



The following sections are the ANSI / IEEE Std 141 formulae used by Volts for voltage drop computations.

AC Circuits

For AC circuits, where AC resistance and inductive reactance are considered, the following is the IEEE Std 141 exact voltage drop formula.

$$V_d = V + IR\cos(\theta) + IX\sin(\theta) - \sqrt{V^2 - (IX\cos(\theta) - IR\sin(\theta))^2}$$

where:

V_d = Voltage drop (Line to Neutral)

V = Voltage (source)

I = Current in amperes (A)

R = AC Resistance from NEC® Chapter 9 Table 9 (Ohms to Neutral)

X = AC Reactance from NEC® Chapter 9 Table 9 (Ohms to Neutral)

distance (L) is considered from the Resistance & Reactance Tables

where Ohms per unit / 1000 * L in same unit = R or X

θ = Angle of Phase Offset = Arc Cosine (device or circuit Power Factor)

Line to Line is computed by Line to Neutral VD / Sqrt(3).

DC Circuits

$$V_d = \frac{2 \times R \times L \times I}{1000} \quad \text{OR} \quad V_d = \frac{2 \times K \times L \times I}{C_M}$$

where:

V_d = Voltage drop

R = DC Resistance from NEC® Chapter 9 Table 8

L = Distance

I = Current in amperes (A)

K = Material Resistivity constant - 12.9 for Cu & 21.2 for Al

C_M = Circular mils of conductor

Ambient Temperature

Additionally, ambient temperature is considered with the following ratio of temperatures formula. This formula is used to adjust the Chapter 9 Table 9 values from 75°C to the installation ambient temperature in Celsius (C).

$$R_2 = R_1 [1 + \alpha(T_2 - 75)]$$

where: $\alpha_{cu} = 0.00323$, $\alpha_{AL} = 0.00330$

R2 = New Conductor Resistance

R1 = Original Conductor Resistance

α = Material Resistivity

T2 = Ambient Temperature in Celsius (TA)

Eddy Currents

Eddy currents are induced currents in surrounding magnetic or non-magnetic metal. These currents create heating in the metal and therefore act as an energy loss that translates into an increase in resistance of the circuit. **NEC® Chapter 9, Table 9** segregates conduits into three groups, PVC, Aluminum and Steel to account for the added resistance with each of the three conduit group types. PVC, being non-metallic, does not produce any eddy currents and therefore has the least resistance value of the three. Steel and Aluminum conduit, being metallic, do produce eddy currents and their respective resistance values are reflective of this.

Complements of Dolphins Software