BS7671 Amendment 2 - Heat Pump Installations – Type B RCDs

RCCB suitable for HP application

Heat Pumps (HP) producing leakage currents above 1kHz, will not be compatible with Type B RCDs that are only manufactured to meet the lowest requirement of BSEN62423, i.e. operation up to 1kHz.

Type B RCDs rated for use up to 1kHz may trip unexpectedly when subjected to leakage currents above 1kHz, or worse, the detection circuit may be saturated (blinded). This will result in the device not detecting residual currents under fault conditions.

BS7671 offers essential guidance for the installation design for those who have the experience to ask the right questions. If unsure, the "skilled person" will seek the advice of the HP and RCD manufacturers, to verify that the characteristics of the equipment they intend to use are compatible.

Marking the RCCB with HP symbol aids identification on site

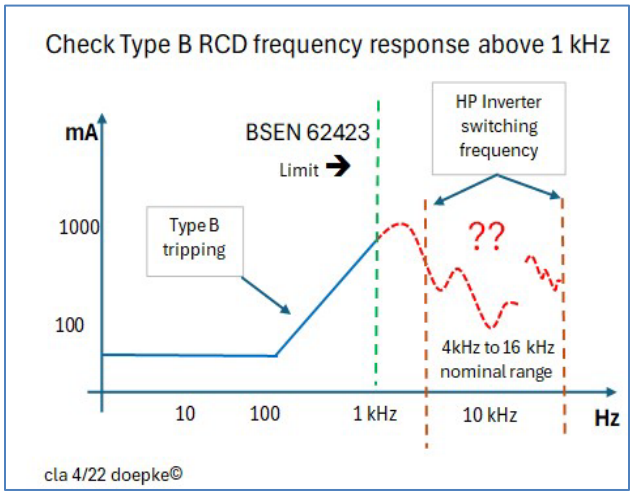
Compatibility of Characteristics – Ref BS 7671

134.1.1 "The installation of electrical equipment shall take account of manufacturers' instructions.

The Domestic Heat Pump Safety Standard BSEN 60335-2-40: 2024+A112024 advises that manufacturers state in their instructions the use of 30mA RCD protection for equipment that is permanently connected to fixed wiring. Check the manufacturers' instructions relating to specification requirements for RCD protection.

Modern HPs contain larger inverters, the characteristics of which must be considered when designing the installation. Installers who have not been involved in commercial or industrial applications may not have had experience with this type of equipment or the application of Type B RCDs.

Type B for use with HPs – Understanding the standards



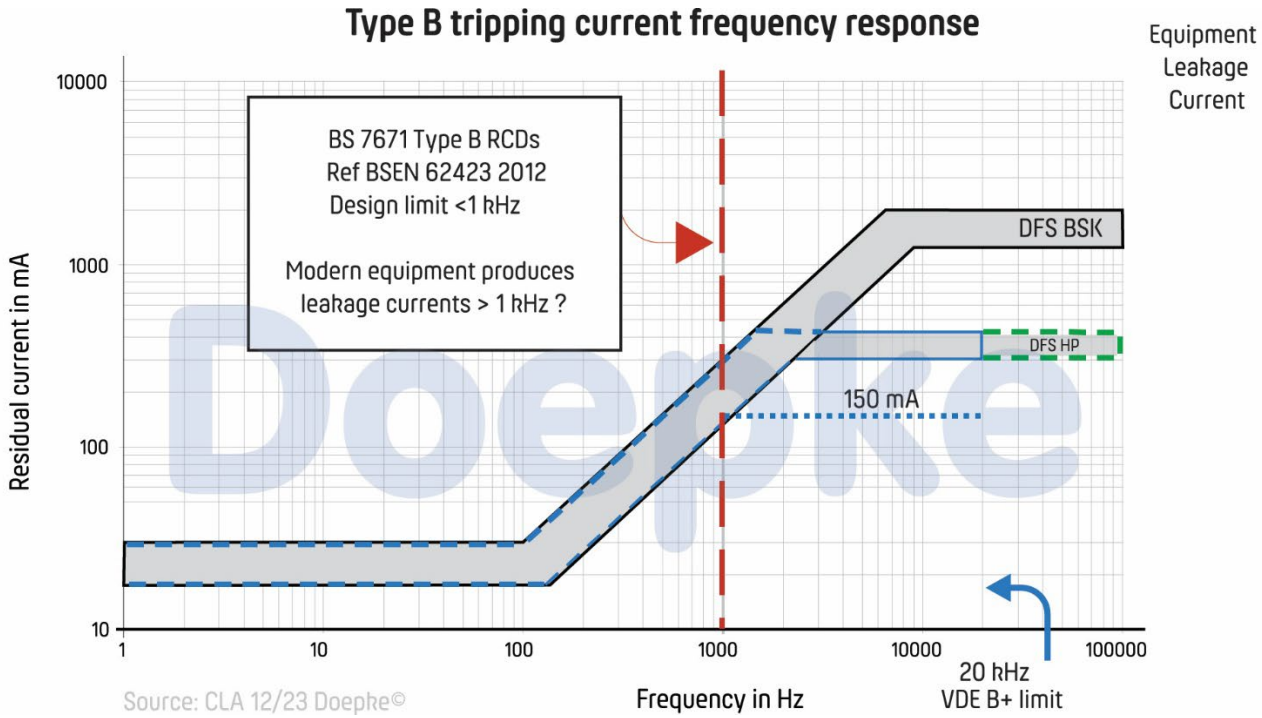
Leakage current in AC circuits is an inherent function of circuit capacitance and increases as a function of frequency. Modern HPs, to improve efficiency, apply inverter technology with switching frequencies in the kHz range.

