

2017

Electrical Design/Build Guide

Based on the 2017
National Electrical Code

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60° C Copper Ampacity
4 - Wire Fill - (Non-Current Carrying Neutral)
4 or 5 - Parallel Raceways

1	2	3	4	5	6	7	8	9	10	11
	60° C WIRE SIZE	GND WIRE SIZE	4-WIRE (40% FILL) CONDUIT SIZE				4-WIRE WITH GROUND (40% FILL) CONDUIT SIZE			
AMPS	AWG	AWG	THW	RHH RHW	THWN TTHN	XHHW	THW	RHH RHW	THWN TTHN	XHHW
	NOTE #3	NOTE #1 & 3		NOTE #2				NOTE #2		

4 - PARALLEL RACEWAYS (NOTE #3)

500	4-1/0	4-2	4-2"	4-2"	4-1 1/2"	4-1 1/2"	4-2"	4-2 1/2"	4-2"	4-2"
580	4-2/0	4-1	4-2"	4-2 1/2"	4-2"	4-2"	4-2"	4-2 1/2"	4-2"	4-2"
660	4-3/0	4-1/0	4-2"	4-2 1/2"	4-2"	4-2"	4-2 1/2"	4-3"	4-2"	4-2"
780	4-4/0	4-1/0	4-2 1/2"	4-2 1/2"	4-2"	4-2"	4-2 1/2"	4-3"	4-2 1/2"	4-2 1/2"
860	4-250	4-2/0	4-2 1/2"	4-3"	4-2 1/2"	4-2 1/2"	4-3"	4-3 1/2"	4-2 1/2"	4-2 1/2"
960	4-300	4-2/0	4-3"	4-3"	4-2 1/2"	4-2 1/2"	4-3"	4-3 1/2"	4-3"	4-3"
1040	4-350	4-3/0	4-3"	4-3 1/2"	4-3"	4-3"	4-3"	4-3 1/2"	4-3"	4-3"
1120	4-400	4-3/0	4-3"	4-3 1/2"	4-3"	4-3"	4-3 1/2"	4-4"	4-3"	4-3"
1280	4-500	4-4/0	4-3 1/2"	4-3 1/2"	4-3"	4-3"	4-3 1/2"	4-4"	4-3 1/2"	4-3 1/2"
1400	4-600	4-4/0	4-3 1/2"	4-4"	4-3 1/2"	4-3 1/2"	4-4"	4-5"	4-3 1/2"	4-3 1/2"
1540	4-700	4-4/0	4-4"	4-5"	4-3 1/2"	4-3 1/2"	4-4"	4-5"	4-4"	4-4"
1600	4-750	4-4/0	4-4"	4-5"	4-4"	4-4"	4-5"	4-5"	4-4"	4-4"

5 - PARALLEL RACEWAYS (NOTE #3)

625	5-1/0	5-1/0	5-2"	5-2"	5-1 1/2"	5-1 1/2"	5-2"	5-2 1/2"	5-2"	5-2"
725	5-2/0	5-1/0	5-2"	5-2 1/2"	5-2"	5-2"	@ 5-2"	5-2 1/2"	5-2"	5-2"
825	5-3/0	5-2/0	5-2"	5-2 1/2"	5-2"	5-2"	5-2 1/2"	5-3"	5-2"	5-2"
975	5-4/0	5-2/0	5-2 1/2"	5-2 1/2"	5-2"	5-2"	5-2 1/2"	5-3"	5-2 1/2"	5-2 1/2"
1075	5-250	5-3/0	5-2 1/2"	5-3"	5-2 1/2"	5-2 1/2"	5-3"	5-3 1/2"	5-2 1/2"	5-2 1/2"
1200	5-300	5-3/0	5-3"	5-3"	5-2 1/2"	5-2 1/2"	5-3"	5-3 1/2"	5-3"	5-3"
1300	5-350	5-4/0	5-3"	5-3 1/2"	5-3"	5-3"	5-3"	5-3 1/2"	5-3"	5-3"
1400	5-400	5-4/0	5-3"	5-3 1/2"	5-3"	5-3"	5-3 1/2"	5-4"	5-3"	5-3"
1600	5-500	5-4/0	5-3 1/2"	5-3 1/2"	5-3"	5-3"	5-3 1/2"	5-4"	5-3 1/2"	5-3 1/2"
1750	5-600	5-250	5-3 1/2"	5-4"	5-3 1/2"	5-3 1/2"	5-4"	5-5"	5-4"	5-4"
1925	5-700	5-250	5-4"	5-5"	5-3 1/2"	5-3 1/2"	5-4"	5-5"	5-4"	5-4"
2000	5-750	5-250	5-4"	5-5"	5-4"	5-4"	5-5"	5-5"	5-4"	5-4"

NOTES: 1. Ground wire sizes are based on conductor ampacity as shown in Column 1.

2. RHW and RHH conductor fill with outer covering.

3. Multiple conductors are per phase, neutral, and ground wire (1-each) per raceway.

Panel Schedules

Listed in this section are 124 panel schedules with 13 calculations each. These schedules provide 1,612 calculations to determine the conduit and wiring configuration of a given installation. The schedules include both single phase and three phase panels.



Overcurrent Protection

Overcurrent protection is based on 100% of the rated ampacity of the panel. The fuse/breaker size selected is equal to the panel ampacity rating. This method of calculation assures compliance to NEC Article 240-3.

Conductors

Phase conductors are sized to carry 100% of the ampere rating of the overcurrent protection. This method of calculation assures compliance to Article 240-3(c) of the NEC. Conductor ampacity is based on NEC Table 310-15(b) copper.

Neutral Conductor Current Carrying

When the neutral conductor is current carrying per NEC 310-15(b)(5), the ampacity of all conductors have been derated to 80% to conform to NEC Table 310-15(b)(3)(a) Adjustment Factors.

Equipment Grounding Conductor

The equipment grounding conductor(s) size is based on the ampacity of the phase conductors. Because the phase conductor ampacity is equal to or greater than the overcurrent protection, this method conforms to NEC Article 250-122.

