Never Connect Neutral and Earth (Ground) Downstream from Main Panel

This Document Explains why Neutral and Earth (Ground) should Never be Bridged Downstream from Electrical Main Panel

The question is often asked what is the maximum voltage permitted between the Neutral and Earth (Ground) conductor and if the Neutral and Earth can be bridged to achieve a zero value.

This can be a difficult topic as it will depend on the earthing arrangement, see:

IEC 60364-5-54 Electrical installations of buildings - Selection and erection of electrical equipment - Earthing arrangements.

In a TN system (TN-S / TN-CS) in a perfect world it should be 0V but we should remember we don't live in a perfect world. In a single-phase installation, the voltage-drop in the phase conductor, and the voltage rise on the neutral, will be equal. Therefore, a neutral/earth voltage of **10 volts** implies a total drop of **20 volts**, which is excessive, so the question arises: Why can't N and E be bridged to achieve this?

The answer is, no, this is not permitted as in a TN-S or TN-CS Network, the only place you're allowed to connect (bond) the Neutral and the Earth (Ground) is in the main service panel fed by the utility. The neutral and Earth wire in any subpanel must be kept separate. The neutral bus must be isolated from the panel chassis. In some countries a bonding jumper that connects the chassis metallic parts to the neutral bus may be provided with the distribution board. Do **NOT** connect this jumper. That can only be done in the main panel. You need a separate Earth bar in the subpanel which is bonded to the panel chassis for all metal panels.

Many people are aware of this requirement but don't completely understand the reasoning behind the rule. Common logic would argue that if you bond the two (neutral and earth) in the main panel, why can't you do it in the subpanel?

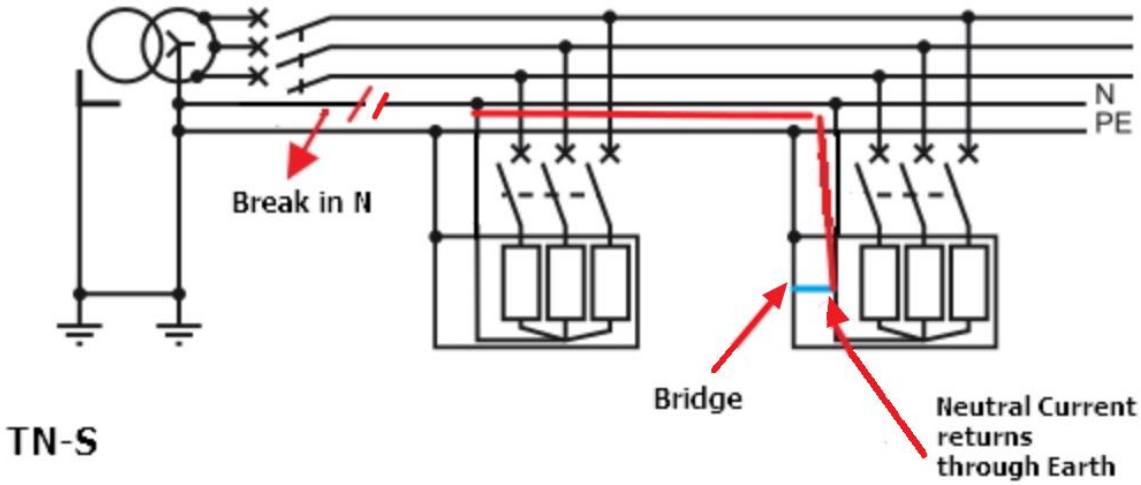
In a perfect world, all connections are sound and firm. Functionally, Neutral current doesn't care how it gets back to the star-point of the transformer but most electrical regulations specify that it is contained in the insulated Neutral wire. Because electricity will take the path of least resistance from Point A to Point B, bonding the neutral and earth in the subpanel means that part of the neutral return current will flow in the Neutral wire and part will travel in the earth path back to the main panel.

Some would say, that it doesn't matter if p*art of the Neutral current is flowing on Earth conductor. It's all at earth potential so what's the problem?* The problem is that we **don't** live in a perfect world. If everything remains a good tight connection, we may have no problem. But let's assume that the neutral connection is a little loose at some point, say at the main panel. This forces all the neutral current to flow through the Earth conductor. If **that's** still bonded well, we still have no functional problem since it's indeed still at earth potential.

Now, let's assume that in addition to the loose neutral connection, there is a loose Earth along the way. We now have a situation where the conduit or Earth conductor is energized with Neutral current trying to find a way back to Earth. This could also make earthed appliances live as well and if you touch any metal part of the installation, or even a screw on a socket, you now become a path to Earth, since the current on the earth conductor has no other way to go due to the loose connections.

Multiple earthing can also lead to earth loops which can affect sensitive electronic equipment.

