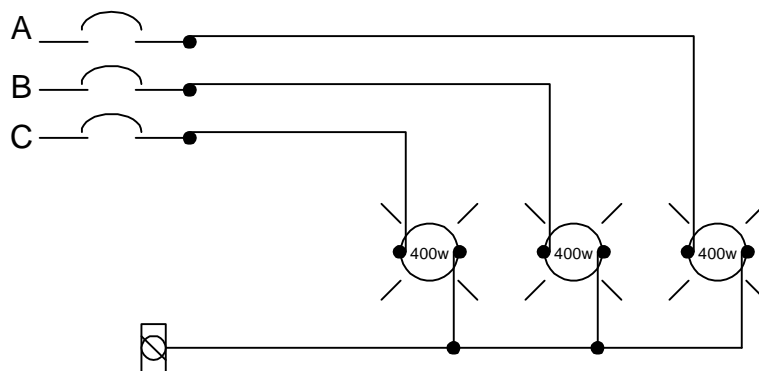


Beware; the Multiwire Branch Circuit

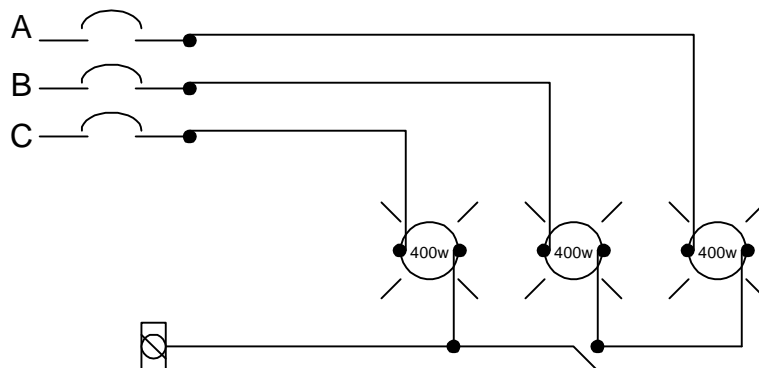
The electrical industry has a formal Code, and it has unwritten rules-of-thumb, just as any other discipline involving construction. The Code changes every three years, and the changes are brought about by new technology and political pressure, but the rules-of-thumb are more subtle. Consequently, they are harder to change. The multiwire branch circuit has been the rule-of-thumb, and the "economy", of the electrical industry for too long. The Code has tried to address some of the safety issues raised by the use of multiwire branch circuits in residences. It requires a common trip of over-current protection for circuits sharing a neutral that are terminated on a common device, (such as a duplex receptacle). However, the danger to equipment in commercial and industrial applications remains. It is time for a change.

The theory of the multiwire branch circuit is sound; a shared neutral conductor will only carry the imbalance of the loads on circuits supplied by different phases of a service. Therefore, if branch circuits are wired and maintained correctly, properly sized over-current protection is adequate for neutral conductors as well as ungrounded conductors.

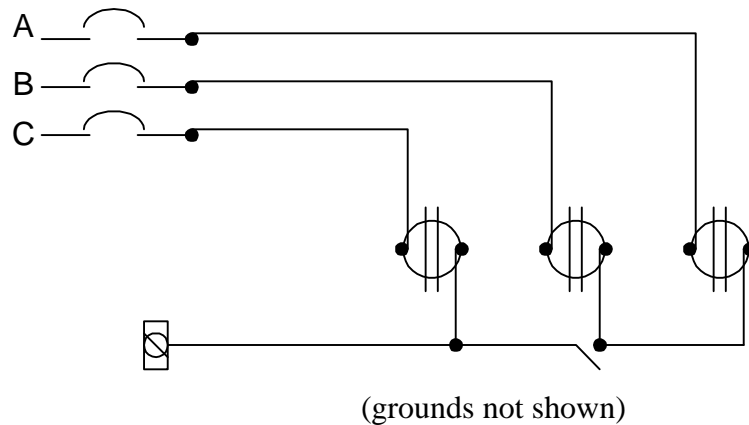
Three adjacent, 20 amp single-pole breakers in a three phase panel feed identical lighting loads, and share a neutral conductor.