HP leakage current and the associated harmonic currents must not have a detrimental effect on the protection offered by the RCD, and the RCD should not trip due to normal circuit leakage current.

At the time of writing, BS7671 Appendix 1 refers to BSEN62423 2012 for Type B: To claim compliance, RCDs do not have to work above 1kHz. The VDE standard 0664-400 (B+) sets an upper limit of 20 kHz.*

This is a recognised issue for larger inverter applications, usually associated with non-domestic installations. Doepke and several European manufacturers' Type B RCDs exceed the requirements of the existing BSEN standard and the VDE standard. Consequently, for applications exceeding the 1kHz value (see clause 133.1.1), reference must be made to the individual manufacturer's Type B RCD characteristics and the HP manufacturer's instructions, relating to the compatibility of upstream protection devices.

The diagram below gives an example of two 30mA Doepke Type B characteristics for use with Heat Pumps. Red dashed line shows the existing 1kHz requirement for BSEN 624232). Doepke Type B RCCBs will operate <150kHz, the graph is truncated at 100 kHz to increase the horizontal axis (readability).



- Grey shaded area: Tripping characteristic for DFS. HP and DFS. BSK*
- Blue line: 20 kHz limit of operation for VDE 0664-400 B+
- Green line: DFS HP operating limit 150 kHz
- HP leakage currents > 20 kHz result from incorrect EMC protection or high supply harmonics
- Example: If 150 mA leakage current at say 4kHz flows in the circuit, it should not trip the RCD

**The performance limit for an RCD with regard to frequency, is a function of the quality and properties of the magnetic materials and the design of detection circuits used in the product:*
Characteristics above 1kHz are based on extrapolation of the tripping requirements in 62423 and the advice /limits given in IEC60479-2 thresholds < 150 kHz. The Doepke 30 mA HP & BSK characteristics are within the threshold limits for ventricular fibrillation < 150kHz / IEC60947-2.

Conclusion

Greener homes require more innovative solutions (equipment) than those traditionally associated with domestic installations. This involves consideration of the characteristics of the equipment we intend to supply with electricity.

Manufacturers such as Doepke publish characteristics for their Type B RCCBs; these can be used to verify that they are compatible with the HP model. HP manufacturers who do not clearly state RCD compatibility requirements risk costly rework when things go wrong.

In addition to safety, using inappropriate products in the HP installation will result in system availability problems for the final customer. This, in turn, affects the reputation of the HP brand and the companies involved in the installation.

As with any complex equipment, HP characteristics vary from one manufacturer to another. Consequently, the design of the electrical supply requirements and associated protection devices may differ. This must be considered with the individual site design requirements based on BS7671 and HP manufacturer's recommendations.

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