

Multi-branch Circuit Wiring Issues

Application Note

120 Vac Inverter/Charger Installations

976-0116-01-01 Rev A

Purpose



WARNING: Fire Hazard

A possible fire hazard can exist if 120 Vac only sources (such as inverters and generators) are wired incorrectly into 120/240 Vac panels containing multi-wire branch circuits.

The purpose of this Application Note is to describe how to prevent a potential fire hazard when using 120 Vac stand-alone inverters or 120 Vac generators in installations that have multi-branch circuit wiring. This Application Note describes how to check for multi-wire branch circuits in the load center and presents some possible solutions to this wiring method.

Multi-wire Branch Circuits

Problem	A potential safety problem exists when installing stand-alone 120 Vac inverters into existing 120/240 Vac wired panels where multi-wire branch circuit wiring methods were used.
Legacy situation	Multi-wire branch circuits are wired differently from “home run” type wiring (Figure 1) in that only one neutral wire is used to provide the neutral-return path for each circuit connected to both phases of the AC grid. This method has been employed by electricians in recent years to keep construction costs down by saving copper and labor costs involved in running a separate conductor for each circuit.
Normal condition	Under normal conditions, this technique is quite safe and meets code requirements. When used as originally installed, the current for each circuit is 180° out-of-phase with each other, so the neutral wire never receives more current than it was designed to handle as the current from each circuit subtracts (or cancels out, leaving only the difference current between the two circuits). Refer to Figure 2.
Safety issue	A safety problem occurs when a stand-alone 120 Vac inverter is installed to power these circuits, causing the one neutral wire to now carry the in-phase currents for both circuits. Since the current is in-phase, the two circuits add instead of subtract, potentially doubling the current flow in the neutral return wire! Refer to Figure 3. The branch circuit breakers do not protect the neutral wire from overload under this condition. This excess current will overheat the neutral wire, potentially creating a fire hazard.