If the neutral connection at one of the 'T' splices loses integrity, some of the loads will try to continue operating in a series configuration with the line-to-line voltage.



Issues of harmonic distortion and power quality have certainly made us more aware of the problems presented by the practice of sharing a neutral. Some manufacturers, and code panels have tried to address the problem by suggesting, or requiring an oversized neutral, but the danger of over-voltage to utilization equipment still exists.



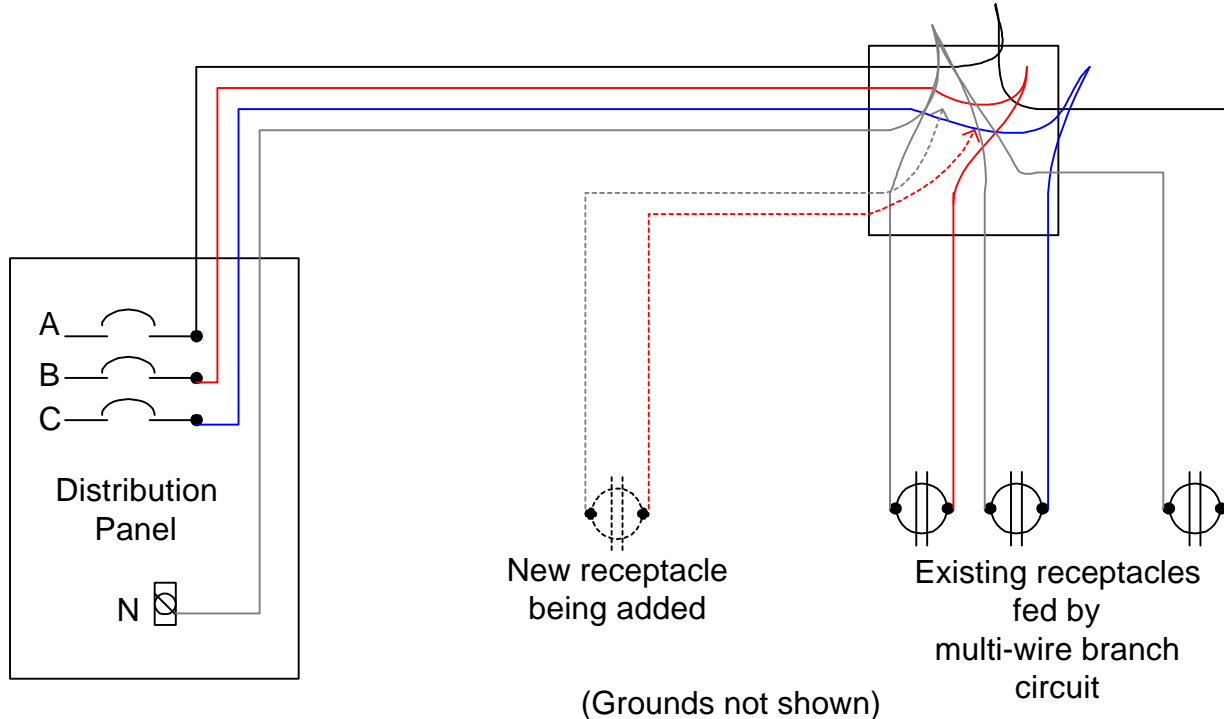
Unfortunately, it has been a common practice in the past, to wire receptacles with the same, shared neutral, multiwire branch circuit methods. The open indicated at the second ‘T’ splice in the neutral, creates a situation in which two pieces of utilization equipment plugged into the outlets fed by breakers ‘A’ and ‘B’ would actually be connected in series with a 208 volt potential. This happens far too frequently, particularly with the use of powered base panels in partition walls for office cubicles. The partition walls have base sections that are usually hard wired to the facility electrical system, then plug into the adjacent sections to distribute power among the offices.