Another potential problem could be if a break occurs in the main neutral. As we go downstream, the cable sizes will usually be smaller and in such cases the neutral load for the entire building could return through the earth of subpanel thus overloading it and creating a fire hazard.

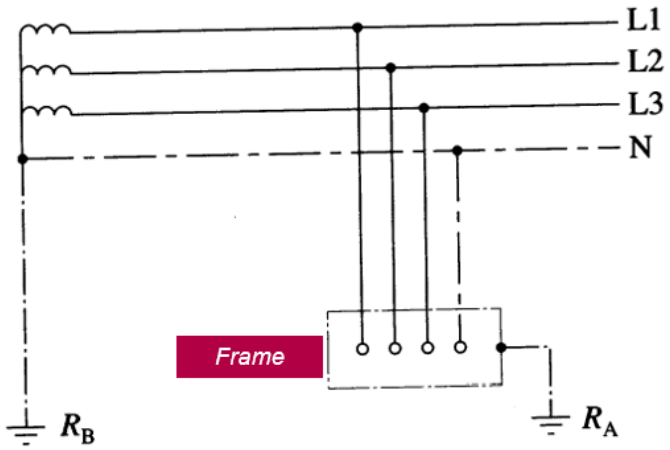


The above scenario shows a broken Neutral upstream and we can assume that the downstream cables are smaller the earth cable will be overloaded

More than one failure mode simultaneously can never be ruled out and in such cases, personal safety is at stake.

The ***Earth Conductor is for safety and should never have any normal current flow on it, it is only there for fault current. If such a fault occurs, there will be no protection and this safety hazard will remain present indefinitely.***

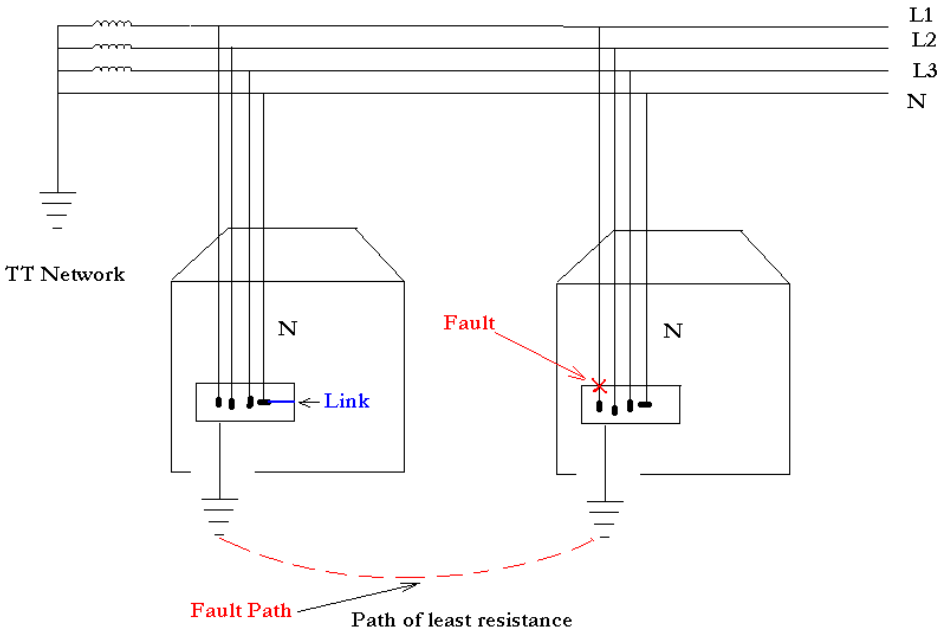
Ok that covers a TN network BUT there are other forms of networks, the TT for example. Here there is no connection between Earth and Neutral in the main panel, the return path for any fault current is through earth.



TT Network

As the Earth Impedance can limit the current flow to Earth, this Network requires RCD (ELCB - GFI) Protection

From the previous example, it is clear, that the neutral current doesn't care how it gets back to the star-point of the transformer and it will always take the path of least resistance and it may even take a path through a neighbours' installation and in such cases the utility company will insist that you clean up your installation, see example below.



In the first building there is a disallowed connection between Neutral and Earth. When a fault occurs in the second building, the earth electrode of the first building offers the best return path so it goes that way. This can cause all sorts of problems, such as RCDs tripping, cable overheating etc.

There are situations where it is a requirement to have 0V between Neutral and Earth and the best solution is such circumstances is the installation of an Isolation Transformer and connecting one leg to earth.

To summarise, there is a very good reason why IEC 60364 and almost all local regulations, (e.g. VDE0100, 18th Edition of the IEE and the NEC) prohibit this practice and it should never be implemented under any circumstances.