HEAT PUMP ASSOCIATION

Heat Pump Association

Guidance on Residual Current Device Selection for Heat Pumps

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Endorsed by NAPIT and NICEIC

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Contents

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Introduction

The integration of heat pumps in electrical installations is rapidly growing and represents a key underpinning initiative in the UK Government's commitment to the decarbonisation of heating. This guidance looks at the requirements of BS 7671[1] and some of the considerations for the installer when required to select an appropriate residual current device (RCD) for a heat pump installation.

This guidance is focussed on typical domestic installations[2] although many of the considerations will apply for any heat pump installation. The guidance is intended to be informative for those with an interest in the subject and instructive for those with electrical competence.

There are some circumstances where a circuit supplying a heat pump may not need RCD protection. However, in most cases, such protection is required, but it is not appropriate to mandate one particular type of RCD for all heat pump installations. The appropriate Type must be selected taking account of the particular installation conditions. In most cases the heat pump manufacturer's instructions will specify the type of RCD which should be used, but the following Q&A explores this in more detail.

Seek advice from an appropriately qualified, registered electrical contractor if selecting an RCD where not covered by manufacturers' instructions.

[1] BS 7671:2018 incorporating subsequent amendments A1:2020, A2:2022 and A3:2024

[2] For example, reference is made to consumer units but not distribution boards and the use of time-delayed or Type S RCDs is not covered as these are primarily used in commercial and industrial installations, see the link for further information at the end of the document.

Simple Selection Steps

STEP 1

- **Always take manufacturer's instructions into account:** If RCD protection is required, it is recommended that manufacturer's specifications are followed (see Question 6).

STEP 2

- **Check if RCD protection is required:** Determine if the wiring system and/or method of construction in place or under design are such that the heat pump circuit doesn't require additional RCD protection (see Question 5).

STEP 3

- **Determine RCD Type from equipment operational characteristics:** If the RCD Type is not specified in Step 1, check if the manufacturer's instructions provide details regarding the electrical characteristics which would allow selection from Table 1.

STEP 4

- **Contact the manufacturer if needed:** If no information is available to support Step 3, contact the heat pump manufacturer for additional information before proceeding with the design and installation, to see if a selection can be made from Table 1.

Following the above steps should resolve which type of RCD, if any, is to be used in conjunction with the installation of a heat pump. Where this is not the case refer to Q10.

Table 1: RCD Types appropriate to heat pump installation

RCD Type & BS 7671 Regulation	Supply Characteristics	Further Notes
Type A: Regulation 531.3.3 (ii)	Designed for operation with alternating sinusoidal residual current and on residual pulsing direct current, whether suddenly applied or smoothly increasing. Provides protection for AC residual currents and pulsating DC currents superimposed on smooth DC up to 6 mA.	Type A RCDs are not suitable for applications associated with inverters producing composite residual currents. Heat pump inverters can produce AC leakage currents with frequency components above and below 50 Hz, resulting in mixed frequency composite residual currents which cannot be reliably detected by Type A RCDs.
Type F: Regulation 531.3.3 (iii)	Tripping characteristics are as per Type A RCDs and additionally for composite residual currents whether slowly rising or suddenly applied. RCD Type F tripping is achieved for residual pulsating DC currents superimposed on up to 10 mA smooth DC. Smooth DC current up to 10 mA will not desensitise the RCD.	
Type B: Regulation 531.3.3 (iv)	Tripping is achieved for residual pulsating direct currents superimposed on a smooth direct current up to 10 mA or 0.4 times the rated residual current ($I_{\triangle n}$), whichever is the greater.	Certain types of heat pump may require a Type B RCD with a specific characteristic suited to the product, see “FURTHER INFORMATION” on page 9.

Questions & Answers

1. What is an RCD?

A residual current device (RCD) is a protective device used to disconnect the electrical supply automatically when an imbalance in current flow (the residual current) is detected between Line and Neutral conductors. The device normally operates when the residual current reaches a preset limit. RCDs are primarily intended to give protection against the risk of injury from electric shock and to provide an additional protective measure for insulation faults and fire hazards due to a persistent earth fault current.

