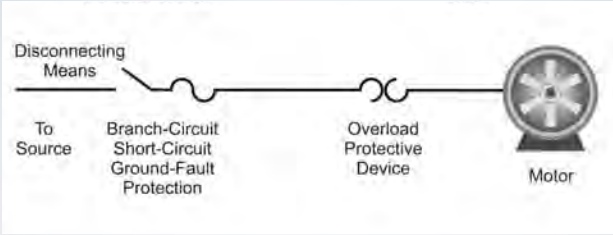
(C) Discusses issues that may be related to startup issues.

(D) is for for motors 1 hp or less, non automatically started.

(E) is for wound-rotor secondaries.

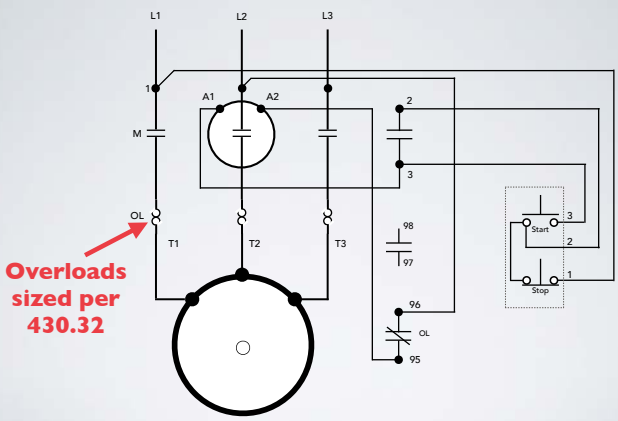
80

HOW DOES AN OVERLOAD PROTECT THE CONDUCTORS?



PLEASE NOTE: OVERLOADS ARE GENERALLY DONE IN PERCENTAGES

81



82

MOTOR NAMEPLATE

Nameplate information:
Manufactures name
HP
Voltage/s
Full Load Current
RPM
Temp Rise
Frequency
Code letter/locked rotor amps
Design letter

Nameplate values for overload

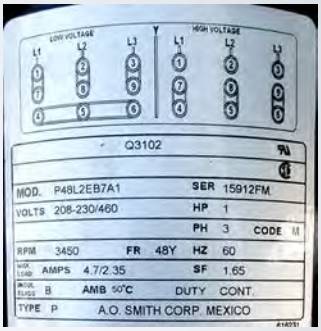
83

NAMEPLATE INFORMATION

84

NAMEPLATE INFORMATION

Please note the wiring diagram for both voltages



HOW TO CALCULATE OVERLAODS

First step in sizing overloads is to actually read the motor label.

Find two things:

First - the rated current at the applied voltage.

Second - the service factor or the temperature rise

HOW TO CALCULATE OVERLOAD PROTECTION

Then we apply the rules in 430.32

If the service factor is 1.15 or greater, or the temperature rise is 40° C or less, then we multiply the current from the label x 125%

All other motors will be sized at 115% of the label current value.

From these calculations, select the right heater elements to protect the motor.

HOW TO CALCULATE OVERLOAD PROTECTION

A very important consideration for motor overcurrent protection

You have to understand and consider the limitations of our equipment designs when employing motors. You may have a piece of equipment that only needs 1.6 HP, so you will naturally install a 2 HP motor. Because this equipment doesn't actually need 2 HP, it draws less amperage. You may find that you need to fine tune your overload protection to actually catch a pending failure (like a bad bearing). By doing this, when the motor draws more current due to the bad bearing, the overload protective device will sense it and protect the entire system.

HOW TO CALCULATE OVERLOAD PROTECTION

So if I have a motor that draws:

8 amps and has a service factor of 1.2, what size overload?

12 amps with a 40°C rise rating, what size overload?

100 amps with no applicable SF or temp rise, what size?

10 amps, 15 amps and 115 amps.

SHORT-CIRCUIT AND GROUND FAULT PROTECTION

430.51 General. Part IV specifies devices intended to protect

the motor branch-circuit conductors, the motor control apparatus,

and the motors against overcurrent due to short circuits

or ground faults. The devices specified in Part IV do not include the types of devices required by 210.8 (GFCI), 230.95 (GFPE), and 590.6 (GFCI).

