THE KILLING GROUND

EARTH YOUR STATION SAFELY

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MOST MODERN HOUSES, especially on estates, have the ac mains wired to them on the protective multiple earth (pme) system. This can present particular hazards to the radio amateur who wishes to provide an external earth to the station for rf purposes, and more so to those who need to apply an external earth to other equipment to overcome emc. But first, what is pme?

Protective multiple earthing

PME started to be used extensively in the 'sixties. Before this, electricity supply systems used three-phase supplies with neutral and earth, and the earth was usually provided by metallic sheathing of the cable. The main earth was at the sub station, and this could have a high resistance. The neutral is at (or near) earth potential anyway, so the idea of pme was born. Here the neutral is the earth, Fig 2.

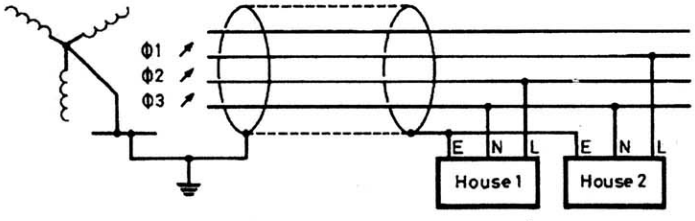

Fig 1. Three-phase neutral plus earth

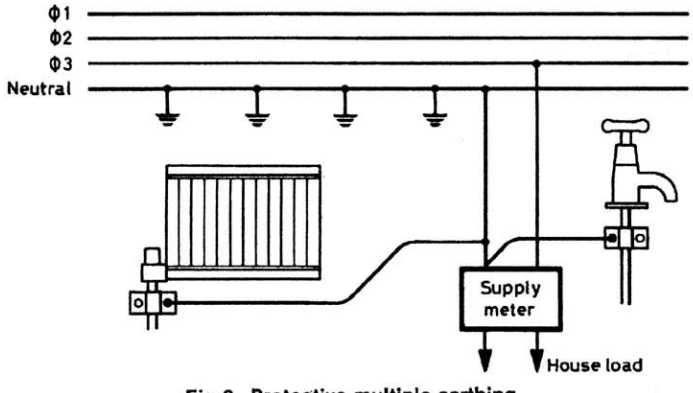

Fig 2. Protective multiple earthing

By bonding the neutral conductor to earth, not only at the substation but at many other points, the earth resistance is now much lower. In a pme system, the water and gas pipes bonded at the house to the neutral conductor and an earth is provided every so often along the run of the neutral. With the 'sixties change to plastic water pipes, the old capabilities of providing a good earth tended to disappear, so bonding of the water pipes is important if, for example, a faulty immersion heater or washing machine is not to make the whole plumbing system live. So in a modern house, the gas and plumbing are all connected to the neutral of the mains near the consumer unit (fusebox), and the neutral is connected to earth in many places along the cable run from the sub-station. This is pme. By measuring the current in live and neutral, it is easy to detect an unbalanced load—such as a radio amateur!, see Fig 3.

The current flowing to earth from the live conductor does not flow back through the neutral, and by measuring the difference, it is easy to switch off the supply if an unbalanced load is presented. This is done by an earth leakage trip. There are two forms of earth leakage trip. One is called a voltage trip and is actuated by a rise in the neutral-earth voltage. (Actually by current in the earth lead.) These are only fitted in older installations. The other form is a current operated trip which is also known as a residual current device (rcd) or a residual current circuit breaker (rccb). This is more usual, but isn't normally fitted in the house.

One problem that can occur is with mains filters as shown in Fig 4. Since the 240V appear across C1 and C2 but no volts appear across C3 and C4. Thus an unbalanced load is provided, and most earth leakage trips are set for about 30mA which provides for filters and some leakage, such as immersion heaters etc. But very good rf filters, such as used in professional screened rooms for instance, have leakages of 1·5A or more, and thus cause problems. Medical electronics have much lower leakage requirements, making rf filtering very difficult.

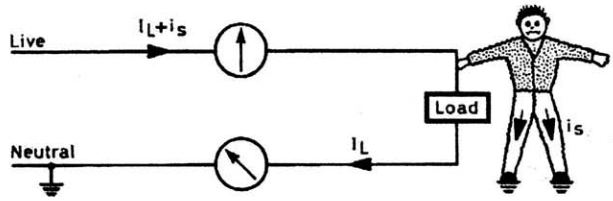

Fig 3. Unbalanced current flow when an earth load is connected

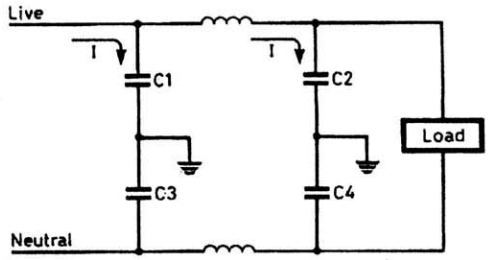

Fig 4. Mains filter with unbalanced current flow

A disadvantage of pme lies in the effect that results if the neutral, but not the live, is broken. In the worst case, the neutral at the consumer unit can reach 240V above earth; see Fig 5. As all the metal work in the house is connected together, no shock hazard exists, because nobody can contact true earth and the metalwork. Because all the metalwork in the house is floating, the occupants are in a Faraday Cage and it doesn't matter what potential they are at. In pme systems, precautions are taken to minimize breakage of the neutral, but it can—and does—occur.

Where's the problem?

Enter John Q Newham. He reads in the books about needing a good earth, separate from the mains earth for earthing his station. He knows—or should know—that a good earth can help prevent emc problems. So, down goes an earth stake, lots of copper wire is bonded to it and buried, and John runs a thick lead into the station, and connects it to the equipment. This is where the problem comes. Look at Fig 5 again. Supposing a fault existed when John brought in his rf earth. With the equipment, radiators and all metalwork floating at 240V, it is likely that John would be electrocuted when he touched his rig. But assume a ruptured neutral occurs later, and look at the set up that John has now got; Fig 6. Current flows from the neighbour's house to earth through John's house, and through the mains lead to his rig and down to his earth. The electricity supply may have a number of earths on the neutral in parallel with John's earth, which will reduce the current, but in the worst case John could have two or three house loads feeding current into his earth. The likelihood of his mains wiring or lead from the wall socket melting are high and earth leads must **NEVER** ever be fused.

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