Raceway Size

Raceway sizes are based on Standard Conduit Area Tables #1 and #2 located in Section #1 of this manual.



3 - Wire Panel Schedules

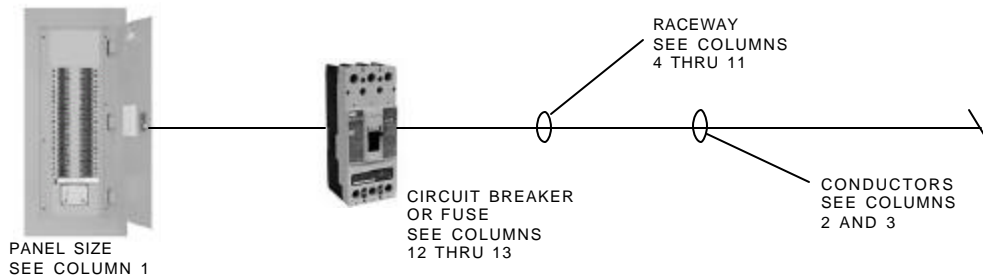
60° C - Copper Conductors

1	2	3	4	5	6	7	8	9	10	11	12	13
PANEL SIZE	CU WIRE SIZE AWG	GND WIRE SIZE AWG	3-WIRE (40% FILL)				3-WIRE WITH GROUND (40% FILL)				BKR FUSE	FUSED SWITCH SIZE
AMPS			THW	RHH RHW	THWN THHN	XHHW	THW	RHH RHW	THWN THHN	XHHW	AMPS	AMPS
	NOTE #3	NOTE #1		NOTE #2				NOTE #2				

60° C TEMPERATURE RATING

60	4	8	1"	1 1/4"	1"	1"	1 1/4"	1 1/4"	1"	1"	60	60
100	1	6	1 1/2"	2"	1 1/4"	1 1/4"	1 1/2"	2"	1 1/2"	1 1/2"	100	100
125	1/0	6	1 1/2"	2"	1 1/2"	1 1/2"	1 1/2"	2"	1 1/2"	1 1/2"	125	200
150	3/0	6	2"	2"	2"	1 1/2"	2"	2 1/2"	2"	2"	150	200
200	250	4	2"	2 1/2"	2"	2"	2 1/2"	3"	2"	2"	200	200
225	300	4	2 1/2"	3"	2"	2"	2 1/2"	3"	2 1/2"	2 1/2"	225	400
300	500	3	3"	3"	3"	3"	3"	3 1/2"	3"	3"	300	400
400	750	3	3 1/2"	4"	3 1/2"	3 1/2"	3 1/2"	4"	3 1/2"	3 1/2"	400	400
600	2-500	2-1/0	2-3"	2-3"	2-3"	2-3"	2-3"	2-3 1/2"	2-3"	2-3"	600	600
800	2-750	2-1/0	2-3 1/2"	2-4"	2-3 1/2"	2-3 1/2"	2-3 1/2"	2-4"	2-3 1/2"	2-3 1/2"	800	800
1000	3-600	3-3/0	3-3"	3-3 1/2"	3-3"	3-3"	3-3 1/2"	3-4"	3-3 1/2"	3-3 1/2"	1000	1000
1200	3-750	3-3/0	3-3 1/2"	3-4"	3-3 1/2"	3-3 1/2"	3-3 1/2"	3-4"	3-3 1/2"	3-3 1/2"	1200	1200
1600	5-500	5-4/0	4-3"	4-3"	4-3"	4-3"	4-3"	4-3 1/2"	4-3"	4-3"	1600	1600
2000	5-750	5-250	5-3 1/2"	5-4"	5-3 1/2"	5-3 1/2"	5-4"	5-4"	5-3 1/2"	5-3 1/2"	2000	2000

- NOTES:
1. Ground wire sizes are based on conductor ampacity.
 2. RHW and RHH conductor fill with outer covering.
 3. Multiple conductors are per phase, neutral, and ground wire (1-each) per raceway.



**Available Short Circuit
Amps - Symmetrical
Typical Utility Transformer**

Three Phase Transformer Nameplate KVA	Short Circuit Amps-Symmetrical 208 Volt	Short Circuit Amps-Symmetrical 480 Volt
75	14,000	
112 1/2	22,300	
150	22,300	
225	29,400	19,000
300	29,400	19,000
500	29,400	21,000
750	38,100	21,000
1,000		21,800
1,500		32,100
2,000		42,100
2,500		51,700
4,000		83,700

Transformer Schedules

Listed in this section are 218 transformer schedules with calculations. These schedules provide 2,943 calculations to determine the conduit and wiring configuration of a given installation. The schedules include both single phase and three phase transformers.



Overcurrent Protection

Primary and secondary overcurrent protection is based on 125% of the rated ampacity of the transformer. The fuse/breaker size selected is the highest rating not exceeding the 125%. If the ampacity rating is 9 amps or less, 167% is used. Per NEC Article 450-3.

Conductors

Primary and secondary conductors are sized to carry 100% of the ampere rating of the overcurrent protection. This method of calculation assures compliance to Article 240-3(c) of the NEC. Conductor Ampacity is based on NEC Table 310-15(b)(16) copper.

Neutral Conductor Current Carrying

When the neutral conductor is current carrying per NEC 310-15(b)(5), the ampacity of all conductors have been derated to 80% to conform to NEC Table 310-15(b)(3)(a) Adjustment Factors.

Equipment Grounding Conductor

The equipment grounding conductor(s) size is based on the ampacity of the phase conductors. Because the phase conductor ampacity is equal to or greater than the overcurrent protection, this method conforms to NEC Article 250-122.

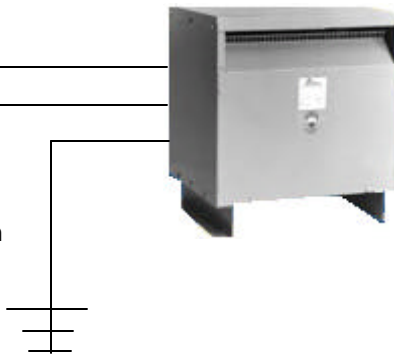
Raceway Size

Raceway sizes are based on Standard Conduit Area Tables #1 and #2 located in Section #1 of this manual.