These rules add to or amend the provisions of Article 240.

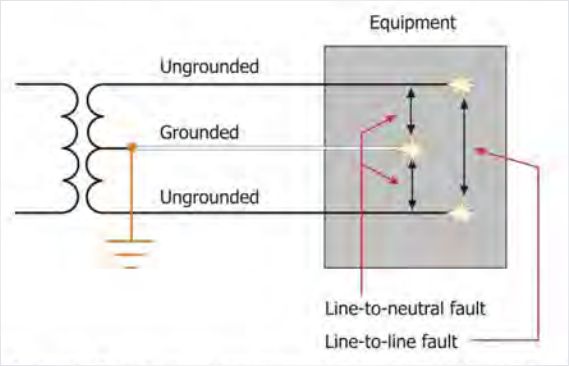
91

WHAT IS A SHORT-CIRCUIT/ GROUND-FAULT?

- A short-circuit is a path of current that goes outside of normal paths and creates a direct connection from one phase to another phase, or phase to neutral.
- A ground-fault is a path of current that goes outside of normal paths and creates a direct connection to a grounded location.

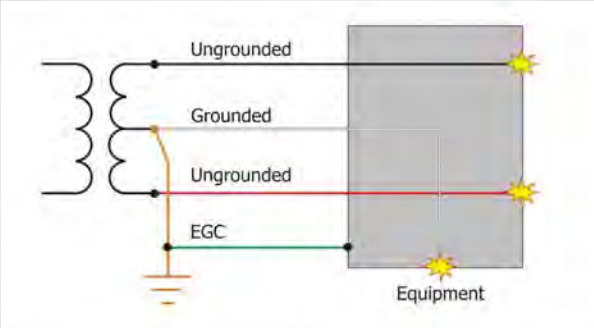
92

SHORT-CIRCUIT, GROUND-FAULT



93

GROUND-FAULT



94

SHORT-CIRCUIT AND GROUND FAULT PROTECTION

430.52 Rating or Setting for Individual Motor Circuit.

(A) General. The motor branch-circuit short-circuit and ground-fault protective device must comply with 430.52(B) and either 430.52(C) or (D) - whichever applies.

(B) All Motors. The motor branch-circuit short-circuit and ground-fault protective device must be capable of carrying the starting current of the motor.

(C) Rating or Setting.

(1) In Accordance with Table 430.52. A protective device that has a rating or setting that does not exceed the value calculated using the values given in Table 430.52(C)(1) must be used unless otherwise permitted by (C)(1)(a) or (b)

95

SHORT-CIRCUIT AND GROUND FAULT PROTECTION

430.52(C)(1)(a) Where the values in (C)(1) do not align with the standard ampere rating devices the next size is permitted.

430.52(C)(1)(b) When the device rating calculated above is insufficient for the required starting current, we have 4 additional steps that may be applied to handle the startup issues.

Previously these were exceptions within this section, they have been moved from exception language to standard code allowances in the 2023 code.

96

SHORT-CIRCUIT AND GROUND FAULT PROTECTION

(2) Overload Relay Table. Where maximum branch-circuit short-circuit and ground-fault protective device ratings are shown in the manufacturer's overload relay table or are otherwise marked on the equipment, they must not be exceeded even if higher values are allowed as shown above.

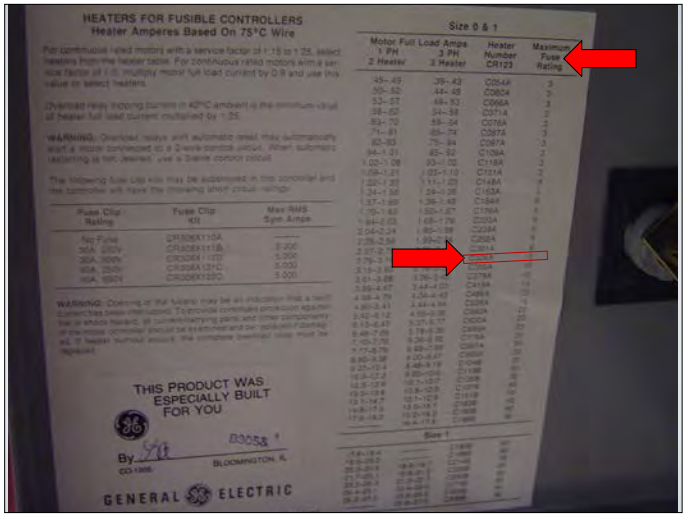
(3) Instantaneous Trip Circuit Breaker. An instantaneous trip circuit breaker can only be used if

