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How to Calculate Voltage Drop for Long Paired Wire Runs

A primary concern when installing lengths of wire is voltage drop. The amount of voltage lost between the originating power supply and the device being powered can be significant. Improper selection of wire gauge can lead to an unacceptable voltage drop at load end. The following chart is designed to help calculate voltage drop per 100 feet of paired wire as a function of wire gauge and load current.
By matching load current (in AMPs) across the top of the chart with wire gauge (AWG) down the left side of the chart, one can determine voltage drop per 100 feet of paired wire run.
NOTE: A paired wire run represents the feed and return line to the load. Therefore, a 500 foot wire pair is equivalent to 1000 feet of total wire.

EXAMPLE ONE:

Given a load current of 1 AMP, and using 18 AWG wire, how much voltage drop can we expect at the load end for a 350 foot run of paired wire?
Using the chart, we match the row for 18 AWG and the column for 1 AMP and determine that voltage drop per 100 feet is 1.27 Volts. By dividing the paired wire length by 100, we get the factor by which we need to multiply voltage drop per 100 feet to determine total voltage drop. Therefore, 350 feet divided by 100 equals 3.5. Multiply 3.5 by 1.27 volts drop per 100 feet to get your total voltage drop. Thus the total voltage drop is 3.5 times 1.27, or 4.445 voltage drop for 350 feet.

$$\boxed{\frac{350}{100} \times 1.27 = 4.45 \text{ Volts}}$$

EXAMPLE TWO:

Given a camera load of 2 AMPs, that is 400 feet from the power source, which wire gauge should be selected to keep voltage drop at the camera to less than 3 volts?
To use the chart, we need to determine what the maximum voltage drop per 100 feet is. We calculate that 100 feet is 1/4 of 400 feet, thus the voltage drop allowed for 100 feet is 1/4 times 3 volts (which is the equivalent of 0.75 volts per 100 feet):
voltage drop per 100 feet = 3/4 = .75 volts per 100 feet.
So, knowing that we can not allow anything greater than a voltage drop of .75 volts per 100 feet, we can now look at the chart and select the wire gauges that will give us lower voltage drops per 100 feet at a 2 AMP load current. In this case, wire gauges of 10 (.40 V), 11 (.50 V), and 12 AWG (.64) will all suffice, with 13 AWG (.80) being a possibility.
Thus, in order to keep voltage drop at the camera to less than 3 volts given a camera load of 2 AMPs and a 400 foot paired wire run, we need to use a wire gauge in the range of 10-13 AWG.

VOLTAGE DROP PER 100 FT RUN OF PAIRED WIRE

Gauge (AWG)	.5 amp - Load Current	1 amp - Load Current	2 amp - Load Current	4 amp - Load Current	10 amp - Load Current
10	0.10	0.20	0.40	0.80	2.00
11	0.13	0.25	0.50	1.01	2.52
12	0.16	0.32	0.64	1.27	3.18
13	0.20	0.40	0.80	1.60	4.00
14	0.25	0.50	1.01	2.02	5.04
15	0.32	0.64	1.27	2.54	6.35
16	0.40	0.80	1.60	3.20	8.00
17	0.50	1.01	2.02	4.03	10.08
18	0.64	1.27	2.54	5.08	12.71
19	0.80	1.60	3.20	6.40	16.01
20	1.01	2.02	4.03	8.07	20.17
21	1.27	2.54	5.08	10.17	25.42
22	1.60	3.20	6.40	12.81	32.02

FORMULA METHODS:

These handy equations can be used to determine voltage drop per 100 feet or wire gauge as an alternative to the chart, even for values that are not on the chart. To arrive at total voltage drop, always divide paired wire run length by 100, and then multiply that number by voltage drop per 100 Feet:

1. To determine voltage drop per 100 feet given load current and wire gauge:

$$V_D = .2 * I_L * 1.26^{(AWG-10)}$$

   VD = Voltage drop per 100 feet (Volts)
   IL = Current load (AMPs)
   AWG = Wire gauge

2. To determine wire gauge necessary given paired wire length, load current, and desired voltage drop per 100 feet:
3.

$$AWG = 10Log\left(\frac{V_D}{I_L}\right) + 17$$

With these useful tools, voltage drop problems can be avoided before installation, saving time, money and ensuring a correctly working system.