2. Why is RCD protection an issue for heat pump installations?

Heat pump inverters can produce AC leakage currents with frequency components above and below 50 Hz together with DC components, resulting in mixed frequency composite residual currents. This cannot be reliably detected by Type A RCDs and, while not always the case, is the reason that heat pump installations typically require the application of Type F or Type B RCDs. The potential for more than one Type of RCD to be suitable is one of the main issues when installing heat pumps.

3. Why are there different types of RCD?

There are different types of RCD to account for the range of characteristics in electrical equipment installed. Each device behaves differently in the presence of DC components and varying frequencies. Table 1 lists the three types that could be appropriate if the circuit selected for the supply of the heat pump installed falls under any of the requirements for RCD protection.

4. Do the Wiring Regulations (BS 7671) have explicit requirements for heat pumps?

BS 7671 (IET Wiring Regulations) does not contain any specific requirements for the installation of RCDs for additional protection on a circuit for a heat pump. The additional requirements are intended for socket-outlets and mobile equipment for use outdoors, and under these circumstances do not apply. Selection of an RCD for a heat pump circuit therefore follows that for other electrical equipment and is covered in the current regulations. The most likely requirement to install an RCD will be because of the type and/or

installation method of the cable supplying the heat pump (regulation group 522.6) and device selection is covered in Regulation 531.3.

The product safety standard BS EN IEC 60335-2-40:2023+A11:2023 covers RCD selection for heat pumps, and can be summarised as follows:

(a) for appliances accessible to the public (for which the maximum leakage current shall not exceed 10 mA) the installation of a residual current device (RCD) having a rated residual operating current not exceeding 30 mA is advisable

(b) for appliances not accessible to the public (for which the maximum leakage current shall not exceed 30 mA) the installation of a residual current device should meet the rated residual operating current specified by the manufacturer.

5. When would a circuit for a heat pump not need RCD selection?

Additional RCD protection is not required where a cable is installed in accordance with one of the methods described in Regulation 522.6.204 indents (i), (ii), (iii) or (iv), where cables in the circuit have mechanical protection to prevent penetration by screws, nails, drilling etc (such as earthed metal armour, metallic conduit or metallic trunking). While this is not typical for existing supplies, it could allow supply design to negate the need for an RCD. However, manufacturer's instructions must be taken into account. Any impact of this approach on product warranty should be understood.

6. When RCD protection is required by BS7671, how should the right type be identified?

Heat pump manufacturers may provide installation information including details for the inclusion of an RCD for heat pump installation. BS 7671 Regulations 134.1.1 and 510.3 both require the installer to take account of the manufacturers' instructions. If the type is specified it is recommended these instructions should be followed and may be required in order to preserve product warranty.

7. Why is Type AC not suitable?

Since the introduction of Amendment 2 (BS 7671:2018+A2:2022), Regulation 531.3.3 has limited the use of type AC RCDs to fixed equipment that contains no DC components within the load current, therefore heat pumps are not compatible with type AC RCDs.

8. What are the consequences of selecting the wrong type of RCD for a particular installation?

Often the first indication that the incorrect Type of RCD has been installed upstream of the heat pump installation is unwanted tripping. For example, using Type A RCDs outside of the design scope could result in such unwanted tripping, or could also result in a failure to operate. Furthermore, powering up and/or powering down the inverter can exceed the transient switch-on limit for Type A RCDs, again resulting in unwanted tripping.

The operational characteristics of a heat pump's inbuilt inverter equipment determines the sensitivity and Type of RCD to be installed upstream. Where fault disconnection within the required time relies on the operation of an upstream RCD (typically in a TT system[3]) using the incorrect Type of RCD in association with a heat pump could lead to 'blinding'[4] of the RCD and a loss of protection. In this case the RCD at the origin and that required for the heat pump will need to be at least of the same type (also see Q11).

