



Sizing the Whole Circuit

Wire size, breaker rating, and box fill are not three separate lookups. Each one depends on the answer to the last. Here is a single 40A circuit walked through all three, start to finish.

A single circuit is never really one decision, it is a short chain of them, and each link depends on the one before it. Get the wire size right and the breaker choice is nearly automatic. Get the wire size wrong and every downstream decision, breaker, box, conduit, inherits the mistake. This guide walks one real 40A circuit through wire, breaker, and box, in the order the decisions actually depend on each other.

Step one: wire size sets the ceiling for everything after it

A 40A load at 25 ft on copper, 3% voltage-drop target, sizes to 8 AWG copper. Its ampacity is 50A, well above the 40A load, and the voltage drop at this short distance is only 0.7%, nowhere near the 3% limit. Ampacity is what governs here, the conductor is not close to being pushed by distance the way it would be on a much longer run.

That 8 AWG choice is not just an answer, it is now a constraint. The breaker has to protect this specific conductor, and the box has to physically fit it. Nothing after this step is independent of it.

Step two: the breaker protects the wire, not the load

With 8 AWG copper carrying a 40A non-continuous load, the breaker sizing engine picks a 40A breaker, the next standard size at or above the load. The reasoning matters more than the number: "A bigger breaker does not mean more capacity. The breaker protects the wire, so it cannot exceed what the conductor can safely carry."

That is the dependency made explicit. If the wire in step one had come out smaller (say the load were lower, landing on 10 AWG), the breaker would be capped by NEC 240.4(D) regardless of the load current, because small conductors carry a hard ceiling on the overcurrent device that can protect them. The wire size decision, not the load alone, sets the breaker's upper bound.

Step three: the box has to physically hold what steps one and two decided

Box fill is the most literal dependency in the chain. It is not a code check on performance, it is a physical volume calculation: how much space does the actual conductor, device, and clamp hardware take up. For the default case, 3 #12 conductors, 1 device, and a ground, the required fill is

13.50 cubic inches, and the smallest standard box that clears it is a 3x2x2.75 device box at 14 cubic inches, half a cubic inch of margin.

Change any upstream decision, a bigger wire gauge, an extra device, a different clamp configuration, and this number moves. The box is sized last because it cannot be sized before everything going into it is known.

Why this matters more than any single number

Looking up wire size, breaker size, and box size as three unrelated lookups is how a circuit ends up internally inconsistent, a wire sized for one load, a breaker sized for a different assumption, a box that was never checked against what actually landed inside it. Running them in dependency order, wire first, then breaker against that wire, then box against everything in it, is what keeps the whole circuit honest.

Key takeaway. Wire, breaker, and box are one decision chain, not three separate lookups. Size the wire first, size the breaker to protect that specific wire, then size the box to physically hold everything the first two decisions put inside it.

Assumptions

- 40A, 240V, non-continuous load, 25 ft run, copper conductor throughout, one device in the box.

Sources

- NEC Table 310.16 (conductor ampacity)
- NEC 240.4(D) (small-conductor overcurrent protection cap)
- NEC 314.16 (box fill volume requirements)

Frequently asked questions

Can the breaker ever force the wire size instead of the other way around?

In practice the load and the run length set the minimum wire size first, and the breaker is chosen to protect whatever wire that produces. Working backward from a desired breaker size to a wire is how undersized conductors happen, the wire has to be checked against the actual load and distance regardless of what breaker someone had in mind.

Does a longer run change the breaker or the box, not just the wire?

A longer run can force a bigger wire (see [The True Cost of Undersizing Wire](#)), and once the wire is bigger, the box fill volume goes up too, since a larger conductor occupies more of the box's counted volume. The breaker itself is set by the load and conductor ampacity, not directly by run length, but everything downstream of a wire-size change moves with it.

Why is box fill measured in cubic inches instead of just device count?

Different conductor sizes, devices, and clamp types occupy different standardized volumes per NEC 314.16, a box that comfortably fits three 14 AWG conductors can be too small for the same three conductors in 10 AWG. Cubic inches is the only unit that captures that difference accurately.

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