System Grounding Conductor

The system grounding conductor size is based on the phase conductor(s) size on the transformer secondary. Per NEC Article 250-66.



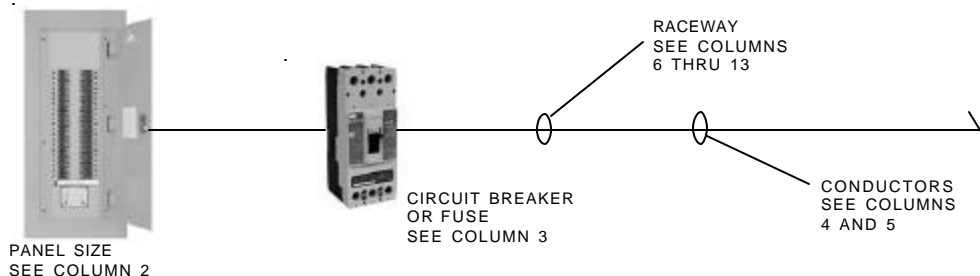
**Single Phase Transformer Schedule
Secondary Side - 120/240 Volts
60° C Copper Conductors**

1	2	3	4	5	6	7	8	9	10	11	12	13
SECONDARY SIDE - 120/240 VOLT - SINGLE PHASE												
XMFR	SECONDARY		CONDUCTORS		RACEWAYS							
	MAX. LOAD AMPS	BREAKER FUSE SIZE AMPS	WIRE SIZE AWG	EQUIP. GND SIZE AWG	3-WIRE (40% FILL)				3-WIRE WITH GROUND (40% FILL)			
THW					RHH RHW	THWN THHN	XHHW	THW	RHH RHW	THWN THHN	XHHW	
			NOTE #3	NOTE #1		NOTE #2				NOTE #2		

60° C COPPER CONDUCTORS

3	12.5	15	14	14	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"
5	20.8	25	10	10	1/2"	3/4"	1/2"	1/2"	1/2"	3/4"	1/2"	1/2"
7.5	31.3	35	8	10	3/4"	1"	1/2"	3/4"	3/4"	1"	3/4"	3/4"
10	41.7	50	6	10	1"	1"	3/4"	3/4"	1"	1 1/4"	3/4"	3/4"
15	62.5	70	4	8	1"	1 1/4"	1"	1"	1 1/4"	1 1/4"	1"	1"
25	104	125	1/0	6	1 1/2"	2"	1 1/2"	1 1/2"	1 1/2"	2"	1 1/2"	1 1/2"
37.5	156	175	4/0	6	2"	2 1/2"	2"	2"	2"	2 1/2"	2"	2"
50	208	250	350	4	2 1/2"	3"	2 1/2"	2 1/2"	3"	3"	2 1/2"	2 1/2"
75	313	350	600	3	3"	3 1/2"	3"	3"	3 1/2"	3 1/2"	3"	3"
100	417	500	3-4/0	3-1	2-2"	2-2 1/2"	2-2"	2-2"	2-2 1/2"	2-2 1/2"	2-2"	2-2"
167	696	800	3-400	3-2/0	2-2 1/2"	2-3"	2-2 1/2"	2-2 1/2"	2-3"	2-3 1/2"	2-3"	2-3"

- NOTES:
1. Equipment Ground wire sizes are based on conductor ampacity.
 2. RHW and RHH conductor fill with outer covering.
 3. Multiple conductors are per phase, neutral, and ground wire (1-each) per raceway.



Single Phase Transformer Schedule

Primary Side - 480 Volts

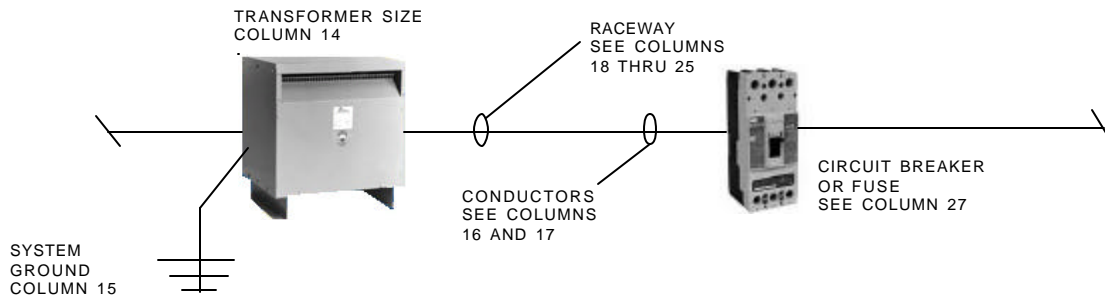
60° C Copper Conductors

14	15	16	17	18	19	20	21	22	23	24	25	26	27
PRIMARY SIDE - 480 VOLT - SINGLE PHASE													
TRANSFORMER		CONDUCTORS		RACEWAYS								PRIMARY	
40° C RISE XMFR KVA	SYS. GND WIRE AWG	WIRE SIZE AWG	EQUIP. GND WIRE AWG	2-WIRE (31% FILL)				2-WIRE WITH GROUND (40% FILL)				MAX. LOAD AMPS	BREAKER FUSE SIZE AMPS
				THW	RHH RHW	THWN THHN	XHHW	THW	RHH RHW	THWN THHN	XHHW		
		NOTE #3	NOTE #1		NOTE #2				NOTE #2				

60° C COPPER CONDUCTORS

3	8	14	14	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	6.3	10
5	8	14	14	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	10.4	10
7.5	8	14	14	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	15.6	15
10	8	10	10	1/2"	1/2"	1/2"	1/2"	1/2"	3/4"	1/2"	1/2"	20.8	25
15	8	8	10	1/2"	3/4"	1/2"	1/2"	1/2"	1"	1/2"	1/2"	31.3	35
25	6	4	8	1"	1"	3/4"	3/4"	1"	1 1/4"	3/4"	1"	52.1	60
37.5	2	2	8	1"	1 1/4"	1"	1"	1"	1 1/4"	1"	1"	78.1	90
50	2	1/0	6	1 1/2"	1 1/2"	1 1/4"	1 1/4"	1 1/2"	1 1/2"	1 1/4"	1 1/4"	104	125
75	2/0	4/0	6	2"	2"	® 2"	1 1/2"	2"	2"	® 1 1/2"	1 1/2"	156	175
100	3/0	350	4	® 2 1/2"	2 1/2"	2"	2"	® 2"	2 1/2"	2"	2"	208	250
167	3/0	3-2/0	3-2	1 1/2"	2"	1 1/2"	1 1/4"	1 1/2"	2"	1 1/2"	1 1/2"	348	400

- NOTES:
1. Equipment Ground wire sizes are based on conductor ampacity.
 2. RHW and RHH conductor fill with outer covering.
 3. Multiple conductors are per phase, neutral, and ground wire (1-each) per raceway.
- ® 2-wire with ground results in a smaller conduit size than 2-wire with no ground.