9. If the manufacturers' instructions don't specify the RCD type, how should a RCD be selected?

Contact the manufacturer, they may have other documentation or guidance that specifies the RCD type or provides operational characteristics that can be used as follows.

Checks should be made with the heat pump technical specifications to ensure that where required, the correct RCD type is used, as most heat pumps impose high frequency electrical noise within the installation and similarly under fault conditions. The type of connected load and location of the fault will determine the characteristics of the residual current.

If the equipment operational characteristics provide sufficient information, the installer may be able to make a selection from Table 1, this can be used as the basis for the RCD Type.

[3] A 'TT system' is a type of earthing system more common in older properties, see Regulation 312.2

[4] RCD blinding is a phenomenon that occurs when a residual-current device (RCD) is saturated by DC current or exposed to high frequency wave forms, preventing it from operating under fault conditions or reducing its sensitivity.

10. What type should be used if there is no instruction from the manufacturer or available information about the equipment characteristics?

Following the Simple Selection Steps at the start of this guidance should resolve the selection of a suitable Type of RCD, where one is needed.

If this is not the case and equipment design characteristics cannot be guaranteed to meet the requirements associated with Type F limits, Type B RCDs should be used.

This is because it provides protection for the broadest range of characteristics, but as a result they represent the most expensive option.

11. When might an existing RCD need to be changed when installing a heat pump?

It is likely that in many cases there will be an RCD at or near the origin of the DNO incoming supply providing fault protection, typically in a TT system[5]. If a new/separate consumer unit is not fitted for the heat pump supply, this has implications when additional RCD protection is installed downstream and may require changing the RCD at the origin. Specifically:

- If Type B is selected for the heat pump circuit, the upstream RCD must be Type B.
- If Type F is selected for the heat pump circuit, the upstream RCD must be either Type F or Type B.
- If Type A is selected for the heat pump circuit, the upstream RCD must be either Type A, or Type F or Type B.
- Type AC can only be used upstream of the heat pump if no additional RCD protection is needed for the heat pump circuit (see question 5). In addition, BS 7671 Regulation 531.3.3 states that Type AC can only be used where it is known that the load current contains no DC components.

Where a new consumer unit is added for the heat pump supply (see Q12), co-ordination of RCDs should use the same logic as that shown above.

[5] A 'TT system' is a type of earthing system more common in older properties, see Regulation 312.2

12. Can I use an available spare way in the existing consumer unit (CU) for additional RCD protection, or should I add a new CU?

There are a number of factors to consider when answering this question.

If considering using the existing consumer unit there may be space limitations even where there is a spare way. More significantly is the issue of compatibility; the general rule of thumb is that to comply with BS 7671 Regulation 536.4.203, you should not mix-and-match[6] different makes of components in the CU. Although devices can appear similar; the dimensions, technical performance and terminals are not necessarily compatible and mixing products may result in an unsafe installation. It should not be assumed that old and new devices and assemblies from the same manufacturer are compatible, because products are subject to continuous development. It is essential that the CU assembly manufacturer's guidance is sought concerning suitability of any substitution or addition[7].

Introducing a new CU for the heat pump supply is a common solution which can ensure component compatibility and mitigate the issues around RCD co-ordination (see Q11).

FURTHER INFORMATION:

A detailed guide for the selection and application of RCDs systems is available from BEAMA here.

Disclaimer

While the information above has been compiled in good faith, no warranty is given or should be implied for its use and the Heat Pump Association hereby disclaims any liability that may arise from its use to the fullest extent permitted under applicable law.

[6] If introducing a new component does not follow the CU manufacturer's guidance the installer of the component legally becomes the original manufacturer with the corresponding obligations for that assembly.
[7] See: https://www.beama.org.uk/resourceLibrary/beama-technical-bulletin---safe-selection-of-devices-for-installation-in-assemblies.html