Some of the partition manufacturers are abandoning the shared neutral method and providing separate neutrals with each ungrounded circuit conductor. This dramatically reduces the possibility of supplying an over-voltage to the equipment served within the office cubicles. The entire electrical industry should follow suit and provide a dedicated neutral with every circuit that distributes 120 volt, power.

The high tech industry has lead the way in writing such requirements into their specifications. By requiring dedicated neutrals with every 120 volt circuit feeding receptacles, some project engineers have eliminated the chance of over-voltage damage to equipment caused by high resistance in the grounded conductor of multiwire branch circuits.

In the interest of safety and protection of equipment, all 120 volt branch circuits that extend beyond a distribution panel board should be complete and independent of any other branch circuit. This means that all 120 volt circuits should have dedicated neutrals, and that shared neutrals should not be employed to feed receptacle circuits. In addition, these dedicated neutrals should be identified with the corresponding circuit number, at every splice. In this way, the electrician that comes to alter or extend an existing circuit, is less likely to tap the wrong neutral.

Another unwritten rule-of-thumb for the electrical industry that is widely practiced in the US, is that conductors brought into a 120/208 volt distribution panel are identified with the appropriate color; A-phase circuit conductors are Black, B-phase are Red, and C-phase are Blue. This helps keep the multiwire branch circuits grouped properly, (a neutral with each group of black, red, and blue ungrounded conductors). However . . .

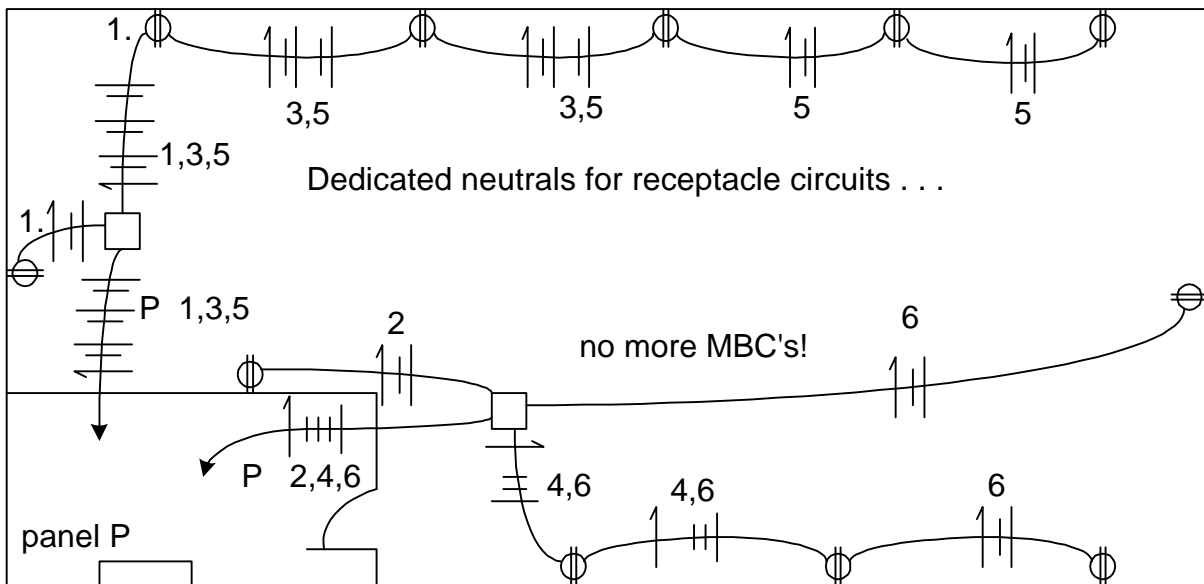


In the above drawing, an electrician is modifying an existing circuit by adding an outlet, and he's chosen the B-phase circuit. In order to implement this addition safely and without risk to utilization equipment fed by the other two circuits, he must turn off all three circuits. Otherwise, when he removes the wire nut from the neutrals to tie in the additional neutral, a momentary interruption in neutral continuity between the other circuits and the panel could cause over-voltage at the receptacles.