- it is adjustable

- part of a listed combination motor controller having coordinated overload and short-circuit and ground-fault protection in each conductor

- the setting is adjusted to no more than the value specified in Table 430.52(C)(1)

97

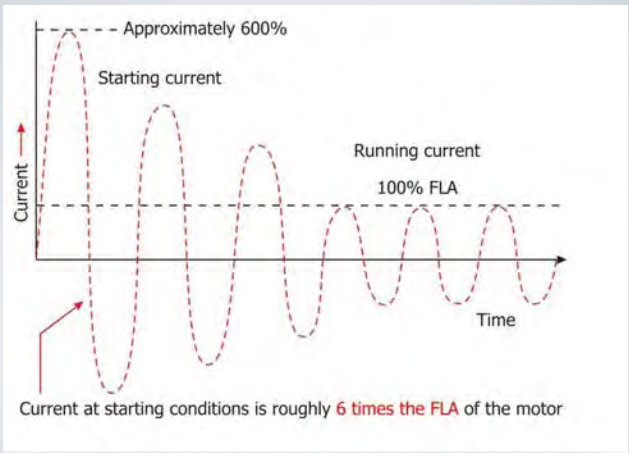


98

Table 430.52 Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground-Fault Protective Devices

	Percentage of Full-Load Current			
Type of Motor	Nontime Delay Fuse[1]	Dual Element (Time-Delay) Fuse[1]	Instantaneous Trip Breaker	Inverse Time Breaker[2]
Single-phase motors	300	175	800	250
AC polyphase motors other than wound-rotor	300	175	800	250
Squirrel cage — other than Design B energy-efficient	300	175	800	250
Design B energy-efficient	300	175	1100	250
Synchronous[3]	300	175	800	250
Wound-rotor	150	150	800	150
DC (constant voltage)	150	150	250	150

99



100

SHORT-CIRCUIT AND GROUND FAULT PROTECTION EXAMPLES

Example 1:

- 30-hp, 460-volt, 3-phase motor used with a dual-element time-delay fuse for the branch-circuit short-circuit, ground-fault protective device
  - Table 430.250 indicates that a 30-hp, 460-volt motor draws 40 amperes
  - Take 40 amperes to Table 430.52(C)(1), column for Dual Element (Time-Delay)
  - Multiply 40 amperes by 175% = <u>70 amperes</u>

<u>Where do we find the breaker, fuse sizes?</u>

101

Table 240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers

Standard Ampere Ratings				
10	15	20	25	30
35	40	45	50	60
70	80	90	100	110
125	150	175	200	225
250	300	350	400	450
500	600	700	800	1000
1200	1600	2000	2500	3000
4000	5000	6000	—	—

102

SHORT-CIRCUIT AND GROUND FAULT PROTECTION EXAMPLES

Example 2:

- 150-hp, 460-volt, 3-phase motor used with a dual-element time-delay fuse for the branch-circuit, short-circuit, ground-fault protective device
  - Table 430.250 indicates that a 150-hp, 460-volt motor draws 180 amperes
  - Take 180 amperes to Table 430.52 in the column under Dual Element (Time-Delay)
  - Multiply 180 amps by 175% = 315 amperes
  - 350 amperes fuse [next higher standard ampere fuse permitted by 430.52(C)(1)(a)

SHORT-CIRCUIT AND GROUND FAULT PROTECTION EXAMPLES

Example 3:

•3-phase, 460-volt, 50-hp motor - Size conductors, overloads, branch-circuit short-circuit and ground-fault protective device

(1) Table 430.250 says 50-hp @ 460-volts = 65 amperes

(2) 430.22 says multiply 65 A x 125% = 81.25 A (minimum circuit conductor ampacity required) - 4 AWG THWN

(3) 430.32 says for 1.15 SF use 125% of nameplate current for overload

(4) Nameplate is 62 amps: 62 X 125% = 77.5 amperes (overload protective device)

SHORT-CIRCUIT AND GROUND FAULT PROTECTION EXAMPLES

Example 3: (cont.)

