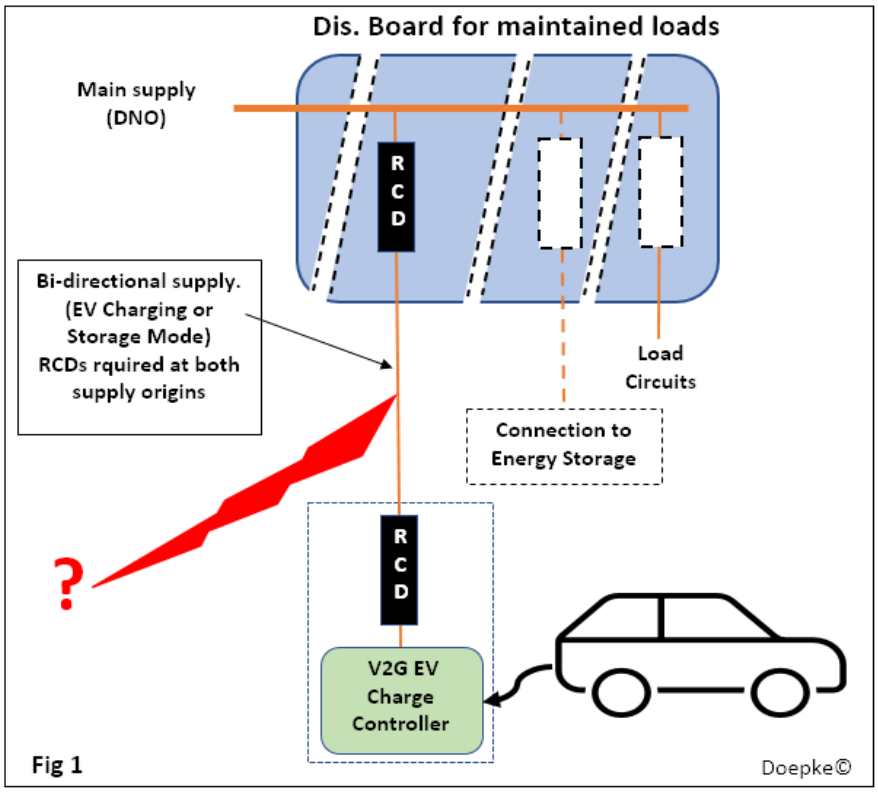
EV Charging: Selectivity between RCDs

Chaz Andrews Doepke Technical Manager – Outlines key points and selection possibilities when connecting RCDs in series for EV installations.

722 Amendment 2 – Design Rules

The IET Code of Practice (CoP) for EV Charging Equipment Installations 4th Edition gives detailed design requirements. Effective and safe design solutions for a specific installation relies on the correct interpretation of the rules e.g. 722.531.3.101 Amd 2 referring to 30 mA RCDs; "*..each charging point ….. shall be protected b*y…." It does not state that the RCD must be in the chargepoint – see Note 3. In Domestic installation with a single Mode 3 charge point, if the design requires a 30mA RCD upstream (see CoP clause 5.6.2), an additional RCD in the chargepoint adds to the operational complexity.

However this does not apply to PEIs containing a V2G or V2H feature i.e. if the vehicle is providing storage - see CoP for EV Charging Installations section 10 and CoP for Electrical Energy Storage Systems section 9: A supply cable with the potential to be fed from either end, requires two 30 mA RCDs to ensure disconnection in the event of a fault - see Fig 1.



Reference CoP EV Charging Installations section 10 Fig 9.8 page 86; based on vehicle to grid / grid to vehicle operating mode, possible location of the fault and the existing installation rules relating to disconnection times for fault protection.

The CoP for Electrical Energy Storage systems Table 9.4 page 98: Specifies safety selection requirements for Types of RCD used in circuits containing Bi-directional inverters. This is applicable to Fig 1 V2G charge controllers.