Motor Schedules - 75° C Conductors

Listed in this section are 170 motor schedules with 19 calculations each. These schedules provide 3,230 calculations to determine the conduit and wiring configuration of a given installation. The schedules include both single phase and three phase motors.



Disconnect

The disconnect size is based on 115% of the motor full load amps per NEC Article 430-110. Note: Disconnect size may have to be increased if a fused disconnect is installed. When this condition exists an “@” precedes the ampacity of the switch size shown in column 15 of the motor schedules.

Short Circuit Protection

The short circuit ground fault protection is based on 175% of the motor full load amps. The fuse/breaker size selected is the largest size not exceeding the 175% . This method of calculation assures compliance to NEC Article 430-52.

Conductors

Conductors are sized to carry 125% of the motor full load amps per NEC Article 430-22. Conductor ampacity is based on NEC Table 310-15(b)(16) copper.

Conductor Length (Voltage Drop)

The maximum conductor length is indicated in column 6 of the motor schedules. This number represents the maximum one-way conductor length before 3% voltage drop is exceeded.

Equipment Grounding Conductor

The equipment grounding conductor(s) size is based on the ampacity of the short circuit ground fault protection per NEC Article 250-122.

Motor Starter Size

The motor starter size is based on the motor full load amps and NEMA standard sizes.

Motor Overload Protection

The motor overload protection is based on 125% of the motor full load amps. The fuse size selected is the largest size not exceeding the 125% . This method of calculation assures compliance to NEC Article 430-32.

Raceway Size

Raceway sizes are based on Standard Conduit Area Tables #1 and #2 located in Section #1 of this manual.

Motor Schedules - 75° C Conductors

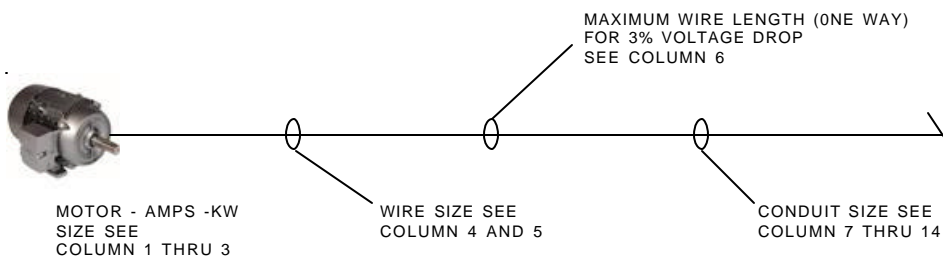
1	2	3	4	5	6	7	8	9	10
				GND WIRE SIZE AWG	MAX WIRE LENGTH FEET	CONDUIT SIZE 3-WIRE (40% FILL)			
HP	FLA	KW	WIRE SIZE AWG			THW	RHH RHW	THWN TTHN	XHHW
					NOTE #1		NOTE #2		

208 Volt Three Phase

1/2	2.4	0.9	14	14	484'	1/2"	1/2"	1/2"	1/2"
3/4	3.5	1.3	14	14	332'	1/2"	1/2"	1/2"	1/2"
1	4.6	1.7	14	14	253'	1/2"	1/2"	1/2"	1/2"
1 1/2	6.6	2.4	14	14	176'	1/2"	1/2"	1/2"	1/2"
2	7.5	2.7	14	14	155'	1/2"	1/2"	1/2"	1/2"
3	10.6	3.8	14	14	110'	1/2"	1/2"	1/2"	1/2"
5	16.7	6.0	10	10	180'	1/2"	3/4"	1/2"	1/2"
7 1/2	24.2	8.7	8	10	191'	3/4"	1"	1/2"	3/4"
10	30.8	11.1	8	10	150'	3/4"	1"	1/2"	3/4"
15	46.2	16.6	6	8	159'	1"	1"	3/4"	3/4"
20	59.4	21.4	4	8	196'	1"	1 1/4"	1"	1"
25	74.8	26.9	3	6	193'	1"	1 1/4"	1"	1"
30	88	32	2	6	205'	1 1/4"	1 1/4"	1"	1"
40	114	41	1/0	6	263'	1 1/2"	2"	1 1/2"	1 1/2"
50	143	52	3/0	4	319'	2"	2"	2"	1 1/2"
60	169	61	4/0	4	338'	2"	2 1/2"	2"	2"
75	211	76	300	3	379'	2 1/2"	3"	2"	2"
100	273	98	500	2	455'	3"	3"	3"	3"
125	343	124	700	1	500'	3 1/2"	3 1/2"	3"	3"
150	396	143	2-250	2-1	337'	2-2"	2-2 1/2"	2-2"	2-2"
200	528	190	2-400	2-1/0	390'	2-2 1/2"	2-3"	2-2 1/2"	2-2 1/2"

NOTES:

1. Maximum wire length (one-way) for 3% voltage drop.
2. RHW and RHH conductor fill with outer covering.
3. Disconnects must be horsepower rated.
4. @ May require larger size if fused switch is used.