•3-phase, 460-volt, 50-hp motor - Size conductors, overloads, branch-circuit short-circuit and ground-fault protective device

(5) Table 430.52(C)(1) says for a dual-element (time delay) fuse, use max. protective device @ 175% of table amperes

(6) Motor 65 A x 175% =113.73 A

(7) Round up to 125 amp fuses

•Note that 430.52(C)(1)(b) permits increase to 225% maximum for a dual-element time delay (DETD) device where the above is not sufficient for starting current of the motor

SHORT-CIRCUIT AND GROUND FAULT PROTECTION EXAMPLES

- Don't expect the motor branch-circuit conductors to be protected at or below their ampacities as normally would be required by Article 240
- The overcurrent protection for the branch circuit conductors of the motor circuit(s) are provided by the combination of motor branch-circuit, short-circuit, and ground-fault protective devices installed in conjunction with properly sized overload protective devices
- See specific conductor applications in Table 240.4(G)

SHORT-CIRCUIT AND GROUND FAULT PROTECTION EXAMPLES

- There are times where understanding normal wiring methods will cause issues for inspectors or others who are not familiar with Article 430.
- A 10 HP 460 V 3 phase motor has a FLC of 14 amps, times 125% gives us 17.5 amps which requires a number 14 AWG THWN conductor. The breaker would be 250% of 14 which equals 35, so the standard size would be a 35 amp breaker.
- Do you see an issue with 14 AWG being protected by a 35 amp breaker?
- Not when it comes to motors

SHORT-CIRCUIT AND GROUND FAULT PROTECTION EXAMPLES

- In this example the motor is rated for 14 amps, and the largest permissible overload device would be 125% or 17.5 amps. The 14 AWG is good for 20 amps, from Table 310.16.
- So when the motor starts to overload, the device will shut down the motor when it pulls 17.5 amps for an extended time.
- Therefore, it provides the protection needed for the conductor, and the 35 amp breaker provides the short-circuit and ground-fault protection.

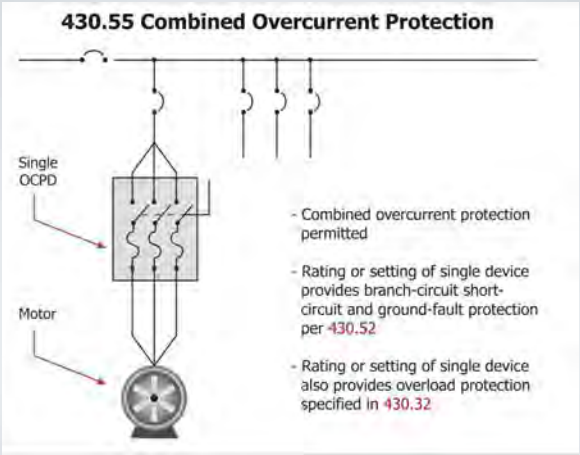
COMBINED OVERCURRENT PROTECTION

Combined Overcurrent Protection. Motor branch circuit short-circuit and ground-fault protection and motor overload protection are allowed to be combined in a single protective device as long as the rating or setting of the device provides the overload protection specified in 430.32.

Due to the unique sizing requirements of 430.32, if this provision is used, it is usually done with a fuse sized according to the percentages of 430.32.

SINGLE DEVICE EXAMPLE

- Example: A 7½-hp, 3-phase, 208-volt motor draws 24.2 amperes based on Table 430.250
- If this motor is provided with a 30-ampere, dual element (time-delay) fuse, the required protection percentages for short-circuit/ground-fault and overload protection are met
- (24.2 amperes x 115% = 27.83 amperes)



MOTOR FEEDER SHORT-CIRCUIT AND GROUND-FAULT PROTECTION

430.62 Rating or Setting — Motor Load.

(A) Specific Load. A feeder supplying a specific fixed motor load(s) and consisting of conductor sizes based on 430.24 must be provided with a protective device that has a rating or setting not greater than the largest rating or setting of the branch circuit short-circuit/ground-fault protective device for any motor supplied by the feeder

