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## **APPLICATIONS NOTES**

# **LEAKAGE CURRENTS IN POWER LINE FILTERS**

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**Approved to ISO9001**

# APPLICATIONS NOTES

## LEAKAGE CURRENTS IN POWER LINE FILTERS

All power line filters normally have capacitance from live to earth and from neutral to earth in order to achieve a high level of asymmetric (common mode) attenuation performance.

### Single Phase Filters

The capacitance from live to earth will conduct a leakage current to earth of 75mA per  $\mu\text{F}$  when used on a 240V 50Hz supply. As most high performance power line filters will have a capacitance to earth of between 10 $\mu\text{F}$  and 100 $\mu\text{F}$ , it can be seen that leakage currents in the order of several amps can be expected to flow through the filter capacitors. This is why it is essential that this type of filter is solidly and permanently earthed to safely carry away these leakage currents.

### Three Phase Filters

In the case of three phase filters, the leakage current is from each phase to earth, and because the leakage currents will be 120 degrees out of phase, they will largely cancel. The resultant leakage current will depend on how well the filter capacitors and the phase voltages are matched. For MPE's 3 phase filters, the resultant leakage current is normally less than 5mA per  $\mu\text{F}$  on each live phase.

### 400Hz Filters

Because of the higher supply frequency, leakage current in line to earth capacitors will be 290mA per  $\mu\text{F}$  for filters operated at 115V 400Hz. As above, there will be some cancellation in three phase filters to give a resultant leakage current in the order of 20mA per  $\mu\text{F}$  for MPE filters. However, it must be remembered that the generator still has to supply the leakage current for each phase as well as its load.

### Filters for Portable Equipment

Some specifications for portable equipment, which may be connected via a plug and socket where the earth integrity cannot be guaranteed, limit the filter capacitance to 5nF. This will limit the leakage current to a much lower level of about 0.4mA but, of course, the filter performance attainable from such filters is greatly reduced because of the capacitance limitation. Other specifications define a maximum permissible leakage current but this again will restrict the filter performance.

### Low Leakage Filters

MPE's Low Leakage Filters have no capacitance from live to earth. In this case the leakage current only flows through the neutral to earth capacitors and so its magnitude is dependent on the capacitance value, the neutral to earth voltage, and the neutral voltage waveform.

The leakage current is 0.314mA per uF per volt on neutral for a 50Hz waveform. As most neutral waveforms have a significant harmonic content, the actual leakage current will be greater than this.

Because the neutral voltage and waveform can not easily be controlled by the user, the precise leakage current can not be defined. However, the main benefit of low leakage filters is that the leakage current is derived from a low source potential i.e. neutral voltage. This type of filter is therefore recommended where safety considerations are paramount.

It should be remembered that RCCB's can not be used on the supply side of even low leakage filters because of switch-on inrush currents and variable harmonic content on the neutral waveform.