In another hypothetical situation, one of the three breakers fails, and an electrician moves the circuit conductor to a spare breaker that doesn't happen to be on the correct phase of the service. Now there is a possibility of over-loading the neutral without tripping any over-current devices. In fact, when the loads on the three circuits aren't balanced, and they have different inductive characteristics, the voltages are no longer 120 electrical degrees apart, and the neutral can be subjected to overload conditions even if the system is correctly connected and maintained.

It's Time for a Change!

D. Clements
Oregon electrical inspector's
certificate #5217EI



The time has come for electricians and electrical engineers to step up to the safety plate, and chose to use a slightly more expensive wiring method. Sure we save a little copper and we have a little less pipe fill using multi-wire branch circuits, but the subtle problems, and the huge potential for damage to utilization equipment, should be reason enough to ban their use. If the engineers specify dedicated neutrals, and electricians resolve to pull a neutral with every 120 volt circuit that feeds convenience outlets and receptacles, we'll save ourselves and our customers, a lot of grief in the future.



It took the electrical industry several generations to recognize the safety issue of separate ground and neutral conductors to ranges and dryers. Let's not make the same mistake with Multiwire Branch Circuits. There are already, far too many MBC installations in existence. Let's stop installing them now . . . and hopefully, the National Electrical Code will follow with revisions that support this choice for quality, rather than economy.

Take this significant step . . .
and improved power quality
will surely follow!

Multiwire Branch Circuits and the 1999 National Electrical Code

Article 100 – Definitions page 70 – 19

Branch Circuit, Multiwire. A branch circuit that consists of two or more ungrounded conductors that have a potential between them, and a grounded conductor that has equal potential difference between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system.

Article 210-4. Multiwire Branch Circuits. page 70 – 37

(a) General. Branch circuits recognized by this article shall be permitted as multiwire branch circuits. A multiwire branch circuit shall be permitted to be considered as multiple circuits. All conductors shall originate from the same panelboard.

FPN: A 3-phase, 4-wire, wye-connected power system used to supply power to non-linear loads may necessitate that the power system design allow for the possibility of high harmonic neutral currents.

(b) Dwelling Units. In a dwelling unit, a multiwire branch circuit supplying more than one device or equipment on the same yoke shall be provided with a means to disconnect simultaneously all ungrounded conductors at the panelboard where the branch circuit originated.

page 70 – 38

(c) Line-to-Neutral Loads. Multiwire branch circuits shall supply only line-to-neutral loads.

Exception No. 1: A multiwire branch circuit that supplies only one utilization equipment.

Exception No. 2: Where all ungrounded conductors of the multiwire branch circuit are opened simultaneously by the branch-circuit overcurrent device.

(d) Identification of the Ungrounded Conductors. Where more than one nominal voltage system exists in a building, each ungrounded conductor of a multiwire branch circuit, where accessible, shall be identified by phase and system. This means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means and shall be permanently posted at each branch-circuit panelboard.

Note from DC, (the author of this article);

Another unwritten rule-of-thumb commonly practiced in the electrical industry is that 120/208 volt circuits utilize black/red/blue w/white neutrals, and 277/480 volt circuits use brown/orange/yellow w/grey neutrals.

Table 310-15(b)(2)(a). Adjustment factors for More than Three Current-Carrying Conductors in a Raceway of Cable. page 70 – 124

Number of Current-Carrying Conductors	Percent of Values in Tables 310-16 through 310-19 as Adjusted for Ambient Temperature if Necessary
4-6	80
7-9	70
10-20	50
21-30	45
31-40	40
41 and above	35

Article 310-15(b)(4). Neutral Conductor. page 70 – 124

(a) A neutral conductor that carries only the unbalanced current from other conductors of the same circuit shall not be required to be counted when applying the provisions of Section 310-15(b)(2)(a).

(b) In a 3-wire circuit consisting of two phase wires and the neutral of a 4-wire, 3-phase wye-connected system, a common conductor carries approximately the same current as the line-to-neutral load currents of the other conductors and shall be counted when applying the provisions of Section 310-15(b)(2)(a).