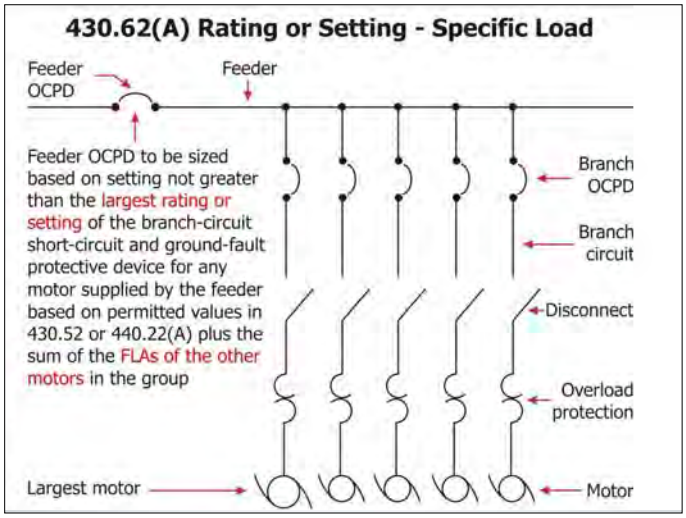
- based on the maximum permitted value for the specific type of a protective device in accordance with 430.52 (or 440.22(A) for hermetic refrigerant motor compressors), plus the sum of the full-load currents of the other motors of the group.

CONTINUED

If the same rating or setting of the branch-circuit short-circuit/ ground-fault protective device is used on two or more of the branch circuits supplied by the feeder, one of the protective devices is considered the largest for the above calculations.

Exception No. 1: Where one or more instantaneous trip circuit breakers or motor short-circuit protectors are used for motor branch-circuit short circuit/ ground-fault protection, the procedure provided above for determining the maximum rating of the feeder protective device applies, with the following change: For the purpose of the calculation, each instantaneous trip circuit breaker or motor short-circuit protector shall be assumed to have a rating that does not exceed the maximum percentage of motor full-load current permitted by Table 430.52 for the type of feeder protective device employed.

Exception No. 2: Where the feeder overcurrent protective device also provides overcurrent protection for a motor control center, Section 430.94 applies.



MOTOR FEEDER PROTECTION CALCULATIONS

Using the following group of 460-volt, 3-phase motors would require feeder protection breaker device at what size?

1@10 hp, 2@50 hp, 3@75 hp, 1@100 hp

10 hp = 14 A, 50 hp = 65 A, 75 hp = 96 A, and 100 hp = 124 A

124 A x 250% = 310 A, go to 350 A breaker (largest rated motor)

14 A + (2 x 65 A) + (3 x 96 A) + (124 A x 2.50) = 782 amperes

14 A + 130 A + 288 A + 350 A = 782 A - round up to 800 A breaker

Conductors must be sized to carry 782 amperes minimum, what size THW for this feeder?

We can use parallel THW 600 kcmil (420 A x 2 = 840 A total), and protect them with a 800 Amp breaker.

MOTOR FEEDER PROTECTION CALCULATIONS

Using the following group of 460-volt, 3-phase motors would require feeder protection fuse device at what size?

1-10 hp, 2-50 hp, 3-75 hp, 1-100 hp

10 hp = 14 A, 50 hp = 65 A, 75 hp = 96 A, and 100 hp = 124 A

124 A x 175% = 217 A, go to 225 fuse (largest rated motor)

14 A + (2 x 65 A) + (3 x 96 A) + (124 A x 1.75) = 657 amperes

14 A + 130 A + 288 A + 225 A = 657 A - round up to 700 A fuse

Conductors must be sized to carry 657 amperes minimum, what size THW for this feeder?

We would use a pair of parallel THW 400 kcmil (335 A x 2 = 670 A), and protect them with a 700 amp fuse.

