PROTECTIVE CONDUCTOR CURRENTS

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FLUORESCENT LIGHTING or other discharge lighting often incorporates electronic high frequency control gear which provides many advantages, including:

- energy saving
- ability to provide dimming,
- lower weight
- increased lamp life
- reduction or elimination of stroboscopic effects
- instant start

A consequence of the use of such control gear is that often electrical filters have to be provided to suppress high frequency noise being superimposed on the mains supply. These filters generally consist of series-connected inductors in each live conductor with capacitors connected between the live conductors and the circuit protective conductor. The small filter capacitors connected between the live conductors and the circuit protective conductor result in a small but non-negligible, protective conductor current. Where a large installation incorporates many luminaires, such as a large office block, the resultant protective conductor current, in the earthing conductor for the installation, can add up to a few amperes.

Protective conductor currents can also result from the mains input filters associated with switch-mode power-supplies of IT equipment and other equipment such as photocopiers, fax machines and motorised equipment employing variable speed drives. See figure 1.

IEC 598 gives the maximum value for leakage current as < 0.5 mA for Class 0 and II and 1 mA for Class I luminaires.

Definitions

The current flowing in the protective conductor is often referred to as 'Earth leakage current'. The definition of protective conductor current, from Part 2 of the 16th Edition of BS 7671, is:

Protective conductor current. *Electric current which flows in a protective conductor under normal operating conditions.*

The term Earth Leakage current is no longer defined.

Interestingly, in the 17th Edition of BS 7671, it is planned that protective conductor current will be defined as:

Protective conductor current. *Electric current appearing in a protective conductor such as leakage current or electric current resulting from an insulation fault.*

The definition planned for the 17th Edition represents a clarification, in that both continuous protective conductor current due to normal operation and occasional protective conductor current due to faults are recognized.

Protective conductor current is generally thought of as the difference of the currents flowing in the line and neutral conductors. Typically this is between the current carrying conductors and the case or frame of the electrical device, which is almost inevitably connected to earth.

However protective conductor current may result from currents flowing in interconnecting cables, such as the outer screen of signal cables, that are connected between different ▶

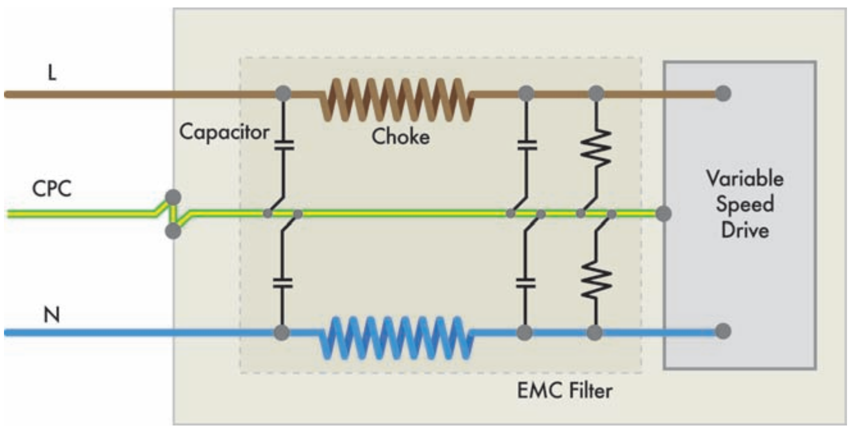


Figure 1: **A typical filter circuit which includes series connected inductors, bypass capacitors and resistors to discharge the capacitors**

◀ items of electrical equipment. See figure 2. The leakage current need not flow via the protective or functional earth. Signal cables coupled to the frame or casing can provide additional routes for protective conductor current flow.

There is a risk of electric shock if a protective conductor becomes disconnected because where the circuit supplies Class I equipment under earth fault conditions there will be no path for the fault current to flow to earth causing operation of the protective device. In addition, the metal case of the item of equipment is likely to remain at an elevated potential presenting a latent risk of shock for someone contacting the case and an item of earthed metalwork, such as a metallic water pipe. Furthermore, where an item of equipment has a protective conductor current, should there be a break in the protective conductor, the metal case of the item of equipment will attain an elevated potential posing a risk of electric shock.

