



Fire alarm voltage drop and battery formula sheet

Built from our fire alarm voltage drop guide and battery guide. Every number in the checks is invented for practice.

Our own one-page summary of the circuit and battery arithmetic in our two guides. Work each check by hand, then confirm it with the calculator named beside it.

- L is one-way length in feet; r is one conductor in ohms per 1,000 ft. If the resistance already covers a pair, do not double it again.
- I is each appliance's maximum listed current at the low end of its range. Vs is the voltage at the NAC terminals under the condition checked.
- The listing, the panel manual and the edition your job enforces control. The cable check is one limit of several.

Voltage drop on a radial NAC

Loop resistance, drop and device voltage

$R_{loop} = 2 \times L \times r / 1,000$; $drop = I \times R_{loop}$; $V_{device} = V_s - drop$

Check: 300 ft, 4.2 ohm per 1,000 ft, 0.600 A, Vs 20.6 V: 2.520 ohm, 1.512 V, last appliance 19.088 V

[Open in calculator: alarmladder.com/tools/fire-alarm-voltage-drop-calculator](https://alarmladder.com/tools/fire-alarm-voltage-drop-calculator)

Longest one-way run, and meters

$L_{max} (ft) = 1,000 \times (V_s - V_{min}) / (2 \times I \times r)$; $L (ft) = L (m) / 0.3048$

Check: 20.6 V, Vmin 16.4 V, 0.600 A, 4.2: 833.3 ft; 91.44 m is 300 ft

[Open in calculator: alarmladder.com/tools/fire-alarm-voltage-drop-calculator](https://alarmladder.com/tools/fire-alarm-voltage-drop-calculator)

Point to point against lumped

each segment carries the sum of the downstream currents; add the segment drops

N equal loads at equal spacing: $drop = lumped\ drop \times (N + 1) / (2 N)$

Check: 0.100 A at 80 ft, 0.200 A at 200 ft, 0.300 A at 300 ft: 1.1592 V, against 1.512 V lumped

Copper resistance model (AWG number n, temperature T in C)

$d (mm) = 0.127 \times 92^{((36 - n) / 39)}$; $A = \pi \times d^2 / 4$; $r_{20} = (1 / 58) \times 304.8 / A$ ohm per 1,000 ft

$r_T = r_{20} \times [1 + 0.00393 \times (T - 20)]$; 75 C multiplies by 1.21615; stranded multiplies the result by 1.02

Check: solid copper at 75 C: 14 AWG 3.0713, 16 AWG 4.8835 ohm per 1,000 ft

[Open in calculator: alarmladder.com/tools/fire-alarm-wire-size-calculator](https://alarmladder.com/tools/fire-alarm-wire-size-calculator)

Pass and fail, eight strobes at 0.150 A (I = 1.200 A, Vs 20.4 V, Vmin 16.0 V)

14 AWG, 250 ft one way: drop 1.843 V, appliance 18.557 V, passes

16 AWG, 450 ft one way: drop 5.274 V, appliance 15.126 V, fails by 0.874 V

Battery capacity

Amp-hours (Is standby amps, Ia full alarm amps, Ts hours, Ta minutes)

base Ah = $I_s \times T_s + I_a \times (T_a / 60)$; with margin m percent, base $\times (1 + m / 100)$

retained fraction f: base / f. A percent added and a fraction retained are not the same number.

Check: 0.150 A, 1.878 A, 24 h, 5 min: $3.600 + 0.1565 = 3.7565$ Ah; with 25% margin 4.6956 Ah

[Open in calculator: alarmladder.com/tools/fire-alarm-battery-calculator](https://alarmladder.com/tools/fire-alarm-battery-calculator)

Sources

NBS Handbook 100, Copper Wire Tables; System Sensor I56-5845-002; Fire-Lite 52750. Worked arithmetic is ours. NEC Chapter 9, Table 8 and NFPA 72 section 10.6.7 are named by number only.

Read next

[Fire alarm voltage drop guide, with every example worked: alarmladder.com/guides/fire-alarm-voltage-drop-formula](https://alarmladder.com/guides/fire-alarm-voltage-drop-formula)

[Fire alarm battery guide: alarmladder.com/guides/fire-alarm-battery-calculation-method](https://alarmladder.com/guides/fire-alarm-battery-calculation-method)

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