EQUIPMENT GROUNDING

- Article 430 equipment is generally required to be connected to an equipment grounding conductor (EGC)
- See Part XIII of Article 430 for specific grounding rules
- The minimum EGC sizes are required to be in accordance with 250.122 and Table 250.122
- Size the EGC based on the rating or setting of the motor branch-circuit short-circuit and ground-fault protective device using Table 250.122
- Note: Section 250.122 indicates that the size of the EGC does not have to be larger than the ungrounded circuit conductors supplying the equipment

EGC CONTINUED

- Equipment grounding conductors for motor circuits shall be sized not smaller than determined by Table 250.122 (based on the rating of the branch-circuit short-circuit and ground-fault protective device)
- Where the overcurrent device is an instantaneous-trip circuit breaker or a motor short-circuit protector, the equipment grounding conductor must be sized not smaller than indicated in Table 250.122 using the maximum permitted rating of a dual element time-delay fuse selected for branch-circuit short-circuit and ground-fault protection
- See 250.122(D)

EGC EXAMPLE

- 50 HP, 208 V, 3-phase motor
- Table value FLC = 143 amps
- DETD fuses 143 x 175% = 250 amps fuse
- Table 250.122 shows 4 AWG CU
- Branch Circuit Conductors sized for 179 amps

DISCONNECTING MEANS

430.102 Location.

(A) Controller. Requires an individual disconnecting means for each controller that is located in sight from the controller location.

(B) Motor. A disconnecting means must be provided for the motor in accordance with (B)(1) or (B)(2).

(1) Separate Motor Disconnect. A disconnecting means located in sight from the motor location and the driven machinery location.

(2) Controller Disconnect. The controller disconnecting means required in accordance with 430.102(A) is permitted to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

121

122

123

DISCONNECTING MEANS, EXCEPTIONS

Exception to (1) and (2): If the controller disconnecting means is lockable, it is not required under either condition (a) or condition (b):

(a) If the location of the disconnecting means for the motor is impracticable or introduces additional or increased hazards to persons or property.

(b) In industrial installations with written safety procedures and conditions of maintenance and supervision that ensure that only qualified persons service the equipment.

124

DISCONNECT LOCATION

The disconnect may be located out of sight of the motor <u>if</u> disconnecting the motor without following certain procedures would create a hazard

125

DISCONNECTING MEANS, CONTINUED

- Locations of disconnects relative to motors and controllers [430.102]
- Operation of disconnects [430.103]
- Be Indicating [430.104]
- Readily Accessible [430.107]
- Types of disconnects [430.109]
- Ampere ratings and interrupting capacity [430.110]

126

DISCONNECT RATING AND INTERRUPTING CAPACITY

430.110(A) General. The disconnecting means for motor circuits rated 1000 volts or less must have a current rating not less than 115 percent of the full-load current rating of the motor.

Exception: A listed unfused motor-circuit switch with a horsepower rating not less than the motor horsepower is permitted to have a current rating less than 115 percent of the full-load current rating of the motor.

DISCONNECTS FOR COMBINATION LOADS

- Multiple motors are controlled by a single disconnect. Calculate the disconnect switch size.
- Motors are 460-volts, 3-phase:
  - 1@25 hp, 1@10 hp, and 1@15 hp

  1. Add all locked-rotor currents, multiply by 115% per 430.110(C)(2)
  2. Take this total value of locked-rotor amperes to Table 430.251(B) to establish the minimum horsepower rating for the switch

DISCONNECTS FOR COMBINATION LOADS

- Multiple motors are controlled by a single disconnect. Calculate the disconnect switch size. (cont.)

  3. Find the locked-rotor amperes using Table 430.251(B)
  4. 25 hp = (183 A); 10 hp = (81 A); 15 hp = (116 A)
  5. 183 A + 81 A + 116 A = 380 amperes
  6. 380 amperes x 115% = 437 amperes
  7. Using Table 430.251(B)….437 amperes requires minimum 75 hp switch

DISCONNECTS FOR COMBINATION LOADS

- Verify with full load current (FLC) from Table 430.250
- 25 hp = 34 A; 10 hp = 14 A; 15 hp = 21 A
- 34 A + 14 A + 21 A = 69 amperes
- 69 amperes x 115% = 79.35 amperes
- 79.35 A x 6 = 476.1 locked rotor amperes (LRA)
- 476.1 amperes using Table 430.251(B) = 75 hp switch
- Note: The locked-rotor current for motors is generally around 600% or 6 times the normal full-load current for a motor

Table 430.251(A) Conversion Table of Single-Phase Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Locked-Rotor Current in Amperes, Single Phase		
	115 Volts	208 Volts	230 Volts
½	58.8	32.5	29.4
¾	82.8	45.8	41.4
1	96	53	48
1½	120	66	60
2	144	80	72
3	204	113	102
5	336	186	168
7½	480	265	240
10	1000	332	300

Table 430.251(B) Conversion Table of Polyphase Design B, C, and D Max. LRC for Selection of Disconnecting Means and Controllers as Determined from HP and Voltage Rating and Design *(in part)*

For use only with 430.110, 440.12, 440.41 and 455.8(C).