This shock risk is extended to all the items of equipment on the particular circuit, whether they individually have high protective conductor currents or not.

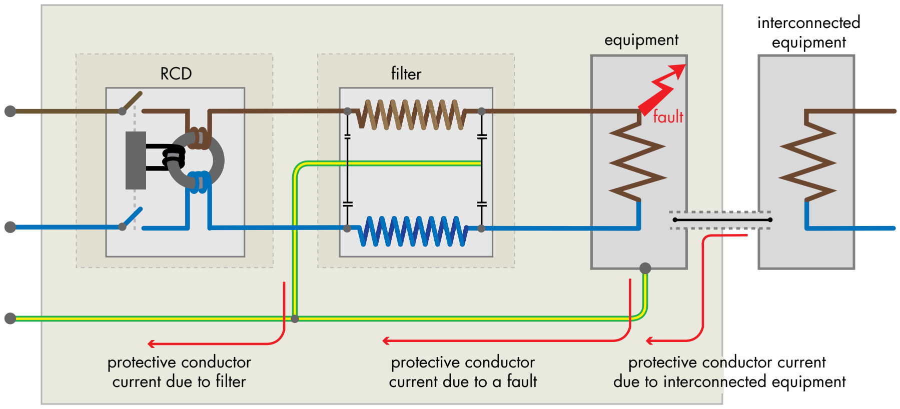
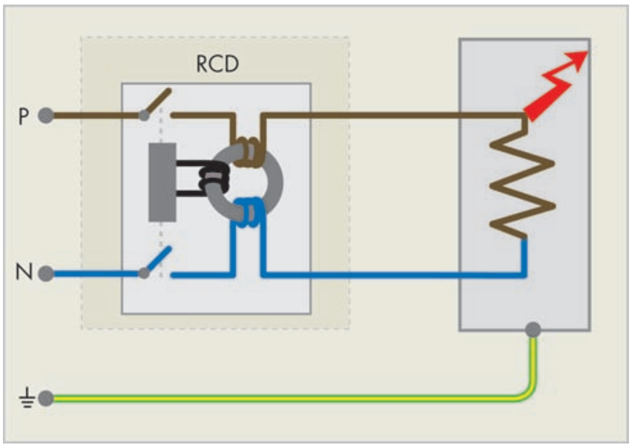


Figure 2: **Protective conductor currents resulting from a filter, a fault or interconnecting cables.**

Figure 3: **RCD operation under fault conditions. The RCD monitors the difference between phase and neutral currents which represents the fault current. The fault current flows in the protective conductor circuit. When this fault current exceeds a predetermined limit, the RCD operates and disconnects the circuit.**



RCD operation. Equipment causing protective conductor currents connected downstream of a residual current device (RCD) can affect the operation of the device.

An RCD operates by monitoring the difference between the line and neutral conductor currents and, when the difference – which represents the earth leakage current – exceeds a predetermined limit, it will operate and disconnect the circuit.

The RCD detects the difference between phase and neutral conductor currents. The difference in the currents may be due to a fault or due to filters in the equipment supplied. The RCD is generally installed for the purpose of detecting an earth fault, providing the circuit is properly designed, as the current resulting from a fault is generally significantly higher than other protective conductor currents.

Design considerations. An installation containing a number of luminaires with electronic switchgear, IT equipment or interconnected equipment can be a cause for concern where RCD protection is required for the respective final circuits.

The installation designer must ensure that the protective conductor current seen by the RCD in normal, fault-free, operation is kept significantly less than that at which the device will operate.

Where it is necessary to specify a residual current device with a residual operating current of 30 mA in order to meet the requirement for additional protection, such as in a socket-outlet circuit, then in order to keep the expected protective conductor currents well below the residual operating current it may be necessary to replace the proposed single circuit by separate circuits each with its own RCD.

Less serious, but equally frustrating, is the effect uncontrolled residual current may have on sensitive equipment which could fail, give false information readings or suffer from noise problems; this could be critical in medical applications.

Technology as we have discussed in this brief article has bought many benefits but as we move to a greener, more sustainable lighting market then adequate provisions must be made by the electrical designers and installers to give sufficient provision to the potential issues raised by the user of new technology in commercial and residential properties. ■