Motor Schedules - 75° C Conductors (continued)

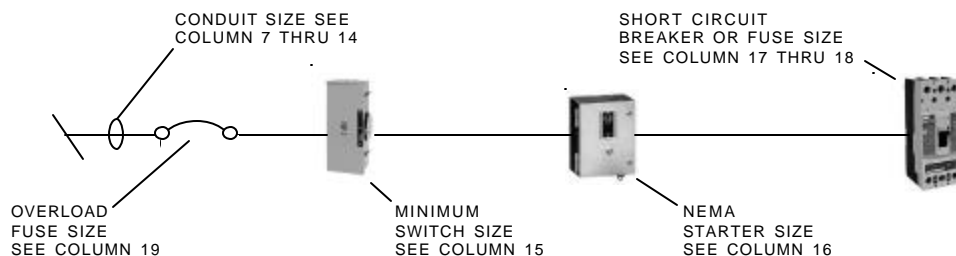
11	12	13	14	15	16	17	18	19
CONDUIT SIZE 3-WIRE - WITH GROUND (40% FILL)				MIN. SWITCH SIZE AMPS	MTR STR	SHORT CIRCUIT BKR	SHORT CIRCUIT RK5 FUZE AMPS	OVER LOAD RK5 FUZE AMPS
THW	RHH RHW	THWN THHN	XHHW		NEMA SIZE	SIZE AMPS		
	NOTE #2			NOTE #3 & 4				

208 Volt Three Phase

1/2"	1/2"	1/2"	1/2"	30	00	10	4	2
1/2"	1/2"	1/2"	1/2"	30	00	10	6	4
1/2"	1/2"	1/2"	1/2"	30	00	10	8	5
1/2"	1/2"	1/2"	1/2"	30	00	10	10	8
1/2"	1/2"	1/2"	1/2"	30	00	10	12	9
1/2"	1/2"	1/2"	1/2"	30	0	15	17.5	12
1/2"	3/4"	1/2"	1/2"	30	0	25	25	20
3/4"	1"	3/4"	3/4"	@ 30	1	40	40	30
3/4"	1"	3/4"	3/4"	60	2	50	50	35
1"	1 1/4"	3/4"	1"	@ 60	3	80	80	50
1 1/4"	1 1/4"	1"	1"	100	3	100	100	70
1 1/4"	1 1/2"	1 1/4"	1 1/4"	@ 100	3	125	125	90
1 1/4"	1 1/2"	1 1/4"	1 1/4"	200	3	150	150	110
1 1/2"	2"	1 1/2"	1 1/2"	200	4	175	175	125
2"	2 1/2"	2"	2"	@ 200	5	250	250	175
2"	2 1/2"	2"	2"	@ 200	5	250	250	200
2 1/2"	3"	2 1/2"	2 1/2"	400	5	350	350	250
3"	3 1/2"	3"	3"	@ 400	6	450	450	300
3 1/2"	4"	3 1/2"	3 1/2"	@ 400	6	600	600	400
2-2 1/2"	2-3"	2-2 1/2"	2-2 1/2"	600	6	600	600	450
2-3"	2-3 1/2"	2-3"	2-3"	800	6	800	800	600

NOTES:

1. Maximum wire length (one-way) for 3% voltage drop.
2. RHW and RHH conductor fill with outer covering.
3. Disconnects must be horsepower rated.
4. @ May require larger size if fused switch is used.



Motor Schedules - 75° C Conductors (continued)

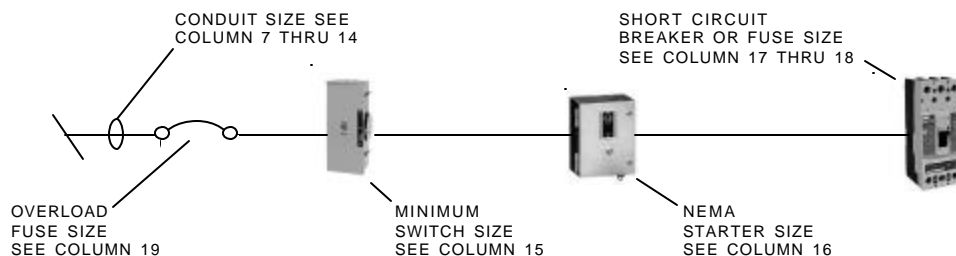
11	12	13	14	15	16	17	18	19
CONDUIT SIZE 3-WIRE - WITH GROUND (40% FILL)				MIN. SWITCH SIZE AMPS	MTR STR	SHORT CIRCUIT BKR	SHORT CIRCUIT RK5 FUZE AMPS	OVER LOAD RK5 FUZE AMPS
THW	RHH RHW	THWN THHN	XHHW		NEMA SIZE	SIZE AMPS	FUSE AMPS	FUSE AMPS
NOTE #2				NOTE #3 & 4				

208 Volt Three Phase

1/2"	1/2"	1/2"	1/2"	30	00	10	4	2
1/2"	1/2"	1/2"	1/2"	30	00	10	6	4
1/2"	1/2"	1/2"	1/2"	30	00	10	8	5
1/2"	1/2"	1/2"	1/2"	30	00	10	10	8
1/2"	1/2"	1/2"	1/2"	30	00	10	12	9
1/2"	1/2"	1/2"	1/2"	30	0	15	17.5	12
1/2"	3/4"	1/2"	1/2"	30	0	25	25	20
3/4"	1"	3/4"	3/4"	@ 30	1	40	40	30
3/4"	1"	3/4"	3/4"	60	2	50	50	35
1"	1 1/4"	3/4"	1"	@ 60	3	80	80	50
1 1/4"	1 1/4"	1"	1"	100	3	100	100	70
1 1/4"	1 1/2"	1 1/4"	1 1/4"	@ 100	3	125	125	90
1 1/4"	1 1/2"	1 1/4"	1 1/4"	200	3	150	150	110
1 1/2"	2"	1 1/2"	1 1/2"	200	4	175	175	125
2"	2 1/2"	2"	2"	@ 200	5	250	250	175
2"	2 1/2"	2"	2"	@ 200	5	250	250	200
2 1/2"	3"	2 1/2"	2 1/2"	400	5	350	350	250
3"	3 1/2"	3"	3"	@ 400	6	450	450	300
3 1/2"	4"	3 1/2"	3 1/2"	@ 400	6	600	600	400
2-2 1/2"	2-3"	2-2 1/2"	2-2 1/2"	600	6	600	600	450
2-3"	2-3 1/2"	2-3"	2-3"	800	6	800	800	600

NOTES:

1. Maximum wire length (one-way) for 3% voltage drop.
2. RHW and RHH conductor fill with outer covering.
3. Disconnects must be horsepower rated.
4. @ May require larger size if fused switch is used.