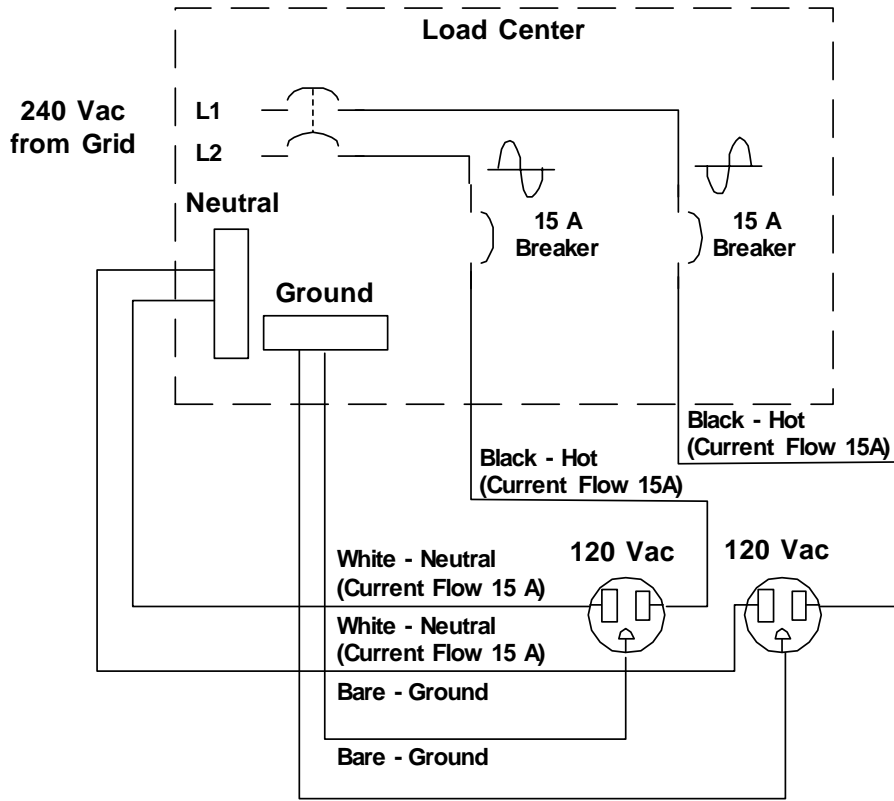


Figure 1 Conventional Home-type Wiring

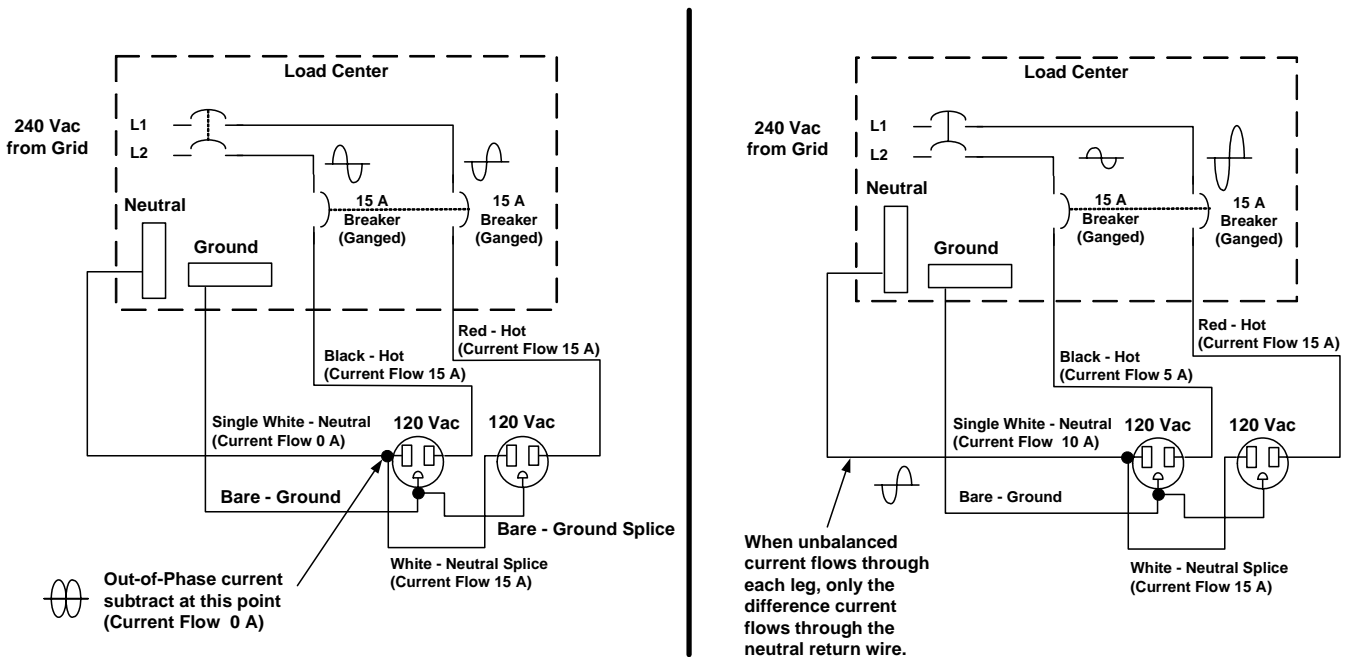


Figure 2 Multi-wire Branch Circuit Wiring and Current Flow

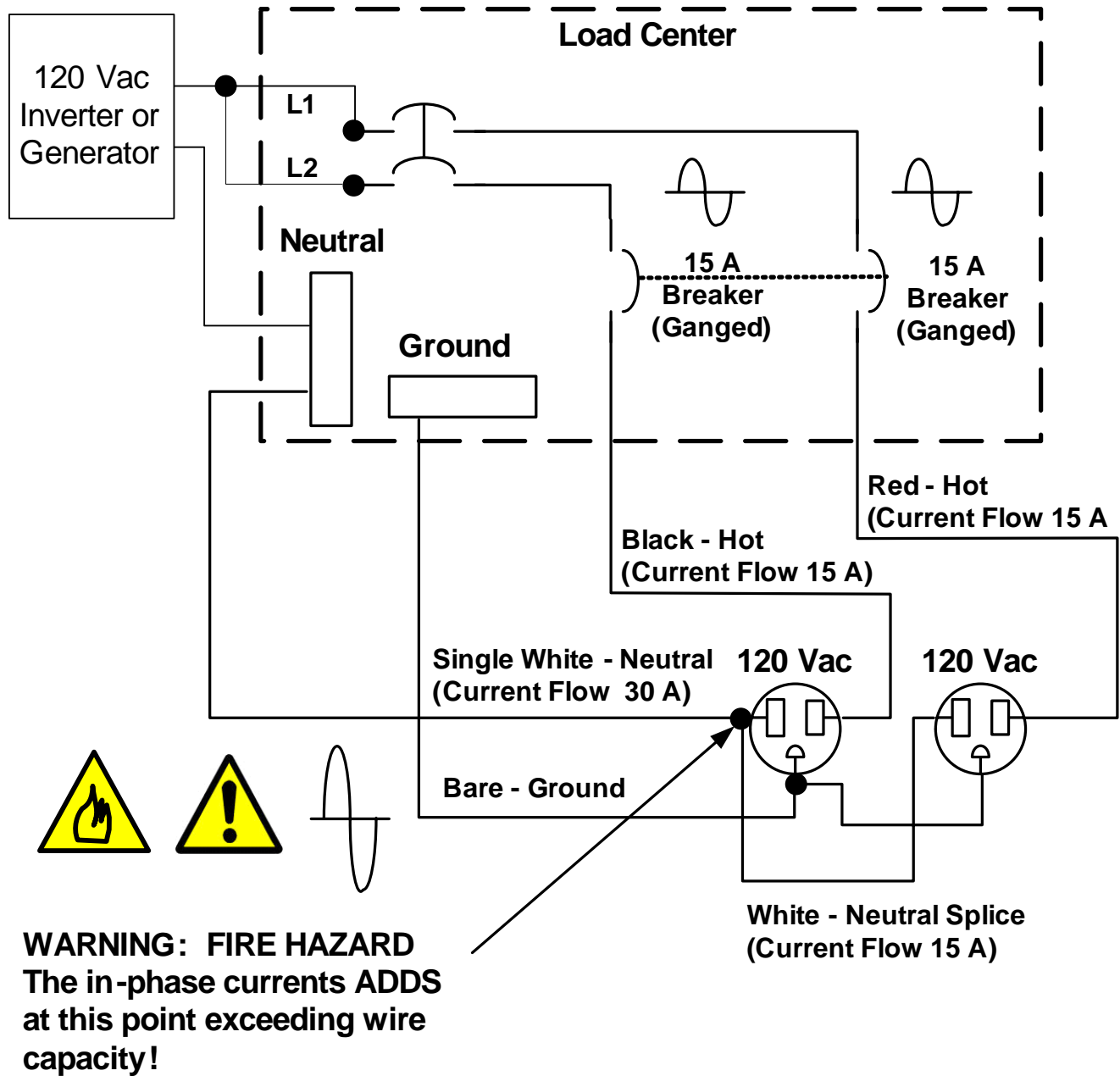


Figure 3 120 Vac Inverter Incorrectly Wired in a Multi-wire Branch Circuit

Identifying Multi-wire Branch Circuits



WARNING: Shock Hazard

The next step involves opening the load center, exposing live circuits. This procedure should only be performed by qualified persons or electricians.

Identifying characteristic

Multi-wire branch circuits can be identified by removing the cover on the load center and inspecting the wiring. Conventional 120 Vac circuits are identified by a 2-wire-plus-ground (black, white, and copper) cable for each circuit. Multi-wire branch circuits use a 3-wire-plus-ground arrangement (black, red, white and copper) for each circuit run.

If this arrangement exists in the panel and it is being powered by a stand-alone 120 Vac inverter, a potential fire hazard exists! For safety, these circuits must be rewired to meet code.

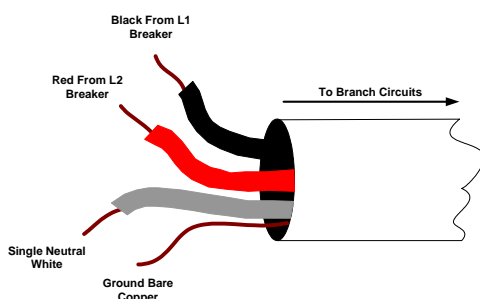


Figure 4 Multi-wire Branch Circuit Wiring

Correcting Multi-wire Branch Circuit Wiring

Correcting multi-wire branch circuit wiring is complicated. It is recommended that you consult a qualified electrician before making any changes to existing wiring to ensure code compliance and safety.

Acceptable options

There are three options which will correct this condition in 120 Vac only systems:

- Rewire existing multi-wire branch circuits to conventional “home run” wiring. This requires a qualified electrician (knowledgeable about multi-wire branch circuit wiring) and is expensive. There may be multiple multi-wire branch circuits located throughout the structure, requiring complete rewiring.
- Add a second inverter in a “series stacked” arrangement. This is an expensive solution, but would restore the original 240 Vac split-phase configuration. This solution may actually be less expensive than having an electrician re-wire the multi-wire branch circuits. It also provides increased power backup protection and can power 240 Vac loads.
- If separate wires are used in conduit, then the neutral wire can be increased in size to accommodate the additional neutral current.