Rated HP	Maximum Motor Locked-Rotor Current in Amperes, Two- and Three-Phase, Design B, C, and D*					
	115 Volts B, C, D	200 Volts B, C, D	208 Volts B, C, D	230 Volts B, C, D	460 Volts B, C, D	575 Volts B, C, D
½	40	23	22.1	20	10	8
¾	50	28.8	27.6	25	12.5	10
1	60	34.5	33	30	15	12
1½	80	46	44	40	20	16
2	100	57.5	55	50	25	20
3	—	73.6	71	64	32	25.6
5	—	105.8	102	92	46	36.8
7½	—	146	140	127	63.5	50.8
10	—	186.3	179	162	81	64.8
15	—	267	257	232	116	93
20	—	334	321	290	145	116
25	—	420	404	365	183	146
30	—	500	481	435	218	174
40	—	667	641	580	290	232
50	—	834	802	725	363	290

*Design A motors are not limited to a maximum starting current or locked rotor current.

ADJUSTABLE SPEED DRIVES SYSTEMS (VFDs)

- 430.120 General
- 430.122 Conductors
- 430.124 Overload protection
- 430.126 Motor overtemperature protection
- 430.128 Disconnecting means
- 430.130 Branch-Circuit Short-Circuit and Ground-Fault Protection for Single Motor Circuits Containing Power Conversion Equipment
- 430.131 Several Motors or Loads on One Branch Circuit Including Power Conversion Equipment

133

134

ADJUSTABLE SPEED DRIVES SYSTEMS (VFDs)

430.120 General. The requirements of Parts I through IX of Article 430 apply to adjustable-speed drives and adjustable-speed drive systems unless modified by the requirements in Part X

135

ADJUSTABLE SPEED DRIVES SYSTEMS (VFDs)

430.122 Conductors — Minimum Size and Ampacity.

(A) Branch/Feeder Circuit Conductors. Circuit conductors that supply power conversion equipment in an adjustable-speed drive system must have an ampacity not less than 125 percent of the rated input current to the power conversion equipment.

Informational Note: Power conversion equipment can have multiple power ratings and corresponding input currents.

136

ADJUSTABLE SPEED DRIVES SYSTEMS (VFDs)

If the unit is equipped with a bypass feature, then the capacity will be 125% of the larger ampacity between

- the VFD rating, or

- the motor when bypassed

137

138

ADJUSTABLE SPEED DRIVES SYSTEMS (VFDs)

Overload protection will be included as part of the drive system.

If the system has a bypass feature, then an overload feature per Part III of 430 will be required.

Multiple motors controlled by one VFD will have separate overloads for each motor per Part III.

See 430.124

139

ADJUSTABLE SPEED DRIVES SYSTEMS (VFDs)

Motor Overtemperature Protection.

If the motor will be operated at a speed other than the motor nameplate rating, then over-temperature protection will be required.

See 430.126

140

ADJUSTABLE SPEED DRIVES SYSTEMS (VFDs)

A disconnecting means is permitted to be installed in the incoming line to the power conversion equipment

This disconnecting means is required to have a rating not less than 115% of the rated input current of the power conversion unit

See 430.128

141

Motor Worksheet

	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6
Motor HP Rating						
Voltage/Phase						
Motor Type: Service factor, Temp Rise						
Motor FLA from Tables in 430						
Table FLA X 125%						
Wire Size--430.22 & Table 310.16						
Nameplate FLA						
Overload Size--430.32						
Short-circuit Ground-fault Protection--430.52						