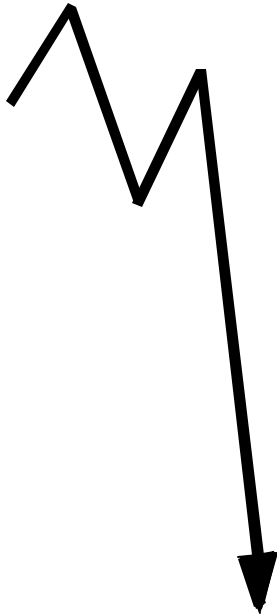


Voltage Drop Single Phase

Listed in this section are 18 voltage drop schedules with 250 calculations each. These schedules provide 4,500 calculations to determine the voltage drop for a given installation. The schedules in this section are for single phase applications.

The National Electrical Code recommends the voltage drop not exceed 5 percent.

Voltage Drop Calculations (from NEC Handbook Article 215)



“Total voltage drop consists of the voltage drop in the feeder plus the voltage drop in the branch circuit. Reasonable operating efficiency will be achieved where the maximum voltage drop of a feeder and a branch circuit does not exceed five percent (5%). Conductors of a feeder should be sized to prevent a voltage drop exceeding three percent (3%) and conductors of a branch circuit should be sized to prevent a voltage drop exceeding two percent (2%).” (See Article 100 N.E.C.® for definition of “Feeder and Branch Circuit”. The five percent (5%) voltage drop value is recommended practice, and as such, it appears as a “Fine Print Note”. Notes are explanatory and not mandatory (see Section 110-1 N.E.C.®).”

“The resistance or impedance of conductors may cause a substantial difference between voltage values at service equipment and voltage values at the point of utilization equipment. Excessive voltage impairs the starting and operation of electrical equipment. In addition to resistance or impedance, length, size, and type of conductor; type of raceway or cable enclosure; type of circuit, AC, DC, single phase, three phase; and power factor are to be considered to determine voltage drop.”

The basic formula for determining voltage drop in either a 2-wire DC circuit, a 2-wire AC circuit, or a 3-wire AC single phase circuit with a balanced load at one-hundred (100%) power factor and where reactance can be neglected is:

$$(2 \times L \times R \times I) \div 1000 = VD$$

Where: VD = voltage drop (based on conductor temperature of 75°C)
L = one-way length of circuit (feet)
R = conductor resistance in ohms per thousand feet.
I = load current (amperes)

Maximum Conductor Length (One-Way)

The tables in this section display the maximum one-way length of a conductor at a given voltage and ampacity. Each table displays both 2% and 3% voltage drops. The formula used to develop these tables is as follows:

$$((V \div 100) \times 3) \div ((2 \times R \times I) \div 1000) = L$$

EXAMPLE

$$((115 \div 100) \times 3) \div ((2 \times 3.1 \times 10) \div 1,000) = 56'$$

Voltage Drop
115 Volt - Single Phase (4-52 Amps)
Maximum Conductor Length (One Way)

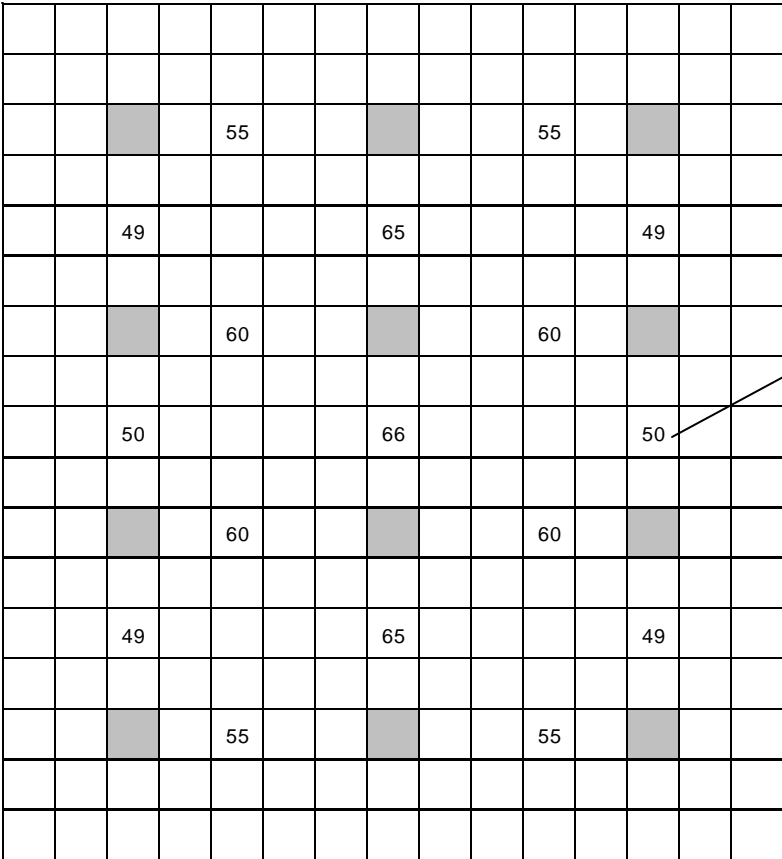
1	2	3	4	5	6	7	8	9	10	11
LOAD	MAXIMUM LENGTH AT 3% VOLTAGE DROP					MAXIMUM LENGTH AT 2% VOLTAGE DROP				
AMPS	#14	#12	#10	#8	#6	#14	#12	#10	#8	#6
4	139'	216'	359'	553'	880'	93'	144'	240'	369'	587'
6	93'	144'	240'	369'	587'	62'	96'	160'	246'	391'
8	70'	108'	180'	276'	440'	46'	72'	120'	184'	293'
10	56'	86'	144'	221'	352'	37'	58'	96'	147'	235'
12	46'	72'	120'	184'	293'	31'	48'	80'	123'	196'
14		62'	103'	158'	251'		41'	68'	105'	168'
16		54'	90'	138'	220'		36'	60'	92'	147'
18			80'	123'	196'			53'	82'	130'
20			72'	111'	176'			48'	74'	117'
22			65'	101'	160'			44'	67'	107'
24			60'	92'	147'			40'	61'	98'
26				85'	135'				57'	90'
28				79'	126'				53'	84'
30				74'	117'				49'	78'
32				69'	110'				46'	73'
34				65'	104'				43'	69'
36				61'	98'				41'	65'
38				58'	93'				39'	62'
40				55'	88'				37'	59'
42					84'					56'
44					80'					53'
46					77'					51'
48					73'					49'
50					70'					47'
52					68'					45'