Recommended option

Add a step-up autotransformer to the output of the inverter to restore the split-phase configuration. This is the least expensive and easiest method to correct for multi-wire branch circuit wiring. Refer to Figure 5. Using this method, half of the current is supplied to one leg of the circuit and half to the other in a split-phase arrangement (180° out-of-phase). This will restore the original functionality and safety to the multi-wire branch circuit.



WARNING: Fire Hazard

Until one of the solutions above is implemented, a stand-alone 120 Vac inverter (or generator) must not be installed where multi-wire branch circuits exist.

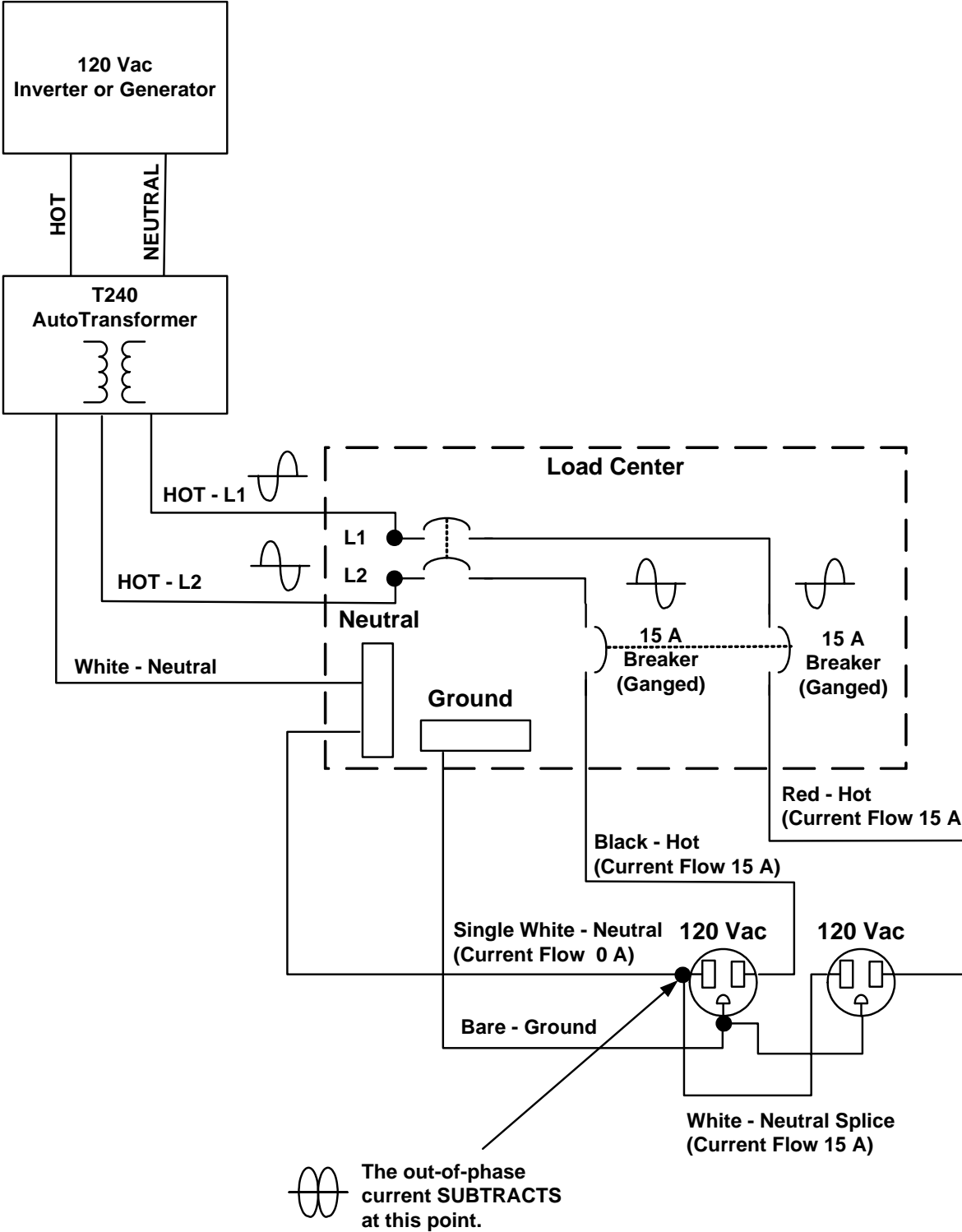


Figure 5 Using a Step-up Autotransformer in Multi-wire Branch Circuit Wiring

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Part number: 976-0116-01-01 Rev A

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