(c) On a 4-wire, 3-phase wye circuit where the major portion of the load consists of nonlinear loads, harmonic currents are present in the neutral conductor; the neutral shall therefore be considered a current-carrying conductor.

(More notes from DC)

These excerpts from the 1999 NEC relate to multiwire branch circuits, and clearly indicate that the NEC recognizes the use of this wiring method.

The following page describes a hypothetical situation that encourages electricians and engineers to use MBCs. This situation occurs frequently in real-world construction, and the significant difference in the cost of installation is usually the deciding factor.

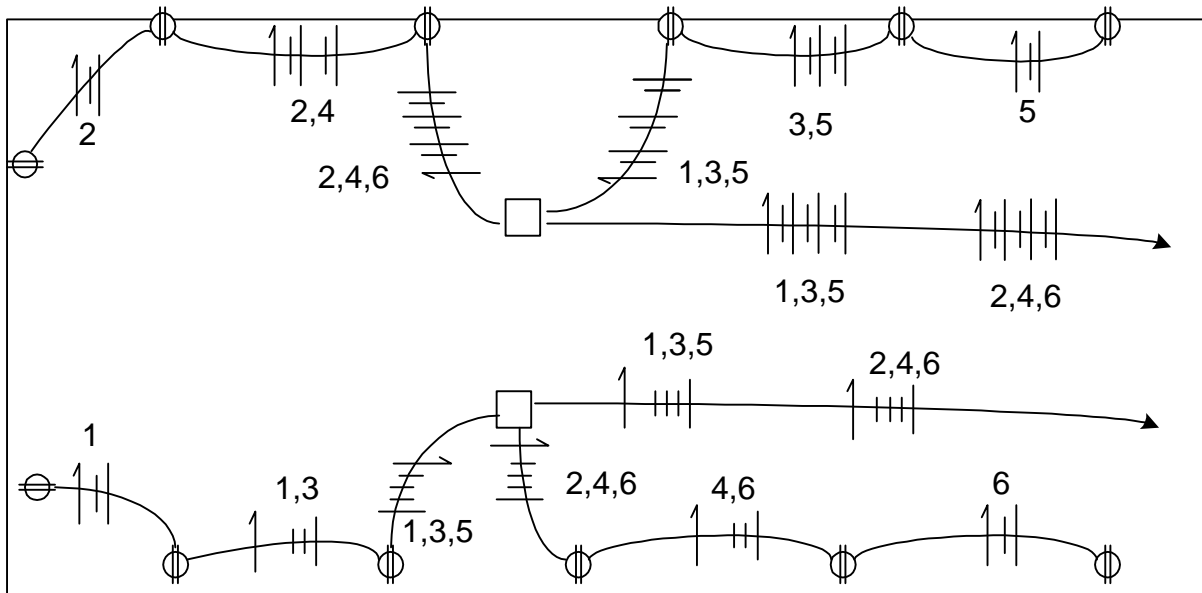
A room in an office building requires 6 – 120 volt, 20 amp circuits for computer equipment. A 120/208 volt, 3-phase, 4-wire, distribution panelboard is located in an electrical closet about 80 feet down the hall.

Here's a few questions about the installation:

1. What size raceway(s) would be required for the 'home run' from the junction box?
2. What size wire would be required in each scenario?
3. Which method would you use;

a. dedicated neutrals

b. Multiwire Branch Circuit



Here's the unfortunate answers;

1. The MBC method could utilize a 3/4" raceway, while the dedicated neutral method would require a 1" conduit.
2. The MBC method requires a maximum of eight current-carrying conductors, while the dedicated neutral method requires 12. According to Table 310-15(b)(2)(a), the MBC method could use #12 conductors, while the dedicated neutrals method would require #10s! Economics dictate that the electrician use MBCs, but it's a short-sighted choice!

The loads are better served and protected by the dedicated neutral method. Other countries of the world do not use MBCs . . .

**It's Time for a Change . . . Quality and Safety,
not Economy!**