- NOTES:
1. Columns 2-6 indicated the maximum one-way conductor length at 3% voltage drop.
 2. Columns 7-11 indicated the maximum one-way conductor length at 2% voltage drop.

Lighting Layouts

The charts included on the following pages have been designed to simplify the task of determining wattage requirements and lighting layouts for given size rooms. They have been based upon the use of standard lighting fixtures. The "foot candle" levels are the average light output from various lighting fixture manufacturers.

2' X 2' Parabolic Lighting Fixtures
 3 - 40W T5 Lamps
 8' X 8' Spacing



Foot Candles @ Desktop

2-LAMP

**2' X 2' Recessed
Lighting Fixtures
2-T8U 31 Watt Lamps
8' x 10' Spacing
29 Foot-Candles Avg**

Room Size 32' x 26' x 9'
Task Height 2.5'
Reflectance 80-50-20
Lumens Per Lamp 2800
Power Density 0.75 W/sq ft

	12		19	19			21	19			19				
	19		35	32			38	32			35				
	19		33	33			37	33			33				
	21		39	37			43	37			39				
	19		34	34			37	34			34				
	19		36	33			38	33			36				

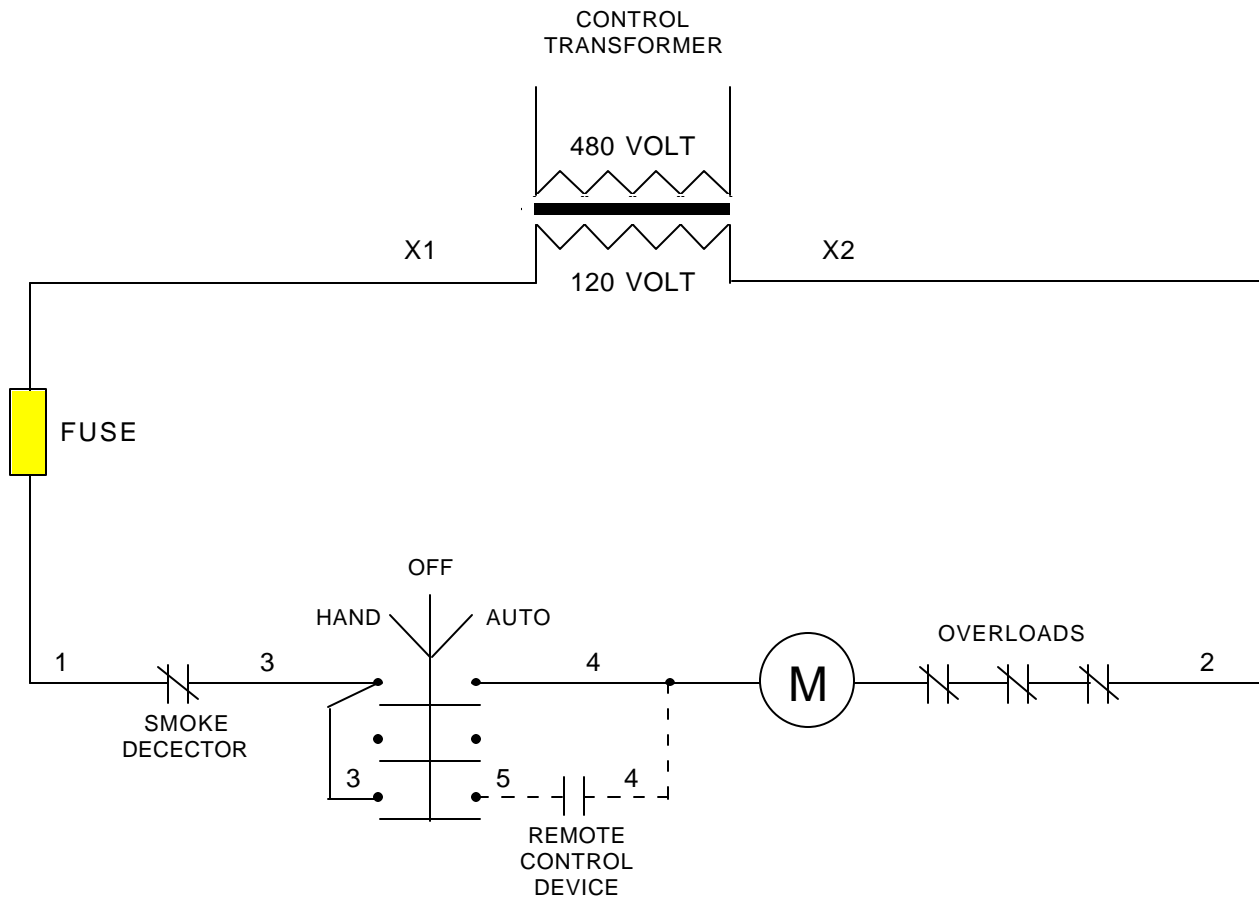
3-LAMP

**2' X 2' Recessed
Lighting Fixtures
3-T8U 31 Watt Lamps
8' x 10' Spacing
38 Foot-Candles Avg**

Room Size 32' x 26' x 9'
Task Height 2.5'
Reflectance 80-50-20
Lumens Per Lamp 2800
Power Density 1.10 W/sq ft

	15		26	25			28	25			26				
	24		48	42			52	42			48				
	25		45	43			49	43			45				
	28		53	48			58	48			53				
	25		45	44			50	44			45				
	25		48	42			52	42			48				

HVAC Control Diagram



SEQUENCE OF OPERATION

Hand-Off-Auto switch will select either the hand or automatic operation. In the automatic position the remote control device will cycle the unit as required. Smoke Detector will automatically stop motor if smoke is detected.