Notes: Wire Type **Short Circuit, Ground Fault Devices** © 2023 HuxTer

142

	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6
Motor HP Rating	7.5	20	50			
Voltage/Phase	3/480	3/480	3/480			
Motor Type: Service factor, Temp Rise	N/A	1.15/40	N/A			
Motor FLA from Tables in 430	11	27	65			
Table FLA X 125%	14	34	81			
Wire Size--430.22 & Table 310.15(B)(16)	#14	#10	#4			
Nameplate FLA	10.5	26	61.5			
Overload Size--430.32	12.07	32.5	70.72			
Short-circuit Ground-fault Protection--430.52	19.25 20	47.25 50	113.75 125			

Notes: Wire Type THWN Short Circuit, Ground Fault Devices DETD

143

	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6
Motor HP Rating	7.5	20	50			
Voltage/Phase	3/480	3/480	3/480			
Motor Type: Service factor, Temp Rise	N/A	1.15/40	N/A			
Motor FLA from Tables in 430	11	27	65			
Table FLA X 125%	14	34	81			
Wire Size--430.22 & Table 310.15(B)(16)	#14	#10	#4			
Nameplate FLA	10.5	26	61.5			
Overload Size--430.32	12.07	32.5	70.72			
Short-circuit Ground-fault Protection--430.52	19.25 20	47.25 50	113.75 125			

Feeder Size

81 + 27 + 11 = 119 A

Which is a # 1 THWN

Feeder SCGF

125 + 27 + 11 = 163 A

Which is a 175 A Fuse

Notes: Wire Type THWN Short Circuit, Ground Fault Devices DETD

144

Motor Worksheet

	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6
Motor HP Rating						
Voltage/Phase						
Motor Type: Service factor, Temp Rise						
Motor FLA from Tables in 430						
Table FLA X 125%						
Wire Size--430.22 & Table 310.16						
Nameplate FLA						
Overload Size--430.32						
Short-circuit Ground-fault Protection--430.52						

Notes: Wire Type **Short Circuit, Ground Fault Devices** © 2023 HtsXer

145

	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6
Motor HP Rating	5	10	20	50		
Voltage/Phase	3/480	3/480	3/480	3/480		
Motor Type: Service factor, Temp Rise	N/A	1.15/40	N/A	N/A		
Motor FLA from Tables in 430	7.6	14	27	65		
Table FLA X 125%	9.5	18	34	81		
Wire Size--430.22 & Table 310.15(B)(16)	#14	#14	#10	#4		
Nameplate FLA	7.2	13.5	26	62		
Overload Size--430.32	8.28	15.53	29.9	71.3		
Short-circuit Ground-fault Protection--430.52	18 20	35 35	67.5 70	162.5 175		

Notes: Wire Type **THWN** Short Circuit, Ground Fault Devices **Inv Time Breaker**

146

	Motor 1	Motor 2	Motor 3	Motor 4
Motor HP Rating	5	10	20	50
Voltage/Phase	3/480	3/480	3/480	3/480
Motor Type: Service factor, Temp Rise	N/A	1.15/40	N/A	N/A
Motor FLA from Tables in 430	7.6	14	27	65
Table FLA X 125%	9.5	18	34	81
Wire Size--430.22 & Table 310.15(B)(16)	#14	#14	#10	#4
Nameplate FLA	7.2	13.5	26	62
Overload Size--430.32	8.28	15.53	29.9	71.3
Short-circuit Ground-fault Protection--430.52	18 20	35 35	67.5 70	162.5 175

Notes: Wire Type **THWN** Short Circuit, Ground Fault Devices

Feeder Size

81 + 7.6 + 14 + 27 = 130 A

Which is a # 1 THWN

Feeder SCGF

175 + 7.6 + 14 + 27 = 224 A

Which is a 225 A Breaker

147

Thank You

148

Motor Worksheet

	Motor 1	Motor 2	Motor 3	Motor 4	Motor 5	Motor 6
Motor HP Rating						
Voltage/Phase						
Motor Type: Service factor, Temp Rise						
Motor FLA from Tables in 430						
Table FLA X 125%						
Wire Size--430.22 & Table 310.16						
Nameplate FLA						
Overload Size--430.32						
Short-circuit Ground-fault Protection--430.52						

Notes: Wire Type **Short Circuit, Ground Fault Devices**