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Voltage Drop

THE "K" FACTOR TABLE gives voltage drop per 1000 ampere-metres for wire in magnetic (steel) or non-magnetic (e.g. aluminum, PVC, etc.) conduits. Examples of its use are given in the Voltage Drop Calculation Example. K Factors are calculated for 60–75℃ wire temperature since this is an estimate of the average temperature at which a circuit operates in service.

For circuits known to be operating at 90℃, multipl y the voltage drop by 1.102 for copper and 1.105 for aluminum.

The table is based on ***Three Phase Line-to-Neutral voltage.*** For circuits operating on other systems, the following CORRECTION FACTOR (f) should be included in the calculation. To correct voltage drop per 1000 metres to voltage drop per 1000 feet, multiply by 0.3048.

Systems	Correction Factor (f)
1 PHASE 2 WIRE (120 V branch circuits)	2
1 PHASE 3 WIRE (240 V residential circuits)	2
1 PHASE 3 WIRE Line to Line	2
3 PHASE 3 WIRE Line to Line	1.73
3 PHASE 4 WIRE Line to Line	1.73
3 PHASE 4 WIRE Line to Neutral	1

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Voltage Drop Estimating Table

For three conductor cables or three single conductor cables in conduit.

“K” Factor - Line-to-neutral voltage drop per ampere per circuit kilometre.

Size AWG or kcmil	COPPER						ALUMINUM					
	Magnetic Conduit or Armour			Non-Magnetic Conduit or Armour			Magnetic Conduit or Armour			Non-Magnetic Conduit or Armour		
	80%P.F.	90%P.F.	100%P.F.	80%P.F.	90%P.F.	100%P.F.	80%P.F.	90%P.F.	100%P.F.	80%P.F.	90%P.F.	100%P.F.
14	8.329	9.341	10.320	8.296	9.304	10.280						
12	5.265	5.896	6.496	5.244	5.873	6.470						
10	3.335	3.726	4.087	3.322	3.711	4.070						
8	2.134	2.374	2.582	2.118	2.355	2.562	3.453	3.858	4.231	3.440	3.843	4.214
6	1.368	1.512	1.625	1.357	1.500	1.612	2.198	2.445	2.662	2.191	2.438	2.654
4	0.882	0.966	1.021	0.875	0.959	1.013	1.410	1.561	1.682	1.403	1.553	1.674
3	0.711	0.775	0.810	0.706	0.769	0.804	1.130	1.246	1.334	1.125	1.241	1.328
2	0.575	0.623	0.642	0.573	0.620	0.639	0.908	0.997	1.058	0.903	0.992	1.053
1	0.469	0.503	0.509	0.467	0.501	0.507	0.733	0.800	0.839	0.729	0.796	0.835
1/0	0.383	0.407	0.404	0.381	0.405	0.402	0.592	0.642	0.665	0.592	0.642	0.665
2/0	0.314	0.330	0.320	0.314	0.330	0.320	0.480	0.517	0.527	0.480	0.517	0.527
3/0	0.260	0.270	0.254	0.260	0.270	0.254	0.392	0.418	0.418	0.392	0.418	0.418
4/0	0.218	0.223	0.203	0.217	0.222	0.201	0.321	0.339	0.332	0.321	0.339	0.332
250	0.193	0.195	0.172	0.192	0.194	0.171	0.280	0.293	0.281	0.280	0.293	0.281
300	0.171	0.170	0.145	0.169	0.169	0.144	0.242	0.250	0.234	0.242	0.250	0.234
350	0.155	0.153	0.127	0.153	0.151	0.124	0.216	0.221	0.203	0.214	0.220	0.201
400	0.142	0.139	0.112	0.141	0.137	0.110	0.195	0.198	0.177	0.193	0.196	0.176
500	0.126	0.121	0.093	0.123	0.118	0.089	0.167	0.168	0.145	0.165	0.165	0.142
600	0.115	0.109	0.080	0.112	0.105	0.076	0.148	0.146	0.122	0.146	0.144	0.119
750	0.101	0.094	0.064	0.105	0.098	0.069	0.131	0.127	0.101	0.132	0.129	0.102
1000	0.096	0.088	0.058	0.090	0.082	0.051	0.114	0.108	0.081	0.110	0.104	0.076

Note: In general, the voltage drop on an aluminum conductor is approximately the same as that for a copper conductor two gauge sizes smaller. For non-metallic sheathed cables, use K factor for non-magnetic conduit or armour. (For other than 3 phase, 4 wire line to neutral voltage drop, *multiply* K factor above by the *f* factors shown in the "K".)

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Examples of Voltage Drop Calculations

$$\textbf{Voltage Drop (volts)} = \frac{\textbf{K} \text{ (from Voltage Drop Table) x } \textit{f} \text{ (from "K" factor table) x } \textbf{Current} \text{ (amps) } \textbf{x length of run} \text{ (metres)}}{\textbf{1000}}$$

$$\textbf{\% Voltage Drop (volts)} = \frac{\textbf{Actual voltage drop} \text{ (volts)}}{\textbf{Actual circuit voltage}} \textbf{ x 100}$$

Example 1:
It is required to run a 120 volts, single phase circuit 70 m long, carrying 20 amps.

What size of copper NMD90 cable should be used if maximum voltage drop required is 3%?

Allowable Vd = 3% x 120
3.6 volts.

$$\textbf{Required K} = \frac{\text{Voltage drop x 1000}}{\textit{f} \text{ x amps x metres}} = \frac{3.6 \text{ x } 1000}{2.0 \text{ x } 20 \text{ x } 70} = 1.28$$

From the table for copper conductors in non-magnetic conduit (assuming 100% power factor), the smallest conductor size that does not exceed K = 1.28 volts/1000 amp m. is a **No. 4 AWG** (k = 1.013).

Example 2:
A 347/600 volt 3 phase, 4 wire system is required to carry 170 amps a total run of 180 m. #2/0 AWG copper RW90 in aluminum conduit is proposed.

What would be the resulting line to neutral voltage drop, assuming a 90% power factor?

$$\textbf{Voltage drop} = \frac{\text{K x } \textit{f} \text{ x amps x metres}}{1000} = \frac{0.330 \text{ x } 1.0 \text{ x } 170 \text{ x } 180}{1000} \textbf{ = 10.1 volts to ground.}$$

As a percentage, this voltage drop is 10.1/347 x 100 = 2.9%

What size of wire would be required to give a 2% drop?

Allowable Vd = 2% x 347
6.9 volts

$$\textbf{Maximum K} = \frac{\text{Voltage drop x 1000}}{\textit{f} \text{ x amps x metres}} = \frac{6.9 \text{ x } 1000}{1.0 \text{ x } 170 \text{ x } 180} = .23$$

From the table, select **#4/0 AWG** copper wire (k = .222).