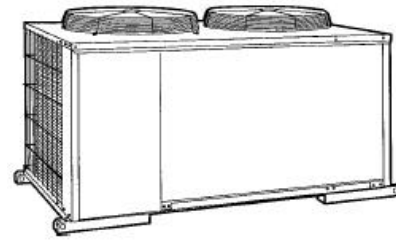
2-Lamp (40 Watt) Fluorescent Fixture

Branch Circuit Load Data

Wattage Based on Ballast Input Watts

Number of Fixtures	Wattage Each	Total Wattage	Amps 1-Phase 120 Volt	Amps 1-Phase 277 Volt	Amps 3-Phase 120/208 V	Amps 3-Phase 277/480 V
1	90	90	0.8	0.3	0.3	0.1
2	90	180	1.5	0.6	0.5	0.2
3	90	270	2.3	1.0	0.8	0.3
4	90	360	3.0	1.3	1.0	0.4
5	90	450	3.8	1.6	1.3	0.5
6	90	540	4.5	1.9	1.5	0.7
7	90	630	5.3	2.3	1.8	0.8
8	90	720	6.0	2.6	2.0	0.9
9	90	810	6.8	2.9	2.3	1.0
10	90	900	7.5	3.2	2.5	1.1
11	90	990	8.3	3.6	2.8	1.2
12	90	1,080	9.0	3.9	3.0	1.3
13	90	1,170	9.8	4.2	3.3	1.4
14	90	1,260	10.5	4.5	3.5	1.5
15	90	1,350	11.3	4.9	3.8	1.6
16	90	1,440	12.0	5.2	4.0	1.7
17	90	1,530	12.8	5.5	4.3	1.8
18	90	1,620	13.5	5.8	4.5	2.0
19	90	1,710	14.3	6.2	4.8	2.1
20	90	1,800	15.0	6.5	5.0	2.2
21	90	1,890	15.8	6.8	5.3	2.3
22	90	1,980	16.5	7.1	5.5	2.4
23	90	2,070	17.3	7.5	5.8	2.5
24	90	2,160	18.0	7.8	6.0	2.6
25	90	2,250	18.8	8.1	6.3	2.7
26	90	2,340	19.5	8.4	6.5	2.8
27	90	2,430	20.3	8.8	6.8	2.9
28	90	2,520	21.0	9.1	7.0	3.0
29	90	2,610	21.8	9.4	7.3	3.1
30	90	2,700	22.5	9.7	7.5	3.3
31	90	2,790	23.3	10.1	7.8	3.4
32	90	2,880	24.0	10.4	8.0	3.5
33	90	2,970	24.8	10.7	8.3	3.6
34	90	3,060	25.5	11.0	8.5	3.7
35	90	3,150	26.3	11.4	8.8	3.8
36	90	3,240	27.0	11.7	9.0	3.9
37	90	3,330	27.8	12.0	9.3	4.0
38	90	3,420	28.5	12.3	9.5	4.1
39	90	3,510	29.3	12.7	9.8	4.2
40	90	3,600	30.0	13.0	10.0	4.3
41	90	3,690	30.8	13.3	10.3	4.4
42	90	3,780	31.5	13.6	10.5	4.6
43	90	3,870	32.3	14.0	10.8	4.7
44	90	3,960	33.0	14.3	11.0	4.8
45	90	4,050	33.8	14.6	11.3	4.9
46	90	4,140	34.5	14.9	11.5	5.0
47	90	4,230	35.3	15.3	11.8	5.1
48	90	4,320	36.0	15.6	12.0	5.2
49	90	4,410	36.8	15.9	12.3	5.3
50	90	4,500	37.5	16.2	12.5	5.4

Commercial Air Cooled Condensing Units



208/230V-3Ø-60HZ (6-20 Ton)

SIZE TON	MIN VOLT	MAX VOLT	MIN CIR AMPS	MAX FUSE OR BKR	MIN SW SIZE	WIRE SIZE/LENGTH 75° C LIMITING 2% VOLTAGE DROP						
						#10 CU	#8 CU	#6 CU	#4 CU	#3 CU	#4 AL	#1 AL
6.0	208	230	25.6	35	60	116'	184'	287'	457'	574'	277'	556'
7.5	208	230	42.5	50	60	---	111'	173'	275'	346'	167'	335'
8.5	208	230	52.7	70	100	---	---	139'	222'	279'	135'	270'
10.0	208	230	62.5	100	100	---	---	117'	187'	235'	113'	228'
12.5	208	230	69.3	100	100	---	---	---	169'	212'	---	205'
15.0	208	230	87.5	125	200	---	---	---	---	168'	---	163'
20.0	208	230	93.4	150	200	---	---	---	---	157'	---	152'

460V-3Ø-60HZ (6-20 Ton)

SIZE HP	MIN VOLT	MAX VOLT	MIN CIR AMPS	MAX FUSE OR BKR	MIN SW SIZE	WIRE SIZE/LENGTH 75° C LIMITING 2% VOLTAGE DROP						
						#12 CU	#10 CU	#8 CU	#6 CU	#8 AL	#6 AL	#4 AL
6.0	460	460	12.9	15	30	320'	510'	808'	1258'	490'	764'	1216'
7.5	460	460	21	25	30	---	314'	497'	773'	301'	470'	747'
8.5	460	460	26.3	35	60	---	250'	397'	617'	240'	375'	596'
10.0	460	460	29.1	40	60	---	226'	358'	558'	217'	339'	539'
12.5	460	460	31.7	50	60	---	---	329'	512'	199'	311'	495'
15.0	460	460	40.7	60	60	---	---	256'	399'	---	242'	385'
20.0	460	460	48.1	80	100	---	---	217'	337'	---	205'	326'