Consider the guidance given in the associated IET CoPs for safe installation designs, before making a decision on the final design of the installation. With new technologies the "*State of Art*" is an important concept to consider in relation to COPs and the year of publication. Designers are expected to have sufficient and appropriate experience to consider existing advise and any additional available information relating to safety issues, design and equipment / system developments.

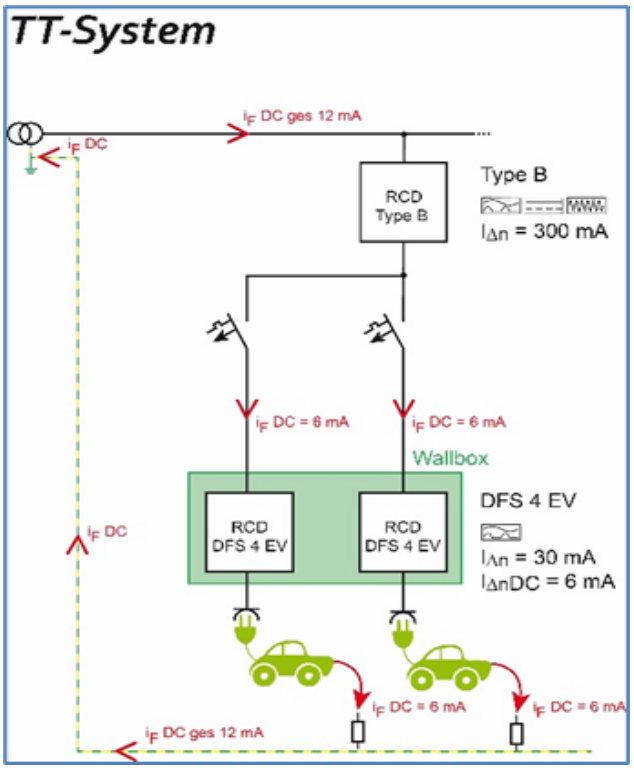


Fig. 2 Type B RCD upstream of two charge points

Different Types of RCD in series

722.531.3.101 Amd 2 Note 1 refers to Regulation 531.3.3; detailing the requirements for selecting Types of RCD, based on the nature of the residual currents e.g. DC components and frequencies flowing through the RCD.

In Fig 2, the upstream RCD will be subjected to the combined residual currents. In this example iFDC would exceed 6 mA up to 12 mA, before one of the chargepoints outputs is switched off.

To meet BS 7671 531.3.3 a Type B RCD is required upstream of two or more chargepoints, as the combined d.c. leakage current can exceed the safe limit specified in the Regulations for the use of Type A or F RCDs – see Fig 3.

Fig 3 details the requirements for the upstream RCD, based on BS7671 722.531.3.101 Note 1 and Regulation 531.3.3; the charging mode, chargepoint design, Type of RCD and N° of chargepoints connected to the feeder circuits containing upstream RCDs.

Charging Method (Chargepoint features)	No. of Chargepoints (Connected to feeder)	Upstream (RCD Type)
Mode 2 + IC-CPD 6 mA or Mode 3 + RDC-DD 6 mA	One	A or F
	Two or more	B
Mode 3 (No RDC-DD)	One	AEV, FEV or B
	Two or more	B
Mode 3 + Type B	One or more	B
Mode 4	One or more	B
Note *Doepke/CLA 4/21*	RDC-DD = Residual Direct Current Detection Device IC CPD = In Cable Control Protection Device	

Fig 3. RCD Selection 722.531.3.101 Note 1 and Regulation 531.3.3

Selectivity

In addition to the RCD Type, selectivity must be considered when installing RCDs in series, specifically with regard to the continuity of supply to other RCD protected services. See CoP Fig 8.1 chargepoints located inside and 8.2 for chargepoints located outside, with the upstream RCD providing fault protection - see BS7671 411.3.2

