Wire Sizing & Voltage Drop

A plain-English field guide to conductor ampacity, the 3 % voltage-drop limit, and the Canadian Electrical Code tables behind them. Prepared by Crescent Electric, Fort McMurray, Alberta.

Two rules decide every wire size

A conductor has to pass **two** separate tests, and you use whichever answer is larger:

1. Ampacity. The wire must safely carry the current without overheating. This comes straight from the Code's ampacity tables — Table 2 for copper and Table 4 for aluminum, using the 75 °C column that matches typical modern terminations.

2. Voltage drop. Over distance, a conductor loses voltage. The Code limits drop to roughly 3 % on a branch circuit and about 5 % from the service to the furthest outlet. Long runs regularly force a size larger than ampacity alone would require.

Ampacity at a glance (75 °C column)

Planning values in amperes for copper (Table 2) and aluminum (Table 4). Derating for ambient temperature, bundled conductors, and insulation type still applies.

Conductor size	Copper (A)	Aluminum (A)	Typical use
14 AWG	15	—	Lighting, general outlets
12 AWG	20	15	Kitchen, garage, 20 A circuits
10 AWG	30	25	Dryer feed, small A/C, 30 A
8 AWG	40	30	Range, 40 A EV charger
6 AWG	60	40	Hot tub, 60 A sub-panel
4 AWG	80	60	Sub-panel, shop feed
3 AWG	90	65	Feeder
2 AWG	100	80	100 A sub-panel (copper)
1 AWG	125	85	Feeder
1/0 AWG	150	100	100 A service (aluminum)
2/0 AWG	175	115	Feeder
3/0 AWG	200	130	200 A service (copper)
4/0 AWG	230	155	200 A service (aluminum)
250 kcmil	255	170	Large feeder
350 kcmil	310	210	320 A service
500 kcmil	380	255	400 A service

Aluminum is not rated for 14 AWG. Where aluminum is used, terminations must be listed for aluminum and treated with the manufacturer's recommended compound.

Continuous loads — anything running three hours or more, such as an EV charger or electric heat — must be sized at 125 % of the load per CEC Rule 8-104. A 40 A continuous charger is wired and protected as a 50 A circuit.

Calculating voltage drop

Voltage drop depends on current, the one-way distance, the conductor's resistance, and the system voltage:

Single-phase: Drop % = (2 × A × L × R ÷ 1000) ÷ V × 100
Three-phase: Drop % = (1.732 × A × L × R ÷ 1000) ÷ V × 100

A = load in amperes • **L** = one-way run length in metres • **R** = conductor resistance in ohms per kilometre (below) • **V** = system voltage. For feet, multiply the length by 0.3048 to get metres.

Conductor resistance (ohms per km at 75 °C)

Size	Copper	Aluminum	Size	Copper	Aluminum
14 AWG	10.3	—	1 AWG	0.51	0.83
12 AWG	6.50	10.4	1/0 AWG	0.40	0.66
10 AWG	4.07	6.56	2/0 AWG	0.32	0.52
8 AWG	2.55	4.13	3/0 AWG	0.254	0.42
6 AWG	1.61	2.66	4/0 AWG	0.203	0.33
4 AWG	1.02	1.67	250 kcmil	0.171	0.28
3 AWG	0.81	1.32	350 kcmil	0.125	0.20
2 AWG	0.64	1.05	500 kcmil	0.089	0.14

Worked example

A 40 A continuous EV charger, 30 m from the panel, on 240 V single-phase, copper:

Sized at 125 % (Rule 8-104) the circuit is 50 A, so ampacity alone calls for 6 AWG copper. Checking drop on 6 AWG: (2 × 40 × 30 × 1.61 ÷ 1000) ÷ 240 × 100 = **1.61 %** — comfortably under 3 %. 6 AWG copper is the answer. Push the same circuit out to 70 m and the drop reaches 3.76 %, so the run gets upsized to 4 AWG.

Maximum run length before you exceed 3 %

One-way distance in metres for copper at 240 V single-phase. Halve these numbers for 120 V circuits — a 120 V run tolerates roughly half the distance for the same current.

Circuit	Load	Copper size	Max run @ 240 V	Max run @ 120 V
15 A lighting/outlets	12 A	14 AWG	70 m	35 m
20 A kitchen/garage	16 A	12 AWG	83 m	42 m
30 A dryer	24 A	10 AWG	88 m	44 m
40 A range	32 A	8 AWG	106 m	53 m
50 A EV charger	40 A	6 AWG	134 m	67 m
60 A sub-panel	48 A	6 AWG	112 m	56 m
100 A sub-panel	80 A	3 AWG	133 m	67 m

Protection that goes with the wire

Circuit	Typical protection	Notes
Bedrooms and living areas	15 A arc-fault breaker	Arc-fault protection is required for most dwelling-unit branch circuits under CEC Rule 26-722.
Kitchen counter receptacles	Two 20 A split or T-slot circuits with ground-fault protection	Receptacles within 1.5 m of a sink need ground-fault protection.
Bathroom receptacles	20 A with ground-fault protection	Serves the bathroom receptacles only.
Outdoor and garage receptacles	15 or 20 A with ground-fault protection	Weather-resistant devices and in-use covers outdoors.
Electric range	40 A double-pole	8 AWG copper typical; confirm the nameplate.
EV charger	Breaker sized at 125 % of the continuous load	40 A charger on a 50 A breaker with 6 AWG copper.
Hot tub	Ground-fault protected disconnect within sight	Bonding of the tub and surrounding metal is required.
Dedicated lighting circuit	15 A	Kept separate from receptacle circuits where practical.

Field notes for Fort McMurray homes

Cold matters. Outdoor and unheated-space runs behave differently than the table values suggest; conductor and cable types must be rated for the installed conditions and for wet locations where applicable.

Aluminum branch wiring. Many homes built in the 1960s and 70s used aluminum for 15 and 20 A circuits. It is not automatically unsafe, but every device and splice must be listed for aluminum. Loose or improperly terminated aluminum connections are one of the most common problems we find.

Older panels. Federal Pacific Stab-Lok panels and fuse panels still turn up locally. Before adding an EV charger, hot tub, or sub-panel, the existing panel and service should be evaluated, not just the new circuit.

Detached garages and shops. These are where voltage drop bites hardest — the run is long and the loads (welder, compressor, heater) are large. Size the feeder for what the shop will eventually hold, not just today's load.

Before you buy wire

Check	Why
Confirm the appliance nameplate rating	Nameplate current, not the brochure, sets the circuit size.
Apply 125 % to continuous loads	Required by CEC Rule 8-104 for loads running 3 hours or more.
Measure the actual one-way run	Include vertical drops and route detours, not the straight-line distance.
Check the drop at the real length	Long runs frequently need one size larger than ampacity alone.
Verify the panel has capacity	A new large circuit may require a service load calculation or panel upgrade.
Confirm terminations are rated	Breaker, lug, and device ratings can limit the usable ampacity column.
Pull the permit	Electrical work in Alberta is permitted and inspected under the Alberta Safety Codes Act.

Run the numbers for your own project

Free wire size, voltage drop and full CEC Section 8 service load calculators:
www.fortmcmurrayelectrician.ca/load-calculator

Questions, quotes, or a second opinion on a panel: **587-557-5494**