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Online Estimation of Intrinsic Parameters of Encapsulated Three-Phase Harmonic Filter Capacitors for IoT Applications

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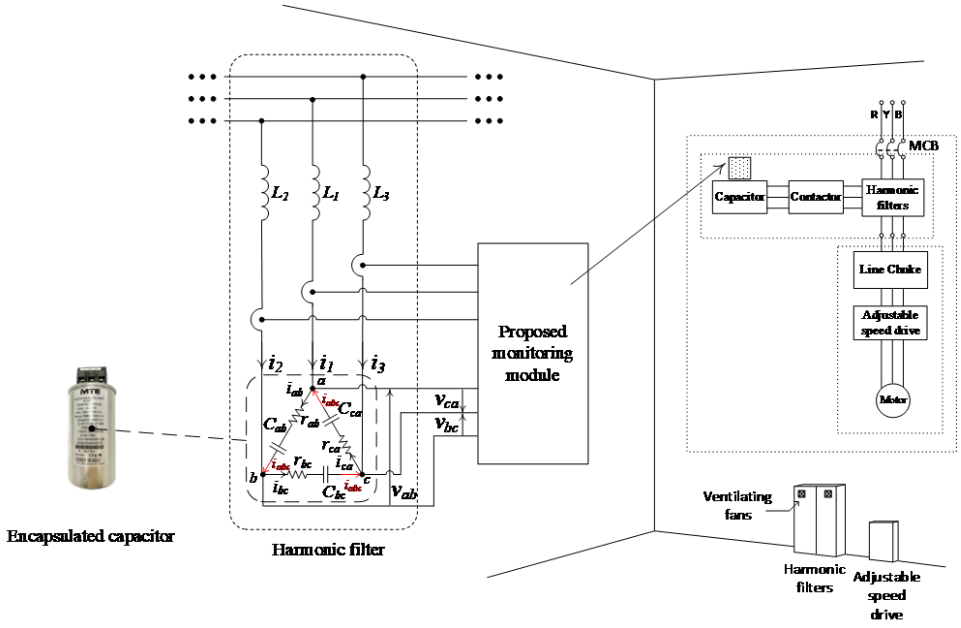

Figure 1. Typical installation of harmonic filter.

IP Status
Patent filed

Technology Readiness Level (TRL) 5

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Opportunity

"Power electronics" is the use of electronic switching devices to efficiently convert and control electrical power. Power electronic systems, such as those in Internet of Things devices, contain input filters to prevent switching noise from contaminating the supply. However, they still generate low-order input current harmonics, causing voltage and current distortion in the distribution network and reducing the power quality of the grid. This is usually caused by the capacitance reduction of filter capacitors, which can lead to the failure of the capacitors. The possibility of failure can be detected through the regular measurement of capacitor voltages. However, detecting the permanent failure of filter capacitors in this manner is neither easy nor accurate using existing mechanisms. Therefore, more accurate technique, involving online estimation of the intrinsic parameters of encapsulated three-phase harmonic filter capacitors, has been developed.

Technology

Researchers have developed a modified particle swarm optimisation (m-PSO) technique and technology for online estimation of the intrinsic parameters of encapsulated capacitors in power electronic systems. First, the line voltage and current associated with the encapsulated capacitor are

sampled. Next, a capacitor current estimator is formulated to estimate the line currents with the sampled line voltages. The errors of the estimated and actual line currents are used to measure the intrinsic parameters with a modified particle swarm optimisation algorithm. In addition, a decoupled technique is formulated to estimate the unmeasurable circulating current in the encapsulated capacitor using the measured line voltages. A prototype for estimating the intrinsic parameters of an encapsulated three-phase capacitor in a harmonic filter has been built and evaluated. The optimal sampling duration and frequency for the application of the proposed technology in IoT devices have also been identified.

Advantages

- The new m-PSO technique offers higher estimation accuracy than its nearest competitor, the Trust-Region-Reflective Least Squares Method.
- More accurate estimation of filter capacitor values in power systems will enable better maintenance of the filters, thus improving the efficiency of filtering switching noise and increasing the power quality of the grid.
- At the optimal sampling duration and frequency identified, the m-PSO technique requires less computational power than existing methods to accurately estimate capacitor values.

Applications

- The high accuracy of the m-PSO technique will ensure the smooth operation and safe operation of harmonic filters, which have numerous industrial applications, such as in UPS systems, data centres and semiconductor production equipment.
- The low computational power requirement of the new technique makes it ideal for use in Internet of Things devices.