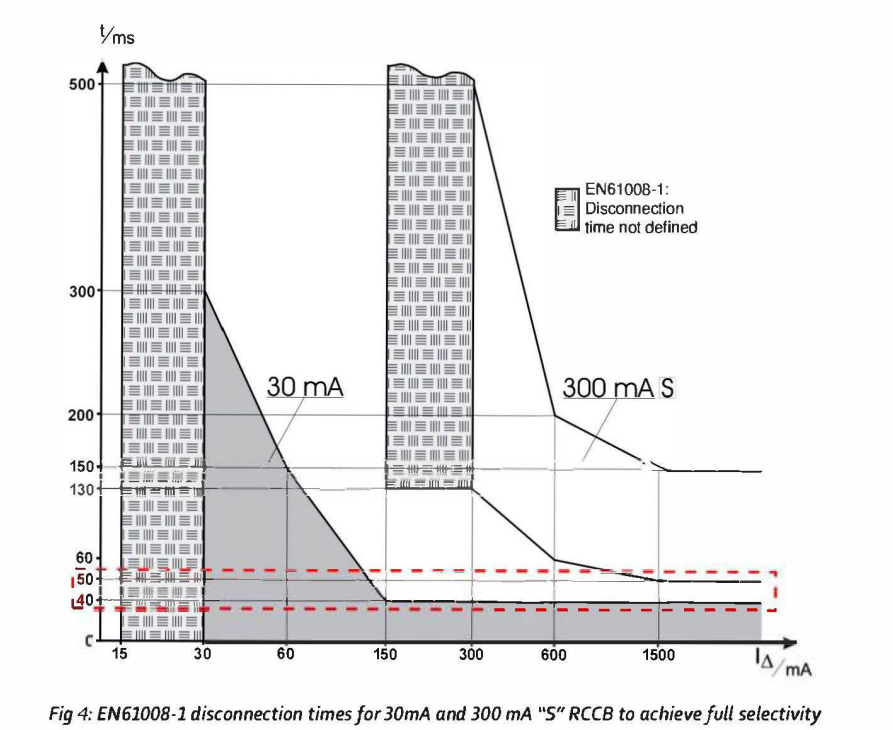


Fig 4: EN61008-1 disconnection times for 30mA and 300 mA "S" RCCB to achieve full selectivity

The product standard BS EN 61008-1 Table 1 specifies a minimum non actuating time of 50 ms* for Selective RCCBs. This is represented graphically in Fig 4; comparing 30 mA general delay and 300 mA selective delay RCCB characteristics.

The 10 ms difference (50-40) is required to achieve full selectivity. Using 100 mA , 100 mA "S" or 300 mA upstream of 30 mA may only achieve partial selectivity under certain residual current fault conditions.

*Note: BS7671 Amd 2 Appendix 3 no longer provides information on RCD time / current characteristics. Refer to manufactures product data sheets for tripping characteristics: Examples;

General Delay ≤ 30 mA RCCB to BS EN 61008-1

Maximum disconnection times	1 · IΔn: ≤ 300 ms; 5 · IΔn: ≤ 40 ms

Selective Delay ≥ 100 mA RCCB to BS EN 61008-1

Non-trip time	50 ms
Maximum disconnection times	1 · IΔn: ≤ 500 ms; 5 · IΔn: ≤ 150 ms
Response delay	1 · IΔn: 130 ms < T ≤ 500 ms; 5 · IΔn: 50 ms < T ≤ 150 ms

Conclusion

Check the EV Manufacturer's chargepoint specification for specific RCD requirements and any additional equipment requirements to meet BS7671. For smaller installations containing multiple chargepoints, it may be cost effective to consider a design using individual feeder circuits with separate RCDs for each charge point. For more complex installations with existing RCD protection on the main incoming supply, consider the design carefully e.g. RCDs, Type and sensitivity already installed, selectivity, possibilities for separate supply etc. Refer to the revised Code of Practice for EV Charging Equipment Installations 4th Edition and Amendment 2 of BS7671. Equipment that fails to at least meet the existing regulations, will not provide the expected level of protection. For further information on RCDs please refer to the Doepke Web Site Product selection pages and Download pages.

Chaz Andrews – Technical Manager, Doepke UK Ltd

***sales@doepke.co.uk* or** www.doepke.co.uk